RSA5100A Series Real-Time Signal Analyzers Printable Help





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- = In North America, call 1-800-833-9200.
- Worldwide, visit <u>www.tektronix.com</u> to find contacts in your area.

Table of Contents

Welcome

Welcome	1
About the Tektronix Signal Analyzer	
Product software	
Accessories	
Standard accessories	
Options	
Options	
Documentation and support	
Video tutorials	

Orientation

Front panel connectors	7
Front-Panel Controls	7
Touch Screen	
Touch-Screen Actions	11
Elements of the Display	13
Rear-Panel Connectors	17
Setting Up Network Connections	17

Operating Your Instrument

Restoring Default Settings	19
Running Alignments	19
Presets	20
Setting Options	26
Operating System Restore	29

Using the Measurement Displays

Selecting Displays	1
--------------------	---

Taking Measurements

Measurements	
Available Measurements	33

General Signal Viewing

Overview

Time Overview	
Time Overview Display	43
Time Overview Settings	45
Navigator View	46
Spectrum	
Spectrum Display	49
Spectrum Settings	51
Spectrogram	
Spectrogram Display	52
Spectrogram Settings	55
Amplitude Vs Time	
Amplitude Vs Time Display	59
Amplitude Vs Time Settings	60
Frequency Vs Time	
Frequency Vs Time Display	60
Frequency Vs Time Settings	62
Phase Vs Time	
Phase Vs Time Display	62
Phase Vs Time Settings	64
RF I & Q Vs Time	
RF I & Q vs Time Display	64
RF I & Q vs Time Settings	65
Common Controls for General Signal Viewing Displays	
General Signal Viewing Shared Measurement Settings	66
Analog Modulation	
Overview	77
AM	
AM Display	77
AM Settings	78
FM	
FM Display	83
FM Settings	85
PM	
PM Display	91
PM Settings	93
RF Measurements	
Overview	101
MCPR	- • •
MCPR (Multiple Carrier Power Ratio) Display	101

MCPR Settings.....

105

Occupie	d BW & x dB BW	
Öccı	upied BW & x dB BW Display	110
	upied BW & x dB BW Settings	112
CCDF		
CCE	DF Display	114
	DF Settings	115
	Time Measurements	
•	ling Time Measurement Overview	116
	Time Displays	
•	ling Time Displays	121
	ling Time Settings	129
	n Controls for Settling Time Displays	
	ling Time Displays Shared Measurement Settings	129
	pectrum Emission Mask)	
· •	1 Display	137
	ctrum Emission Mask Settings	141
-	n Controls for RF Measurements Displays	
RF N	Measurements Shared Measurement Settings	148
WLAN Meas	surements	
		155
	Overview	155
	Chan Response	157
	AN Channel Response Display	157
	AN Channel Response Settings	159
	Constellation	1.00
	AN Constellation Display	160
	AN Constellation Settings	161
WLAN I		1.00
	AN EVM Display	162
	AN EVM Settings	163
	Mag Error	1.64
	AN Magnitude Error Display	164
	AN Magnitude Error Settings	165
	Phase Error	1.00
	AN Phase Error Display	166
	AN Phase Error Settings	167
	Power vs Time	
	AN Power vs Time Display	168
	AN Power vs Time Settings	170
	Spectral Flatness	
	AN Spectral Flatness Display	171
WL	AN Spectral Flatness Settings	172

WLAN Summary	
WLAN Summary Display	173
WLAN Summary Settings	177
WLAN Symb Table	
WLAN Symbol Table Display	178
WLAN Symbol Table Settings	180
Common Controls for WLAN Analysis Displays	
WLAN Analysis Shared Measurement Settings	180
OFDM Analysis	
Overview	191
OFDM Chan Response	
OFDM Channel Response Display	191
OFDM Channel Response Settings	
OFDM Constellation	
OFDM Constellation Display	194
OFDM Constellation Settings	195
OFDM EVM	
OFDM EVM Display	195
OFDM EVM Settings	196
OFDM Flatness	
OFDM Spectral Flatness Display	197
OFDM Spectral Flatness Settings	198
OFDM Mag Error	
OFDM Magnitude Error Display	199
OFDM Magnitude Error Settings	200
OFDM Phase Error	
OFDM Phase Error Display	201
OFDM Phase Error Settings	202
OFDM Power	
OFDM Power Display	203
OFDM Power Settings	204
OFDM Summary	
OFDM Summary Display	205
OFDM Summary Settings	206
OFDM Symb Table	
OFDM Symbol Table Display	
OFDM Symbol Table Settings	208
Common Controls for OFDM Analysis Displays	
OFDM Analysis Shared Measurement Settings	208

Noise Figure and Gain Measurements

Overview	217
Noise Table Display	
Noise Table Display	218
Noise Table Settings	219
Gain Display	
Gain Display	220
Gain Settings	221
Noise Figure	
Noise Figure Display	222
Noise Figure Settings	222
Noise Temperature	
Noise Temperature Display	223
Noise Temperature Settings	224
Y Factor	
Y Factor Display	225
Y Factor Settings	226
Uncertainty Calculator	
Uncertainty Calculator Display	227
Uncertainty Calculator Settings	229
Common Controls for Noise Figure and Gain Displays	
Noise Figure and Gain Measurement Settings	230
Pulsed RF	
	241
Overview Pulse Table Display	241
Pulse Table Display	241
Pulse Table Settings	241
Pulse Trace Display	242
Pulse Trace Display	243
Pulse Trace Display	243 245
Pulse Statistics	243
	245
Pulse Statistics Display Pulse Statistics Settings	243 247
Common Controls for Pulsed RF Displays	24/
Pulsed RF Shared Measurement Settings	248
	240
APCO P25 Analysis	

APCO P25 Analysis	259
Overview	259
P25 Standards Presets	260
P25 Displays	261

P25 Measurements	262
P25 Test Patterns	270
P25 Constellation	
P25 Constellation Display	273
P25 Constellation Settings	275
P25 Eye Diagram	
P25 Eye Diagram Display	275
P25 Eye Diagram Settings	277
P25 Power vs Time	
P25 Power vs Time Display	278
P25 Power vs Time Settings	
P25 Summary	
P25 Summary Display	280
P25 Summary Settings	
P25 Symbol Table	
P25 Symbol Table Display	283
P25 Symbol Table Settings	
P25 Frequency Deviation Vs Time	
P25 Frequency Dev vs Time Display	286
P25 Frequency Dev Vs Time Settings	
Common Controls for P25 Analysis Displays	
P25 Analysis Shared Measurement Settings	289
LTE Analysis	
LTE Analysis	301
Overview	
LTE Standards preset test setups	
LTE displays	
LTE measurements	
LTE Status Messages	
LTE ACLR	517
LTE ACLR display	314
LTE ACLR Settings	
LTE Channel Spectrum	510
*	317
LTE Channel Spectrum display	31/

LTE Channel Spectrum Settings	319
LTE Constellation	
LTE Constellation display	319
LTE Constellation Settings	321
LTE Power vs Time	
LTE Power vs Time display	321
LTE Power vs Time Settings	323

319

Common Controls for LTE Analysis Displays	
LTE Analysis Measurement Settings	323

Bluetooth Analysis

	Division Analysis	341
	Bluetooth Analysis	341 341
	Overview	341 342
	Bluetooth Standards presets	342 345
	Bluetooth displays	
	Bluetooth measurements and test setups	345
	Bluetooth Status Messages	350
	Bluetooth (BT) Constellation	251
	Bluetooth Constellation display	351
	BT Constellation Settings	353
	Bluetooth (BT) Eye Diagram	
	Bluetooth Eye Diagram display	353
	BT Eye Diagram Settings	355
	Bluetooth (BT) CF Offset and Drift	
	Bluetooth Carrier Frequency Offset and Drift display	356
	BT CF Offset and Drift Settings	358
	Bluetooth (BT) Summary	
	Bluetooth Summary display	358
	BT Summary Settings	363
	Bluetooth (BT) Symbol Table	
	Bluetooth Symbol Table display	363
	BT Symbol Table Settings	366
	Bluetooth (BT) Frequency Deviation Vs Time	
	Bluetooth Frequency Dev vs Time display	367
	BT Frequency Dev Vs Time Settings	371
	Bluetooth (BT) 20dB Bandwidth	
	Bluetooth 20dB Bandwidth display	371
	BT 20dB BW settings	373
	Bluetooth (BT) InBand Emission	
	Bluetooth InBand Emission display	374
	Common Controls for Bluetooth Analysis Displays	
	Bluetooth Analysis Measurement Settings	376
Audio	o Analysis	
	Overview	391
	✓ * ♥▲ * ▲♥ **	~ ~ 1

	571
Audio Spectrum	
Audio Spectrum Display	391
Audio Spectrum Settings	392
Audio Summary	

Audio Summary Display	393
Audio Summary Settings	394
Common Controls for Audio Analysis Displays	
Audio Analysis Measurement Settings	394
GP Digital Modulation	
Overview	405
Constellation	
Constellation Display	406
Constellation Settings	407
Demod I & Q vs Time	
Demod I & Q vs Time Display	408
Demod I & Q vs Time Settings	410
EVM vs Time	
EVM vs Time Display	410
EVM vs Time Settings	411
Eye Diagram	
Eye Diagram Display	412
Eye Diagram Settings	414
Frequency Deviation vs Time	
Frequency Deviation vs Time Display	414
Frequency Deviation vs Time Settings	416
Magnitude Error vs Time	
Magnitude Error vs Time Display	416
Magnitude Error vs Time Settings	418
Phase Error vs Time	
Phase Error vs Time Display	418
Phase Error vs. Time Settings	420
Signal Quality	
Signal Quality Display	420
Signal Quality Settings	425
Symbol Table	
Symbol Table Display	426
Symbol Table Settings	427
Trellis Diagram	
Trellis Diagram Display	427
Trellis Diagram Settings	429
Common Controls for GP Digital Modulation Displays	
GP Digital Modulation Shared Measurement Settings	429
Standard Settings Button	430
Symbol Maps	
Symbol Maps	446

User Filters	
Overview: User Defined Measurement and Reference Filters	451
User Filter File Format	452

Marker Measurements

Using Markers	
Using Markers	455
Controlling Markers with the Touchscreen Actions Menu	456
Measuring Frequency and Power in the Spectrum Display	457
Common Marker Actions	
Marker Action Controls	458
Peak	458
Next Peak	458
Marker to Center Frequency	458
Define Markers Control Panel	
Enabling Markers and Setting Marker Properties	458
Markers Toolbar	
Using the Markers Toolbar	460
Noise Markers in the Spectrum Display	
Measuring Noise Using Delta Markers in the Spectrum Display	461

Mask Testing

The Mask Test Tool	463
Mask Test Settings	463
Define Tab (Mask Test)	463
Actions Tab	469

Analyzing Data

Analysis Settings	
Analysis Settings	471
Analysis Time Tab	471
Spectrum Time Tab	473
Frequency Tab	473
Units Tab	476
Analyzing Data Using Replay	
Replay Overview	477
Replay Menu	478
Acq Data	479
Replay All Selected Records	479
Replay Current Record	479
Replay from Selected	479
Pause	480

Stop	480
Select All	480
Select Records from History	480
Replay Toolbar	480

Amplitude Corrections

Amplitude Settings	483
External Gain/Loss Correction Tab	483
External Gain Value	483
External Loss Tables	483

Controlling the Acquisition of Data

Acquisition Controls in the Run Menu	
Continuous Versus Single Sequence	487
Run	487
Resume	487
Abort	487
Acquisition Controls in the Acquire Control Panel	
Sampling Parameters Tab	488
Advanced Tab (Acquire)	489
FastSave	490
FastSave Tab	493
Acquire	493
Using Triggers to Capture Just What You Want	
Triggering	
Triggering	495
Frequency Mask Trigger	498
Mask Editor (Frequency Mask Trigger)	499
Trigger Settings	502
Event Tab	503
Time Qualified Tab	512
Advanced Tab (Triggering)	513
Actions Tab (Triggering)	514

Managing Data, Settings, and Pictures

Saving and Recalling Data, Settings, and Pictures	515
Data, Settings, and Picture File Formats	516
Printing Screen Shots	520

Reference

Online Help	521
Menus	

	Menu Overview	521
	File Menu	
	File Menu	521
	View Menu	
	View Menu	524
	Replay	
	Replay Menu	526
	Markers Menu	
	Markers Menu	526
	Setup Menu	
	Setup Menu	526
	Presets Menu	
	Presets Menu	526
	Tools Menu	
	Tools Menu	526
	Window Menu	
	Window Menu	527
	Help Menu	
	Help Menu	527
Tro	oubleshooting	
	Error and Information Messages	527
	Displaying the Windows Event Viewer	533
Up	grading the Product Software	
	How to Find Out if Software Upgrades are Available	534
Ch	anging Settings	
	Settings	535

Glossary

Index

Welcome

This help provides in-depth information on how to use the RSA5100A Series Real-Time Spectrum Analyzers. For a shorter introduction to the Signal Analyzer, refer to the *RSA5100A Series Real Time Signal Analyzer Quick Start User Manual*. To see tutorial examples of how to use your analyzer to take measurements in different application areas, refer to the *RSA5100A and RSA6100B Series Real Time Signal Analyzer Application Examples Reference*.

Product software

- System software: The RSA5100A Series product software runs on a specially configured version of Windows 7. As with standard Windows 7 installations, you can install other compatible applications, but the installation and use of non-Tektronix software is not supported by Tektronix. If you need to reinstall the operating system, follow the operating system restore procedure provided in <u>Operating System Restore (see page 29)</u>. Do not substitute any version of Windows that is not specifically provided by Tektronix for use with your instrument.
- Product software: The product software is the instrument application. It provides the user interface (UI) and all other instrument control functions. You can minimize or even exit/restart the instrument application as your needs dictate.

Standard accessories

The standard accessories for the instruments are shown below. For the latest information on available accessories, see the <u>Tektronix Web site</u>.

Quick Start User Manual

- English Option L0, Tektronix part number 071-2838-XX
- Japanese Option L5, Tektronix part number 071-2840-XX
- Russian, Option L10, Tektronix part number 071-2841-XX
- Simplified Chinese Option L7, Tektronix part number 071-2839-XX
- English Option L0, Tektronix part number 071-3064-XX
- Japanese Option L5, Tektronix part number 071-3068-XX
- Simplified Chinese Option L7, Tektronix part number 071-3066-XX
- Russian, Option L10, Tektronix part number 071-3070-XX

Application Examples Reference

- English Tektronix part number 071-2834-XX
- Simplified Chinese Option L7, Tektronix part number 071-2835-XX
- Japanese Option L5, Tektronix part number 071-2836-XX
- Russian, Option L10, Tektronix part number 071-2837-XX

Product Documentation CD-ROM

The Product Documentation CD-ROM contains a collection documentation available for your product, in PDF format. See <u>Documentation (see page 5)</u> for a list of the documents included on the CD-ROM.

NOTE. To check for updates to the instrument documentation, browse to <u>www.tektronix.com/manuals</u> and search by your instrument's model number.

Important documents folder

Certificate of Calibration documenting NIST traceability, 2540-1 compliance, and ISO9001 registration

Power cords

- North America Option A0, Tektronix part number 161-0104-00
- Universal Euro Option A1, Tektronix part number 161-0104-06
- United Kingdom Option A2, Tektronix part number 161-0104-07
- Australia Option A3, Tektronix part number 161-0104-05
- 240V North America Option A4, Tektronix part number 161-0104-08
- Switzerland Option A5, Tektronix part number 161-0167-00
- Japan Option A6, Tektronix part number 161-A005-00
- China Option A10, Tektronix part number 161-0306-00
- India Option A11, Tektronix part number 161-0324-00
- No power cord or AC adapter Option A99

Optical wheel mouse

Options

To view a listing of the software options installed on your instrument, select Help > About Your Tektronix Real-Time Analyzer. There is a label on the rear-panel of the instrument that lists installed hardware options.

Options can be added to your instrument. For the latest information on available option upgrades, see Tektronix Web site.

Documentation

In addition to the instrument Help, the following documents are available. Many documents are provided on the documentation CD provided with the instrument. For the most up to date documentation, visit the Tektronix Web site www.tektronix.com/downloads.

- Quick Start User Manual (071-2838-XX English). This manual has information about installing and operating your instrument. This manual is also available in Simplified Chinese (071-2839-XX), Japanese (071-2840-XX), and Russian (071-2841-XX). These manuals are available in both print and a printable PDF file.
- Application Examples Reference (071-2834-XX). This manual provides examples of how to solve problems using an RSA5100A and RSA6100B Series Signal Analyzer. The Application Examples Reference is also available in Simplified Chinese (071-2835-XX), Japanese (071-2836-XX), and Russian (071-2837-XX). These are available in both print and a printable PDF file.
- Programmer Manual (077-0523-XX). This manual provides information to use commands for remotely controlling your instrument. This is available as a printable PDF file.
- Service Manual (077-0648-XX). This manual includes procedures to service the instrument to the module level. This is available as a printable PDF file.
- Specifications and Performance Verification Technical Reference Manual (077-0520-XX). This manual includes both the specifications and the performance verification procedures. This is available as a printable PDF file.
- Declassification and Security Instructions (077-0521-XX) This document helps customers with data security concerns to sanitize or remove memory devices from the instrument. This is available as a printable PDF file.

The most recent versions of the product documentation, in PDF format, can be downloaded from <u>www.tektronix.com/manuals</u>. You can find the manuals by searching on the product name.

Other documentation

Your instrument includes primary and supplemental information on CD-ROM:

Documents CD (Tektronix part number 063-4463-XX)

Video tutorials

You can browse the Tektronix YouTube channel (www.youtube.com/user/tektronix) to find video tutorials about various topics related to your product. You can also subscribe to the Tektronix YouTube channel to keep up with new postings.

Searching for topics

For example, you can watch a video tutorial about using the WLAN Presets. To find a video on this topic, do the following. The following image shows you what the Tektronix YouTube Channel looks like.

1. Click on the search icon located just above the video you see when the page first loads.

NOTE. This icon allows you to search the Tektronix YouTube channel specifically. The search icon located at the top of the page allows you to search all of YouTube.

- 2. Type in the keyword "WLAN" in the search field.
- 3. Click the search icon to start the search.
- 4. Videos related to the topic will appear. Click a video to view it.

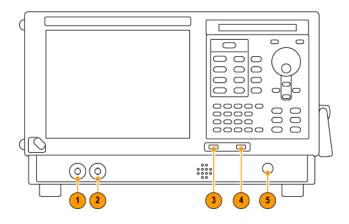
Tektronix		Subscribe
H Videos Discussion About	WLAN	
Tektronix E Subscribe	0 >	How to use an oscilloscope 119,684 views 2 years ago Tony and lan from Tektronix walk through what is an oscilloscope, how to use an oscilloscope, and other oscilloscope basics. You'll see how you might use an oscilloscope to look at an RC circuit, something many engineers encounter early in their studies. From there, learn about the most important oscilloscope controls and how to use them. What is an Oscilloscope? At its heart, an oscilloscope is a device that sho Read more
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Tektronix Tutorials

Tektronix explains the basics about every day test and measurement equipment that play an important role for engineers.

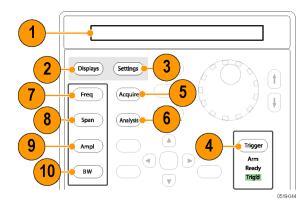


Front panel connectors

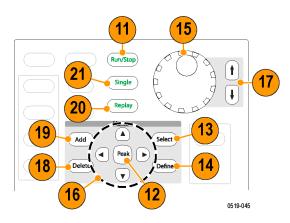


Connector	Description
Trig Out	Trigger output connector. 50 Ω , BNC, High > 2.0 V, Low < 0.4 V, (output current 1 mA).
Trig In	External Trigger input connector, -2.5 V to +2.5 V (user settable).
USB 2.0	USB 2.0 connector.
USB 2.0	USB 2.0 connector.
RF Input	RF input connector 50 Ω .
	Trig Out Trig In USB 2.0 USB 2.0

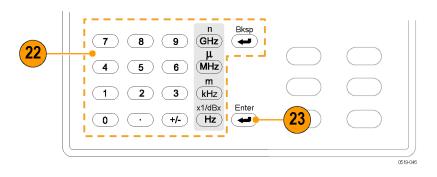
Front-Panel Controls



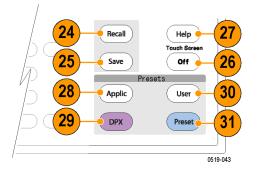
Reference	Item	Function	Menu Equivalent
1	Media	DVD-RW or removable hard disk drive.	
2	Displays	Opens the Displays dialog box enabling you to select which displays to open.	Setup > Displays
3	Settings	Opens/closes the Settings control panel for the selected display.	Setup > Settings
4	Trigger	Opens/closes the Trigger control panel.	Setup > Trigger
5	Acquire	Opens/closes the Acquire control panel.	Setup > Acquire
6	Analysis	Opens/closes the Analysis control panel.	Setup > Analysis
7	Freq	Press to adjust the measurement frequency.	Setup > Analysis > Frequency
8	Span (Spectrum)	Press to adjust the span or press and hold to display the Freq & Span control panel for the General Signal Viewing displays.	
9	Amplitude	Opens/closes the Amplitude control panel.	Setup > Amplitude
10	BW (Spectrum)	Press to adjust the bandwidth or press and hold to display the BW control panel for the General Signal Viewing displays.	



Reference	Item	Function	Menu Equivalent
11	Run/Stop	Starts and stops acquisitions.	Run > Start Run > Stop
12	Peak (Markers section)	Moves the active marker to the maximum peak of the trace in the selected display. If markers are turned off, the marker reference (MR) will appear at the maximum peak.	Markers > Peak
13	Select (Markers section)	Selects the next marker. If markers are turned off, the MR marker (marker reference) will appear.	
14	Define (Markers section)	Opens the Markers control panel. If markers are turned off, the MR marker (reference) will appear.	
15	Control knob	Changes values in numeric and list controls. Pressing the knob (clicking it) is the same as pressing the Enter key on a keyboard.	
16	Arrow keys	Move the Markers. The Up arrow moves the selected marker to the next highest peak. The down arrow moves the selected marker to the next lower peak value. The right and left arrows move the selected marker to the next peak.	
17	Increment/decre- ment keys	Increments or decrements the selected value	
18	Delete, (Markers section)	Deletes the selected marker	
19	Add, (Markers section)	Add a marker to the selected trace	
20	Replay	Replays the current acquisition record	
21	Single	Sets the Run mode to Single Sequence	



Reference	Item	Function	Menu Equivalent	
22	Keypad	Enters values in numeric controls.		
23	Enter	Completes data entry in controls. Same as pressing the Enter key on an external keyboard.		



Reference	Item	Function	Menu Equivalent
24	Recall	Opens the Recall dialog box.	File > Recall
25	Save	Opens the Save As dialog box.	File > Save As
26	Touch Screen Off	Turns the touch screen on and off. It is off when lighted.	
27	Help	Displays the help.	Help > Online Manual
28	Applic	Sets the instrument to the selected Application Preset values.	Presets > Application
29	DPX	Sets the instrument to the selected DPX Preset values.	Presets > DPX
30	User	Sets the instrument to the selected User Preset values.	Presets > User
31	Preset	Returns the instrument to the default or preset values.	Preset

Touch Screen

You can use touch to control the instrument in addition to the front-panel controls, mouse, or extended keyboard. Generally, touch can be used anywhere that click is mentioned in this help.

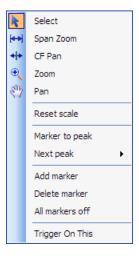
To disable the touch screen, push the front-panel **Touch Screen Off** button. When the touch screen is off, the button is lighted. You can still access the on-screen controls with a mouse or keyboard.

You can adjust the touch screen operation to your personal preferences. To adjust the touch screen settings, from Windows, select **Start** > **Control Panel** > **Touch Screen Calibrator**.

NOTE. If the instrument is powered on in Windows Safe Mode, the touch screen is inoperative. You will need to use a mouse or keyboard to restore normal operation.

Touch-Screen Actions

You can use the touch screen to change marker settings and how waveforms are displayed by using the Touch-screen Actions menu.



To use the Touch-screen Actions menu, touch the display in a graph area and hold for one second, then remove your finger. You can also use a mouse to display the Touch-screen Action menu by clicking the right mouse button.

lcon	Menu	Description
k	Select	Selects markers and adjusts their position.
[↔ •]	Span Zoom	Zooms the graph area about the selected point. Touch the graph display at a point of interest and drag to increase or decrease the span about the point of interest. Span Zoom adjusts the span control and can affect the acquisition bandwidth.
* +	CF Pan	Adjusts the Center Frequency according to horizontal movement.
•	Zoom	Adjusts horizontal and vertical scale of the graph. The first direction with enough movement becomes the primary scale of adjustment. Adjustment in the secondary direction does not occur until a threshold of 30 pixels of movement is crossed.
		Dragging to the left or down zooms out and displays a smaller waveform (increases the scale value). Dragging to the right or up zooms in and displays a larger waveform (decreases the scale value).
Eus .	Pan	Adjusts horizontal and vertical position of the waveform. The first direction with enough movement becomes the primary direction of movement. Movement in the secondary direction does not occur until a threshold of 30 pixels of movement is crossed.
	Reset Scale	Returns the horizontal and vertical scale and position settings to their default values.
	Marker to peak	Moves the selected marker to the highest peak. If no marker is turned on, this control automatically adds a marker.
	Next Peak	Moves the selected marker to the next peak. Choices are Next left, Next right, Next lower (absolute), and Next higher (absolute).
	Add marker	Defines a new marker located at the horizontal center of the graph.
	Delete marker	Removes the last added marker.
	All markers off	Removes all markers.
	Trigger On This	Use to visually define trigger parameters in the DPX display (present only in the DPX Spectrum display).

Touch-Screen Menu for Spurious Display

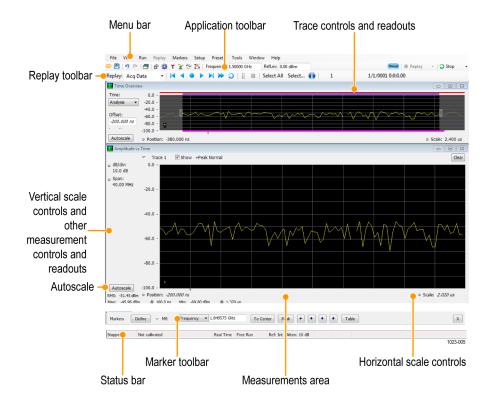
The Touch-screen actions menu in the Spurious display has some minor changes compared to the standard version used in other displays.



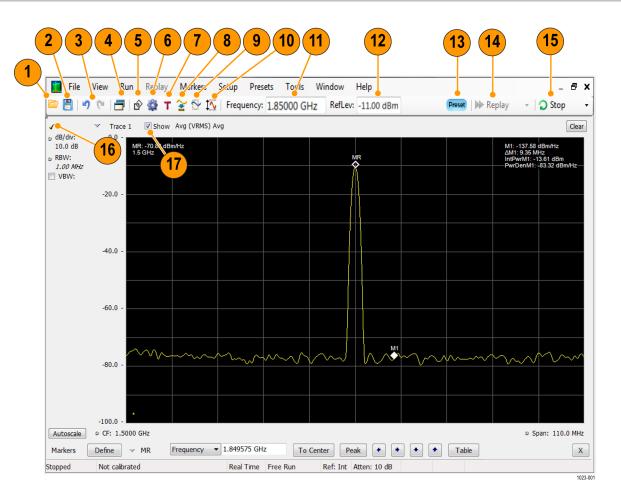
lcon	Menu	Description
-	Single-range	Changes the current multi-range display to a single range display. The displayed range is the range in which you display the touchscreen-actions menu. Selecting Single-range from the menu is equivalent to selecting Single on the Settings > Parameters tab.
-	Multi-range	Changes the current single-range display to a multi-range display. Selecting Multi-range from the menu is equivalent to selecting Multi on the Settings > Parameters tab.
-	Marker -> Sel Spur	Moves the selected marker to the selected spur.

Elements of the Display

The main areas of the application window are shown in the following figure.

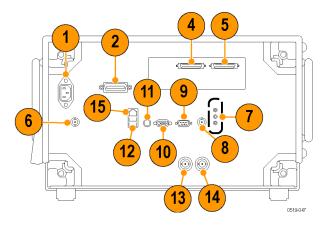


Specific elements of the display are shown in the following figure.



Ref number	Setting	Description	
1	Recall	Displays the Open window in order to recall setup files, acquisition data files, or trace files.	
2	Save	Opens the Save As dialog in order to save setup files, pictures (screen captures), acquisition data files, or export measurement settings or acquisition data.	
3	Undo / Redo	Undoes or redoes the previous edit to a display or measurement settings, a preset, or a measurement change.	
4	Displays	Opens the Select Displays dialog box so that you can select measurement displays.	
5	Markers	Opens or closes the Marker toolbar at the bottom of the window.	
6	Settings	Opens the Settings control panel for the selected display. Each display has its own control panel.	
7	Trigger	Opens the Trigger control panel so that you can define the trigger settings.	
8	Acquire	Opens the Acquire control panel so that you can define the acquisition settings.	
9	Analysis	Opens the Analysis control panel so that you can define the analysis settings such as frequency, analysis time, and units.	
10	Amplitude	Opens the Amplitude control panel so that you can define the Reference Level, configure internal attenuation, and enable/disable the (optional) Preamplifier.	
11	Frequency	Displays the frequency at which measurements are made. For spectrum displays, this is called "Center Frequency". To change the value, click the text and use the front panel knob to dial in a frequency. You can also enter a frequency with the front panel keypad or use the front panel up and down buttons.	
12	Reference Level	Displays the reference level. To change the value, click the text and enter a number from the keypad or use the front panel up and down buttons.	
13	Preset	Recalls the Main (see page 21) preset.	
14	Replay	Runs a new measurement cycle on the last acquisition data record using any new settings.	
15	Run / Stop	Starts and stops data acquisitions. When the instrument is acquiring data, the button label has green lettering. When stopped, the label has black lettering. You can specify the run conditions in the Run menu. For example, if you select Single Sequence in the Run menu, when you click the Run button, the instrument will run a single measurement cycle and stop. If you select Continuous, the instrument will run continuously until you stop the acquisitions.	
16	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display indicates the display for which the acquisition hardware is optimized.	
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.	
		a checkinark, as there is not a single optimized measurement.	

Rear-Panel Connectors



ltem	Description
1	AC Input, main power connector
2	GPIB
4,5	Digital I and Q Outputs (Option 05)
6	+28 V DC Output, switched
7	Microphone in; Headphone, audio output; and Line In connectors
8	External Trigger 2 Input
9	COM 2, serial port for connecting peripherals
10	VGA external monitor output (resolution not limited to VGA)
11	PS2 keyboard input
12	USB 2.0 ports for mouse and other peripherals (printers, external hard disks)
13	Ref Out, reference frequency output
14	Ref In, reference frequency input
15	LAN, Ethernet network connector

Setting Up Network Connections

Because the instrument is based on Windows, you configure network connections for the instrument the same way you would for any PC based on Windows. See **Help and Support** in the Windows **Start** menu to access the Windows Help System for information on setting up network connections.

Restoring Default Settings

To restore the software to its factory default settings:

- 1. Select Presets > Preset Options.
- 2. In the Presets tab of the Options control panel, click to the view the **Preset type** drop down menu and select **Main**.
- 3. Click to the view the Presets drop down menu and select Original.
- 4. Click the red X icon in the top right corner of the Options control panel to close the panel.
- 5. Select **Presets** > **Main** from the menu bar to return the software to its original factory default settings.

NOTE. You can also press the Preset button on the front-panel or click the **Preset** button on the right-hand side of the display menu bar to load the Main preset.

NOTE. The Original Main preset resets all settings and clears all acquisition data (previously recalled waveform files). Settings that have not been saved will be lost.

Running Alignments

Alignments are adjustment procedures. Alignments are run by the instrument using internal reference signals and measurements and do not require any external equipment or connections.

These are the settings for Alignments:

- Automatically align as needed
- Run alignments only when the Align Now button is pressed

If **Automatically align as needed** is selected, alignments run whenever the signal analyzer detects a sufficient change in ambient conditions to warrant an alignment.

If **Run alignments only when "Align Now" button is pressed** is selected, the signal analyzer never runs an alignment unless you manually initiate an alignment using the Align Now button.

NOTE. There are a few critical adjustments that must run occasionally even if Automatically align is not enabled.

Alignment Status

When the signal analyzer needs to run an alignment, it displays a message on screen. If no message is displayed, you can assume that the signal analyzer is properly aligned.

NOTE. If you must use the instrument before it has completed its 20-minute warm-up period, you should perform an alignment to ensure accurate measurements.

Initiating an Alignment

- 1. Select Tools > Alignments.
- 2. Select the Align Now button.

The signal analyzer will run an alignment procedure. Status messages are displayed while the alignment procedure is running. If the instrument fails the alignment procedure, an error message will be displayed. If the instrument fails an alignment, run Diagnostics (Tools > Diagnostics) to see if you can determine why the alignment failed.

Alignments during warm-up. During the 20-minute warm-up period, the signal analyzer will use the alignment data generated during the previous use of the instrument as it warms to operating temperature (if Auto mode is selected). During the specified period for warm-up, the instrument performance is not warranted.

Alignments during normal operation. Once the signal analyzer reaches operating temperature ± 3 degrees C (as detected inside the instrument), an alignment will be run. If an alignment becomes necessary during a measurement cycle (if Auto mode is selected), the measurement is aborted and an alignment procedure is run. Once an alignment procedure is completed, the measurement cycle restarts.

Instruments with an HD option have certain components that require alignment for ± 1 degree C change. In these cases, once the signal analyzer reaches operating temperature ± 1 degree C (as detected inside the instrument), an alignment will be run.

NOTE. The first time the instrument runs after a software upgrade (or reinstall), the instrument will perform a full alignment after the 20-minute warm-up period. This alignment cannot be aborted and it occurs even if alignments are set to run only when manually initiated.

Alignments Are Not Calibrations

Alignments are adjustment procedures run by the instrument using internal reference signals and measurements. Calibrations can only be performed at a Tektronix service center and require the use of traceable test equipment (signal sources and measuring equipment) to verify the performance of the instrument.

Presets

Menu Bar: Presets

The analyzer includes a set of configurations or presets that are tailored to specific applications. These configurations, referred to as Presets, open selected displays and load settings that are optimized to address specific application requirements.

Available Presets

Select **Presets** > **Preset Options** from the menu bar to access the available types of Presets:

- Main
- DPX
- Standards
- Application
- User

You can set if a preset is immediately executed when selected, or if a list of presets is displayed from which you can select the Preset to recall. Available presets are described in the following table.

Presets	Description
Main	
Current	This Preset sets the instrument to display a Spectrum display with settings matched to show a Spectrum display with settings appropriate for typical spectrum analysis tasks. This preset was updated from the original factory preset with version 3.2 of the instrument software.
Original	This Preset is the original factory preset used with software versions 1.0 through 3.2. This version of the factory preset is included to allow users to maintain compatibility with existing remote control software.
)PX	
Open the DPX display	The Open the DPX display opens the DPX display without closing existing displays.
Swept	The DPX Swept Preset displays the DPX Spectrum display with the span set to maximum and the center frequency set to 1/2 the span.
Real Time	The DPX Real Time Preset displays the DPX Spectrum display with the center frequency set to 1.5 GHz and the span set to the maximum available real-time bandwidth.
Zero Span	The DPX Zero Span Preset displays the DPX Zero Span display with the position set to 0 s and the sweep set to 1 ms.
Standards	
WLAN (see page 155)	This preset sets the instrument to display the WLAN Summary, WLAN Constellation, and SEM displays. After you select the standards and bandwidth, the software configures these displays to apply the parameters appropriate for typical WLAN analysis tasks.
P25 (see page 301)	This preset sets the instrument to display the MCPR, Time Overview, P25 Summary, and P25 Constellation displays. After you select the standard and modulation type, the software configures these displays to apply the parameters appropriate for typical P25 analysis tasks.
Bluetooth (see page 301)	This preset set the instrument to display a particular set of displays depending on which combination of standard (Low Energy or Basic Rate) and test setup (one of up to eight) you select. After you select the standard and test setup, the software configures the displays to apply the parameters appropriate for typical Bluetooth analysis tasks.
Application	
Time-Frequency Analysis (see page 25)	The Time-Frequency preset configures the instrument with settings suited to analyzing signal behavior over time.

Presets	Description
<u>Spectrum Analysis (see page 25)</u>	The Spectrum Analysis application preset provide you with the settings commonly used for general purpose spectrum analysis.
Modulation Analysis (see page 23)	The Modulation Analysis setup application preset provides you with the most common displays used during modulation analysis. Only present when Option 21 is installed.
Pulse Analysis (see page 24)	The Pulse Analysis application preset provides you with the most common displays used during pulse analysis, and makes changes to the default parameters to settings better optimized for pulsed signal analysis. Only present when Option 20 is installed.
Spur Search Multi Zone 9k-1GHz	The Spur Search application preset configures the instrument to show the Spurious display with the frequency range set to 9 kHz to 1 GHz.
Phase Noise (see page 24)	The Phase Noise application preset opens the Phase Noise display, and makes changes to the default parameters to settings better optimized for phase noise analysis. Only present when Option 11 is installed.
Noise Figure (see page 26)	The Noise Figure application preset opens the Gain, Noise Figure, and Noise Table displays, and makes changes to the default parameters to settings better optimized for noise figure analysis. Only present when Option 14 is installed.
User	
User Preset 1	This Preset is provided as an example for you to create your own Presets. This preset displays the Spectrum, Spectrogram, Frequency vs Time, and Time Overview displays.
User Preset 2	This Preset is provided as an example for you to create your own Presets. This preset displays the Spurious display configured to test for Spurious signals across four ranges.

Preset Options

Select the **Presets** > **Preset Options** menu to open the Options control panel. This panel allows you to select the following. Once you have chosen these settings, you can access any preset or list of presets from **Presets** on the menu bar.

- **Preset type**: Select the Preset type.
- **Presets**: Select which preset you want to display for that particular preset type.
- Preset action: Recalling Presets results in either of two actions. One action is to immediately execute a Preset. The second action displays a list of Presets from which you select the Preset you want to recall. You can select from Recall selected preset or Show list.

Configuring a User Preset

After you have selected a preset:

- Set the measurement frequency using the front-panel knob or keypad.
- Adjust the span to show the necessary detail.

Recalling a Preset

To recall a preset, select **Presets** and then the desired preset type.

NOTE. You can set which presets to recall from the Presets > <u>Preset Options (see page 22)</u> control panel.

To recall a named (User) preset from the front panel, press the button on the front panel matching the preset type you want to recall. For example, to recall a DPX preset type, press the DPX button.

NOTE. You can also click the Preset button on the right-hand side of the menu bar to load the Main preset.

NOTE. The only Presets recalled by the front-panel Preset button, the Preset icon in the icon bar, and the *RST remote command, are the Main Presets. Application, DPX, Standards, and User Presets can only be recalled using selections in the Presets menu.

Creating User Presets

You can add your own presets to the list that appears in the User Presets dialog box. Configure the analyzer as needed for your application and create a Setup file in C:\RSA5100A Files\User Presets. The name you give the file will be shown in the User Presets list on the Presets tab of the Options control panel. For instructions on how to save a Setup file, see Saving Data (see page 515).

Standards Presets

The Standards presets allow you to recall preconfigured displays for the standards that you select. You can select from the following standards groups.

WLAN: The IEEE wireless LAN (WLAN) standards specify the wireless interface between two wireless clients or a wireless client and a base station. The WLAN presets allow you to access displays preconfigured for the WLAN standards and bandwidths you select.

NOTE. More information is available about WLAN standards <u>here (see page 155)</u>. You can also watch a video tutorial about WLAN Presets at www.youtube.com/user/tektronix. Click <u>here (see page 5)</u> for information about searching the Tektronix YouTube channel for videos.

P25: The Project 25 (P25) TIA-102 standards specify the design of interoperable digital two-way wireless communications products. The P25 presets allow you to access displays preconfigured for the P25 standards you select. You can choose either the Phase 1 (FDMA) standard or the Phase 2 (TDMA) standard.

NOTE. More information is available about P25 standards <u>here (see page 301)</u>.

Modulation Analysis

The Modulation Analysis application preset opens the following displays:

- DPX display: Shows you a continuous spectrum monitoring of the specified carrier frequency.
- Signal Quality: Shows a summary of modulation quality measurements (EVM, rho, Magnitude Error, Phase Error, and others).
- Constellation: Shows the I and Q information of the signal analyzed in an I vs. Q format.
- Symbol Table: Shows the demodulated symbols of the signal.

To use the Modulation Analysis preset (assuming the Preset action is set to Show list in the Presets tab of the Options control panel):

- 1. Select Presets > Application. Select Modulation Analysis and then click OK.
- 2. Set the measurement frequency using the front-panel knob or keypad. Your signal should appear in the DPX display.
- 3. Set the reference level so that the peak of your signal is about 10 dB below the top of the DPX display.
- 4. Set the modulation parameters for your signal. This includes the Modulation Type, Symbol Rate, Measurement Filter, Reference Filter and Filter Parameter. All of these settings are accessed by pressing the Settings button.

For most modulated signals, the Modulation Analysis application preset should present a stable display of modulation quality. Additional displays can be added by using the Displays button, and other settings can be modified to better align with your signal requirements.

Phase Noise

The Phase Noise application preset opens the Phase Noise display.

Pulse Analysis

The Pulse Analysis application preset opens the following displays:

- DPX: The DPX display is opened with the maximum available span.
- Time Overview: Shows amplitude vs. time over the analysis period.
- Pulse Trace: Shows the trace of the selected pulse and a readout of the selected measurement from the pulse table.
- Pulse Measurement Table: This shows a full report for the user-selected pulse measurements.

You can make a selected pulse and measurement appear in the Pulse Trace display by highlighting it in the Pulse Measurement Table. Key pulse-related parameters that are set by the Pulse Analysis application preset are:

- Measurement Filter: No Filter.
- Measurement Bandwidth: This is set to the maximum real-time bandwidth of the instrument (40 MHz in a base instrument or 110 MHz with instruments with Option 110). Note: The label on the "Measurement Bandwidth" setting is just "Bandwidth". Like the main instrument Preset

command and the other application presets, the Pulse Analysis application preset also sets most other instrument controls to default values.

Analysis Period: This is set to 2 ms to ensure a good probability of catching several pulses for typical signals.

To use the Pulse Analysis preset (assuming the Preset action is set to Show list in the Presets tab of the Options control panel):

- 1. Select Presets > Application. Select Pulse Analysis and then click OK.
- 2. Set the Center Frequency control to the carrier frequency of your pulsed signal.
- **3.** Set the Reference Level to place the peak of the pulse signal approximately 0-10 dB down from the top of the Time Overview display.

You may need to trigger on the signal to get a more stable display. This is set up in the Trigger control panel. ("Trig" button). Using the Power trigger type with the RF Input source works well for many pulsed signals.

4. Set the Analysis Period to cover the number of pulses in your signal that you want to analyze. To do this, click in the data entry field of the Time Overview window and set the analysis length as needed.

Spectrum Analysis

The Spectrum Analysis application preset opens a Spectrum display and sets several parameters. The Spectrum Analysis preset sets the analyzer as follows.

Spectrum Analysis : Sets the frequency range to maximum for the analyzer, and sets the RF/IF optimization to Minimize Sweep Time.

To use the Spectrum Analysis preset (assuming the Preset action is set to Show list in the Presets tab of the Options control panel):

- 1. Select Presets > Application. Select Spectrum Analysis and then click OK.
- 2. Set the measurement frequency using the front-panel knob or keypad.
- 3. Adjust the span to show the necessary detail.

Time-Frequency Analysis

The Time-Frequency Analysis application preset opens the following displays:

- Time Overview: Shows a time-domain view of the analysis time 'window'.
- Spectrogram: Shows a three-dimensional view of the signal where the X-axis represents frequency, the Y-axis represents time, and color represents amplitude.
- Frequency vs. Time: This display's graph plots changes in frequency over time and allows you to make marker measurements of settling times, frequency hops, and other frequency transients.
- Spectrum: Shows a spectrum view of the signal. The only trace showing in the Spectrum graph after selecting the Time-Frequency Analysis preset is the Spectrogram trace. This is the trace from the Spectrogram display that is selected by the active marker. Stop acquisitions with the Run button

because its easier to work with stable results. In the Spectrogram display, move a marker up or down to see the spectrum trace at various points in time.

The analysis period is set to 5 ms.

To use the Time-Frequency Analysis preset (assuming that Time-Frequency Analysis is the selected preset on the list of Application Presets and Preset action is set to Recall selected preset):

- 1. Select Presets > Application. Select Time-Frequency Analysis and then click OK.
- 2. When the preset's displays and settings have all been recalled and acquisitions are running, adjust the center frequency and span to capture the signal of interest.
- **3.** Set the Reference Level to place the peak of the signal approximately 0-10 dB down from the top of the Spectrum graph.
- 4. If the signal is transient in nature, you might need to set a trigger to capture it. For more information on triggering in the time and frequency domain, see <u>Triggering (see page 495)</u>.

When the signal has been captured, the spectrogram shows an overview of frequency and amplitude changes over time. To see frequency transients in greater detail, use the Frequency vs. Time display.

The Time-Frequency Analysis preset sets the analysis period to 5 ms. The Spectrum Span is 40 MHz. The RBW automatically selected for this Span is 300 kHz. For a 300 kHz RBW, the amount of data needed for a single spectrum transform is 7.46 μ s. A 5 ms Analysis Length yields 671 individual spectrum transforms, each one forming one trace for the Spectrogram to display as horizontal colored lines. This preset scales the Spectrogram time axis (vertical axis) to -2, which means that the Spectrogram has done two levels of time compression, resulting in one visible line for each four transforms. This results in 167 lines in the Spectrogram for each acquisition, each covering 29.84 μ s.

Noise Figure

The Noise Figure and Gain Measurements application preset opens the following displays:

- Gain: This display shows gain versus frequency of the signal. The gain measurement is the ratio of output power to input power in an amplifier or circuit element.
- Noise Figure: This display shows the noise factor in dB. This measurement can help you assess the low level sensitivity of the DUT. Lower noise figure is found in better performing DUTs. Noise factor is defined as the ratio of the input signal to noise ratio to the output signal to noise ratio (Input SNR/Output SNR).
- Noise Table: This table lists selected measurements in a spreadsheet format, showing the numeric value at step frequencies for Gain, Noise Figure, Y Factor, Noise Temperature, PHot, and PCold.

You can read more about Noise Figure and Gain measurements here (see page 217).

Setting Options

Menu Bar: Tools > Options

There are several settings you can change that are not related to measurement functions. The Option settings control panel is used to change these settings.

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Settings tab	Description
Presets	Use this tab to configure Presets. You can specify the action to take when a preset is recalled and which preset to recall when the Preset button is selected.
Analysis Time	Use this tab to specify the method used to automatically set the analysis and spectrum offsets when the Time Zero Reference (see page 471) is set to Trigger.
Save and Export	Use this tab to specify whether or not save files are named automatically and what information is saved in acquisition data files.
GPIB	Use this tab to set the primary GPIB address for the instrument.
Security	Selecting the Hide Sensitive readouts check box causes the instrument to replace measurement readouts with a string of asterisks.
Prefs	Use this tab to select different color schemes for the measurement graphs and specify how markers to automatically jump to the <u>next peak (see page 459)</u> when you drag them. When this setting is deselected, you can drag a marker to any point on the trace.

Presets

The Presets tab in the Options control panel allows you to specify actions taken when you press the Preset button. You can read more about this tab here (see page 22).

Analysis Time

The Analysis Time tab in the Options control panel is used to specify the method used to automatically set the analysis and spectrum offsets when the <u>Time Zero Reference (see page 471)</u> is set to Trigger. The available settings are:

- Include trigger point Selects an algorithm that uses the measurements to determine how far in advance of the trigger to set the analysis offset. The analyzer tries to ensure that data about the trigger point is included in the analyses.
- Start at trigger point (legacy) The method used by the instrument in prior versions, which sets the Analysis Offset to zero when possible. The analyzer tries to ensure that data following the trigger point is included in the analyses. Use this method if your measurements or procedures depend on past behavior of the Auto Analysis Offset function.

Save and Export

The Save and Export tab allows you to specify whether or not files are saved with an automatically generated name, and how much data is saved in an acquisition data file.

All files. The Automatically increment filename/number function can automatically name saved files by appending a number to a base file name. Use this tab to enable/disable automatic naming of files. For example, if **Automatically Increment Filename Number** is disabled, when you select Save from the File menu, you will have to enter a name for the file.

Acquisition data files. This setting specifies whether saved data files include the entire acquisition record or only the data for the analysis length (a subset of the acquisition record). You can choose from the following:

- IQ records: Includes IQ records
- DPX spectra: Includes DPX spectra
- Both: Includes both IQ records and DPX spectra

You can also select to include an entire IQ record or just the analysis length of it.

TIQ acquisition data files. Specifies which data records to save. You can choose from the following:

- Current acquisition: Saves the current acquisition.
- Current frame: If Fast Frame is enabled, saves only the current frame. The current frame is the one most recently analyzed.
- Selected frames: If Fast Frame is enabled, saves the specified frames.
- All in history: Saves all acquisition records in the history.
- Save TIQ file now: Invokes the Save As dialog box with the Save as type drop-down list set to TIQ.

Security

The Security tab enables you to hide sensitive readouts in displays with readouts, such as the OFDM Summary display.

Prefs

The Prefs tab enables you to set properties that apply to all displays.

Color scheme. The Color scheme setting provides three color schemes for the measurement graphs. The color scheme setting does not change the overall instrument application or Windows color scheme.

- Thunderstorm This scheme displays graphs in shades of blue. This provides a less vibrant color scheme than the default setting.
- Blizzard This scheme displays graphs with a white background to save ink when printing.
- Classic The default setting. This scheme displays the graph area with a black background.

Markers snap to peaks when dragged. When selected, this setting causes makers to automatically jump to the <u>next peak (see page 459)</u> when you drag them. When this setting is deselected, you can drag a marker to any point on the trace.

Operating System Restore

The instrument contains an operating system restore file on a separate partition of the hard drive.

The preferred method to restore the instrument operating system is to use the hard disk restore file.

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CAUTION. Using the restore process reformats the hard drive and reinstalls the operating system. All saved data is lost. If possible, save important files to external media before performing a system restore.

1. Restart the instrument. During the boot-up process you will see the following message at the top of the screen: Starting Acronis Loader... press F5 for Acronis Startup Recovery Manager.

NOTE. To successfully complete the system restore, you must use the Windows version of the Acronis software. Using a generic Macintosh keyboard starts the DOS version of the Acronis software. Do not use a Macintosh keyboard.

- 2. Repeatedly press the F5 key until the Acronis True Image Tool opens. There is a 5-second time period from when the message appears until the instrument proceeds with the normal instrument startup. If the instrument does not open the Acronis application, power off the instrument, then power on the instrument and try again.
- 3. Click Restore.
- **4.** In the Confirmation dialog box, click Yes to restore the instrument operating system, or No to exit the restore process. The restore process takes approximately 30 minutes; the actual time depends on the instrument configuration.

Selecting Displays

Menu Bar: Setup > Displays

Application Toolbar:

Use the Select Displays dialog to choose the displays that appear on the screen.

Choose any combination bel	ow, or use an App	lication Pres	et. Appl	ication Presets
Measurements:	Available displays	:		
General Signal Viewing Analog Modulation GP Digital Modulation RF Measurements OFDM Analysis P25 Analysis Audio Analysis Pulsed RF WLAN Analysis Noise Figure and Gain	Amplitude vs Time RF IQ RF I&Q vs S Time	DPX pectrogram	Frequency vs Time Time Overview	Phase vs Time
Selected displays:				
				Add
Spectrum				Remove
		ſ	ОК	Cancel

To select displays:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. Select one of the choices under Measurements. The measurement chosen determines the choices available in Available displays.
- **3.** Double-click the desired display in the **Available displays** box or select the desired display and click **Add**.
- 4. Click OK.

Interactions Between Displays

Different displays can require different settings, for example acquisition bandwidth, analysis length, or resolution bandwidth, to achieve optimum results. The application automatically adjusts some settings

to optimize them for the selected display. The check mark indicator in the upper, left-hand corner of the display indicates the display for which the application is optimized. Depending on application settings, some displays might stop displaying results if they are not the selected display.

Available Measurements

The automatic measurements available include RF power measurements, OFDM analysis, WLAN analysis, APCO P25 analysis, Bluetooth analysis, audio analysis, analog modulation measurements, digital modulation measurements, noise figure and gain measurements, and pulsed RF measurements.

Power measurements

Measurement	Description
Channel Power	The total RF power in the selected channel (located in the Chan Pwr and ACPR display).
Adjacent Channel Power Ratio (ACPR)	Measure of the signal power leaking from the main channel into adjacent channels.
Multi-Carrier Power Ratio (MCPR)	The ratio of the signal power in the reference channel or group of channels to the power in adjacent channels.
Peak/Avg Ratio	Ratio of the peak power in the transmitted signal to the average power in the transmitted signal (located in the CCDF display).
CCDF	The <i>Complementary Cumulative Distribution Function</i> (CCDF). CCDF shows how much time a signal spends at or above a given power level relative to the average power of a measured signal.

Measurement	Description	
Channel Response	Plots the channel response (magnitude or phase) versus the subcarrier or frequency. Here, the channel refers to all sources of signal frequency response impairment up to the analyzer input, including the transmitter itself, as well as any transmission medium through which the signal travels between the transmitter and the analyzer.	
Constellation	Shows the WLAN signal modulation amplitude and phase in I (horizontal) versus Q (vertical) form. For multicarrier WLAN OFDM signals, the points show all data symbol subcarriers' modulation. For single-carrier 802.11b, each point corresponds to a single modulated chip.	
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.	
Flatness	Ratio of the peak power in the transmitted signal to the average power in the transmitted signal	
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.	
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.	
Power	shows the data symbols' individual subcarrier Power values versus symbol interval (time) and subcarrier (frequency).	

OFDM analysis

WLAN measurements

Measurement	Description	
Channel Response	Plots the channel response (magnitude or phase) versus the subcarrier or frequency. Here, the channel refers to all sources of signal frequency response impairment up to the analyzer input, including the transmitter itself, as well as any transmission medium through which the signal travels between the transmitter and the analyzer.	
Constellation	Shows the WLAN signal modulation amplitude and phase in I (horizontal) versus Q (vertical) form. For multicarrier WLAN OFDM signals, the points show all data symbol subcarriers' modulation. For single-carrier 802.11b, each point corresponds to a single modulated chip.	
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.	
Flatness	Ratio of the peak power in the transmitted signal to the average power in the transmitted signal	
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.	
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.	
Power vs Time	The signal power amplitude versus time. For 802.11b signals, the packet Power-On and Power-Down ramp times are also measured.	
Summary	Shows several measurements of WLAN signal quality.	
Symbol Table	Shows decoded data values for each data symbol in the analyzed signal packet. For OFDM (non-802.11b) signals, results are presented with subcarrier (frequency) indices in the horizontal dimension and symbol (time) intervals in the vertical dimension. For 802.11b signals, the Preamble, Header, and Data (PSDU) symbol values are presented sequentially, with symbol indices in the left column.	

Digital Modulation measurements

Measurements for all modulation types except nFSK, C4FM, OQPSK and SOQPSK

Measurement	Description	
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.	
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.	
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.	
MER (RMS)	The MER is defined as the ratio of I/Q signal power to I/Q noise power; the result is indicated in dB.	
IQ Origin Offset	The magnitude of the DC offset of the signal measured at the symbol times. It indicates the magnitude of the carrier feed-through signal.	
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.	
Gain Imbalance	The gain difference between the I and Q channels in the signal generation path. Constellations with gain imbalance show a pattern with a width that is different form height.	
Quadrature Error	The orthogonal error between the I and Q channels. The error shows the phase difference between I and Q channels away from the ideal 90 degrees expected from the perfect I/Q modulation. Not valid for BPSK modulation type.	
Rho	The normalized correlated power of the measured signal and the ideal reference signal. Like EVM, Rho is a measure of modulation quality. The value of Rho is less than 1 in all practical cases and is equal to 1 for a perfect signal measured in a perfect receiver.	

Measurements for OQPSK and SOQPSK modulation types

Measurement	Description
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.
Offset EVM	Offset EVM is like EVM except for a difference in the time alignment of the I and Q samples. For EVM, I and Q samples are collected at the same time, for every symbol decision point (twice the symbol rate for offset modulations). For Offset EVM, the I and Q symbol decision points are time-aligned before collecting the I and Q samples. In this case, one I and one Q sample is collected for each symbol (half as many samples as the same number of symbols for (non-offset) EVM.
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.
MER (RMS)	The MER is defined as the ratio of I/Q signal power to I/Q noise power; the result is indicated in dB.
IQ Origin Offset	The magnitude of the DC offset of the signal measured at the symbol times. It indicates the magnitude of the carrier feed-through signal.
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.
Gain Imbalance	The gain difference between the I and Q channels in the signal generation path. Constellations with gain imbalance show a pattern with a width that is different form height.
Quadrature Error	The orthogonal error between the I and Q channels. The error shows the phase difference between I and Q channels away from the ideal 90 degrees expected from the perfect I/Q modulation. Not valid for BPSK modulation type.
Rho	The normalized correlated power of the measured signal and the ideal reference signal. Like EVM, Rho is a measure of modulation quality. The value of Rho is less than 1 in all practical cases and is equal to 1 for a perfect signal measured in a perfect receiver.

Measurement	Description
Peak FSK err	Peak value of the frequency deviation error at the symbol point.
RMS FSK Err	RMS value of the frequency deviation error at the symbol point.
Peak Mag Err	The Peak magnitude difference between the measured signal and the reference signal magnitude.
RMS Mag Err	The RMS magnitude difference between the measured signal and the reference signal magnitude.
Freq Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.
Freq Deviation	Frequency distance from the center frequency at the symbol point.
Symbol Rate Error	This compares the user-entered symbol rate to the instrument calculated symbol rate of the analyzed signal.
Symbol Rate	When in Auto-symbol rate, the instrument calculates the symbol rate of the signal and the instrument calculates the error between the user entered value and the instrument calculated value.

Measurements for nFSK modulation types

Measurements for C4FM modulation type

Measurement	Description
RMS Error Magnitude	RMS value of the frequency deviation error at the symbol point.
Carrier Frequency Error	Frequency difference between averaged signal frequency and the center frequency.
Deviation	Frequency distance from the center frequency at the symbol point.
Length	Number of symbols in the analysis area.

Analog Modulation measurements

Measurements for AM modulation

Measurement	Description	
+AM	Positive peak AM value.	
-AM	Negative peak AM value.	
Total AM	Total AM value, which is equal to the peak-peak AM value divided by 2.	

Measurements for FM modulation

Measurement	Description	
+Pk	Positive peak frequency deviation.	
–Pk	Negative peak frequency deviation.	
RMS	RMS value of the frequency deviation.	
Pk-Pk/2	Peak-to-peak frequency deviation divided by 2.	
Pk-Pk	Peak-to-peak frequency deviation.	

Measurement	Description
+Pk	Positive peak phase deviation.
–Pk	Negative peak phase deviation.
RMS	RMS value of the phase deviation.
Pk-Pk	Peak-to-peak phase deviation.

Measurements for PM modulation

Noise Figure and Gain measurements

Measurement	Description	
Noise Temperature This measures thermal noise in the system.		
Y Factor	This measurement method relies on a measurement of Noise Powers. These measurements during the calibration portion of the Y Factor technique are close to the noise floor limit; therefore, a low noise, low level measuring receiver or a spectrum analyzer with a low noise sensitive preamplifier is required.	
Gain	The measures the ratio of output power to input power in an amplifier or circuit element.	
Noise Figure	This measures how much noise is added by an amplifier of other system component. Noise Figure is Noise Factor expressed in dB. Noise factor is defined as the ratio of the input signal to noise ration to the output signal to noise ratio (Input SNR/Output SNR) for a reference load at an equivalent source noise temperature of 290K.	
Uncertainty	Shows the uncertainty in noise and gain measurements and also provides values showing the contribution of various elements to the overall uncertainty.	

APCO P25 measurements

Measurement	Description
RF output power	Measure of RF output power when the transmitter is connected to the standard load during defined duty cycle.
Operating frequency accuracy	Measure of the ability of the transmitter to operate on its assigned frequency.
Unwanted emissions (ACPR)	Ratio of the total power of a transmitter under prescribed conditions and modulation to that of the output power that falls within a prescribed bandwidth centered on the nominal frequency of adjacent channels.
Frequency deviation	Measurement of the amount of frequency deviation that results for a Low Deviation and High Deviation test pattern.
Modulation fidelity	Measures the degree of closeness to which the modulation follows the ideal theoretical modulation determined by the rms difference between the actual deviation and the expected deviation for the transmitted symbols.
Symbol rate accuracy	Measures the ability of the transmitter to operate at the assigned symbol rate (4.8 kHz for Phase 1, 6 kHz for Phase 2).
Transmitter power and encoder attack time	Measures the time required for a transmitter to prepare and transmit information on the radio channel after changing state from standby to transmit (applies to conventional mode).
Transmitter power and encoder attack time with busy/idle operations	Measures the time required for a transmitter to prepare and transmit information on the radio channel after the receiving channel changes state from busy to idle.

Measurement	Description	
Transmitter throughput delay	Measures the time it requires for audio changes in the microphone to be encoded and transmitted over the air.	
Transient frequency behavior	Measures the difference of the actual transmitter frequency and assigned transmitter frequency as a function of time when the RF output power is switched on or off.	
HCPM transmitter logical channel time alignment	Measures the ratio of total transmitter power under prescribed conditions and modulation to the peak power that falls in a prescribed bandwidth centered on the nominal frequency of the adjacent channel during the transmitter power ramping interval.	

Bluetooth measurements

Measurement	Description	
Modulation characteristics	Verifies that the modulation characteristics of the transmitted signal are correct. This measurement can only be done if the payload has the bit pattern 10101010 or 11110000.	
Carrier frequency offset and drift	Verifies that the carrier frequency offset and carrier drift of the transmitted signal is within the specified limits for the Basic Rate and Low Energy standards. This test can be done only if the payload contains 10101010 bit pattern.	
Output power	Verifies the maximum peak and average power emitted from the EUT. The standard recommends this test be done for a PRBS payload pattern.	
In-band emission / ACPR	Verifies that the in-band spectral emission is within limits. The standard document recommends that this measurement be done with Hopping off, finding the integrated power in 1 MHz band (with RBW 100 kHz) in 80 channels starting from 2401 MHz to 2481 MHz. The integrated power values calculated in the adjacent channels are compared against recommended limits (except the three channels around transmitted frequency). This measurement is referred to as ACPR in the Basic Rate standards document.	
20 dB bandwidth	Verifies if the emissions inside the operating frequency range are within limits. This measurement is done with Hopping off. The difference between frequency points at which the power level drops to 20 dB below the peak power of the emission is found as 20 dB bandwidth.	
Frequency range These measurements verify if the emissions inside the operating frequency ran within the limits.		
Power density	This measurement verifies the maximum RF output power density.	
Out-of-band spurious emission	This measurement can be done for FCC or ETSI masks using the Spurious display.	
Relative power	Verifies the relative power in the GFSK and PSK part of the Enhanced Data Rate signal. This measurement is supported only when an Enhanced Data Rate signal is detected.	

LTE measurements

Measurement Description	
Cell ID detection	The Cell ID is detected from the input LTE signal.
	For TDD and FDD.
Adjacent Channel Leakage Ratio (ACLR)	The Adjacent Channel integrated power is calculated and shown. The relative power compared to the reference signal is also computed. The computed power is compared against limits suggested by the selected standard and pass/fail is reported. For TDD and FDD.

Measurement	Description	
Channel Power	The channel power is calculated in the channel bandwidth.	
	For TDD and FDD.	
Occupied Bandwidth	The Occupied bandwidth is calculated as bandwidth containing 99% of the total integrated power in the selected span around the selected center frequency.	
	For TDD and FDD.	
Operating Band Unwanted Emission	The power in the offset regions is calculated and presented and compared against limits set in the offset and limits table and pass/fail is reported.	
	For TDD and FDD.	
T _{OFF}	The power in off-slot region is computed and compared against selected limits.	
	For TDD only.	

Pulse measurements

Measurement Description		
Average ON Power	The average power transmitted during pulse on.	
Peak Power	Maximum power during pulse on.	
Average Transmitted Power	The average power transmitted, including both the time the pulse is on and the time it is off, and all transition times.	
Pulse Width	The time from the rising edge to the falling edge at the -3 dB / -6 dB level (50%) of the user selected 100% level. Level is user selectable for Volts or Watts.	
Rise Time	The time required for a signal to rise from 10% to 90% (or 20% to 80%) of the user selected 100% level.	
Fall Time	The time required for a signal to fall from 90% to 10% (or 80% to 20%) of the user selected 100% level.	
Repetition Interval	The time from a pulse rising edge to the next pulse rising edge.	
Repetition Rate	The inverse of repetition interval.	
Duty Factor (%)	The ratio of the width to the pulse period, expressed as a percentage.	
Duty Factor (Ratio)	The ratio of the pulse width to the pulse period.	
Ripple	Ripple is the peak-to-peak ripple on the pulse top. It does not include any preshoot, overshoot, or undershoot. By default, the first 25% and the last 25% of the pulse top is excluded from this measurement to eliminate distortions caused by these portions of the pulse.	
	If the Amplitude units selected in the Amplitude panel (affects all amplitude measurements for the analyzer) are linear, the Ripple results will be in %Volts. For log units, the Ripple results will be in %Watts. The default for the general Units control is dBm, so the Ripple results default is %Watts.	
	See also <u>Ripple (see page 548)</u> .	
Ripple dB The Ripple measurement expressed in dB.		
Droop	Droop is the power difference between the beginning and the end of the pulse On time. A straight-line best fit is used to represent the top of the pulse. The result is a percentage referenced to the Average ON Power.	
Droop dB	The Droop measurement expressed in dB.	

Measurement	Description
Overshoot	The amount by which the signal exceeds the 100% level on the pulse rising edge. Units are %Watts or %Volts.
Overshoot dB	The Overshoot measurement expressed in dB.
Pulse-Pulse Phase Difference	The phase difference between the selected pulse and the first pulse in the analysis window. The instantaneous phase is measured at a user-adjustable time following the rising edge of each pulse.
Pulse-Pulse Freq Difference	The difference between the frequency of the current pulse and frequency of the previous pulse. The instantaneous frequency is measured at a user-adjustable time following the rising edge of each pulse.
RMS Freq Error	The RMS Frequency Error measurement is the RMS average of the Freq Error vs. Time trace, computed over the Measurement Time.
Max Freq Error	The maximum frequency error is the difference between the measured carrier frequency of the signal and the user-selected center frequency of the analyzer.
RMS Phase Error	The RMS Phase Error measurement is the RMS average of the Phase vs Time trace, computed over the Measurement Time.
Max Phase Error	The phase is measured at each point during the pulse's ON time. The phase error for each point is the difference between the measured phase value and the calculated ideal phase value. After the phase error is calculated for all points in the acquisition record, the largest error in the positive direction and the largest in the negative direction are determined. Whichever of these two values has the greater absolute value is designated the Max Phase Error.
Freq Deviation	The Frequency Deviation measurement is the difference between the maximum and minimum measured values of the signal frequency during the Measurement Time.
Delta Frequency (Non-chirped pulse)	The Delta Frequency measurement is the difference from the measurement frequency to each pulse frequency. Pulse frequency is calculated across the time defined by the Frequency Domain Linearity setting in the Define tab.
	The measurement is available for modulation types CW (Constant Phase), CW (Changing phase). and Other (manual) setting in the Freq Estimation tab.
	The measurement is not specified for chirp or other signals and no answer is returned when frequency estimation is set to Chirp.
	If frequency estimation is set to Other, then Frequency Offset must be set to 0 Hz and the Range can be set to \pm 40% of the acquisition bandwidth.
	A least-square fit of slope of phase vs. time over the measurement period is used for the measurement of the individual pulse frequency. Frequency difference is calculated as the difference between the reference frequency and the calculated frequency of the pulse.
Phase Deviation	The Phase Deviation is the difference between the maximum and minimum Phase values measured during the ON time of a pulse.
Impulse Response Amplitude	The difference in dB between the levels of the main lobe and highest side lobe.
Impulse Response Time	The difference in time between the main lobe and highest side lobe.
Time	This is the time in seconds relative to the time reference point in the first acquisition record in the data set.

Overview

The displays in General Signal Viewing (Displays > Measurements > General Signal Viewing) are:

- Amplitude vs Time
- Frequency vs Time
- Phase vs Time
- RF I & Q vs Time
- Spectrogram
- Spectrum
- Time Overview

These displays provide extensive time-correlated multi-domain views that connect problems in time, frequency, phase and amplitude for enabling you to more quickly understand cause and effect when troubleshooting.

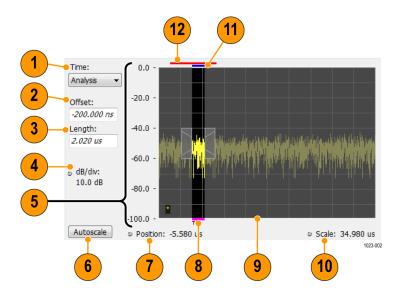
Time Overview Display

The Time Overview display shows the entire acquisition record and shows you how the spectrum time and analysis time fit within the acquisition record. This enables you to see how you can adjust the spectrum time and analysis time to measure portions of the data.

You can specify the maximum number of trace points in the Time Overview display. You can set the maximum number of trace points to 1K, 10K, 100K, 1M points or to Never decimate. If the Acquisition Length includes more than 10,000 sample points (and Max trace points is not set to Never decimate), the trace is decimated (using the +Peak method, similar to +Peak detection in a Spectrum display) to 10,000 points. This decimated trace is what is used for marker measurements.

The Time Overview window displays the Spectrum Length and Analysis Length. The Spectrum Length is the period of time within the acquisition record over which the spectrum is calculated. The Analysis Length is the period of time within the acquisition record over which all other measurements (such as Amplitude vs. Time) are made. The Spectrum Length and Analysis Length can be locked together so that the data used to produce the Spectrum display is also used for measurement displays; however, they do not have to be tied together. They are by default specified separately and used to analyze different parts of the acquisition record.

Elements of the Time Overview Display



ltem	Element	Description
1	Time	Select the type of time analysis to be performed. You can select Analysis, Spectrum, or Linked.
2	Offset	Sets the offset of the selected analysis time control.
3	Length	Sets the length of the selected analysis time control.
4	Position and Scale	Adjusts the vertical scale and position.
5	Scale indicators	Shows the vertical scale.
6	Autoscale button	Resets the horizontal scale to display the entire acquisition record and the vertical scale to show all trace points.
7	Horizontal offset	Adjusts the horizontal offset.
8	Results Timeline	This fuchsia line indicates the portion of the record actually used for calculating the selected result. For example: if a pulse measurement is selected, it shows the period of the specific pulse. For a constellation display, it shows the points included in the demodulation.
9	Amplitude vs. Time graph	The trace represents the entire acquisition record (at full horizontal scale). The graph indicates the Analysis Length or Spectrum Length on the graph with a darker background.
10	Horizontal Scale	Adjusts the span of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the acquisition record by adjusting the offset.
11	Spectrum Length and Offset Indicator (red line, top of graph)	This red line indicates the Spectrum Length and Offset. The longer the time, the longer the bar. Adjusting the offset shifts the bar left or right.
12	Analysis Length and Offset Indicator (blue line, top of graph below red line)	The blue line indicates the Analysis Length and Offset. The longer the time, the longer the bar. Adjusting the offset shifts the bar left or right.

NOTE. The area with black background (not gray) in the Amplitude vs. Time Graph highlights the control selected in the Analysis Time Control drop-down list.

Changing the Time Overview Display Settings (see page 45)

Time Overview Settings

Menu Bar: Setup > Settings

Application Toolbar: 鄻

The Setup settings for Time Overview are shown in the following table.

Settings tab	Description
Scale (see page 73)	Adjusts the vertical and horizontal scale and offset of the display.
Trace (see page 47)	Allows you to select the types of trace to display and its function.
Prefs (see page 74)	Specifies whether or not certain display elements are shown.

Navigator View

The Time Overview Navigator View places the Time Overview display across the top of the application screen. This allows you to adjust the area of interest in the Navigator View and see the results simultaneously in the other displays. For example, in the following image, adjusting the mask in the Navigator View moves the trace and markers in all of the other displays.



Show Navigator View

To show the Navigator View, select **View** > **Navigator View**. To remove the Navigator View, deselect Navigator View in the View menu.



Trace Tab

The Trace Tab allows you to set the display characteristics of displayed traces.

Scale Trace Prefs			
	Show	E Freeze	Save Trace As
Detection: +Peak -	🔽 Count		Show recalled trace
Function: Avg (VRMS) 🔻	10]	

Description
Shows / hides the selected trace.
Sets the Detection method used for the trace. Not available for saved traces. Available detection methods are +Peak, -Peak, +/-Peak, Avg (VRMS), and Sample. Not all detection methods are available in all displays.
Selects the trace processing method. Available settings are: Normal, Average, Max Hold, and Min Hold.
Sets the number of traces averaged to generate the displayed trace. (Present only when Function is set to Average.)
Halts updates to the selected trace.
Saves the selected trace to a file for later recall and analysis.
Displays a saved trace instead of a live trace.

Detection

Trace Detection occurs when the trace is being decimated by the measurement. For example, if the maximum number of trace points is 100,000, and the selected analysis region is 200,000 samples, the measurement must decimate the 200,000 resulting trace points by 2 to prevent exceeding the 100,000 trace point limit. Since only one value can be selected for each trace point, an algorithm must be used to select (detect) the appropriate value to use.

The IQ samples in a data acquisition can be detected in a variety of ways. The number of IQ samples available to each trace point varies with both analysis length and trace length. For example, with Spectrum Length set to 'Auto' in the Analysis menu, the instrument analyzes just enough samples to produce one IQ sample pair per trace point. In this case, the detection method chosen has very little effect, as the +Peak, -Peak, Avg (VRMS) and Sample values are all equal. Changing the Spectrum Length causes the available detection methods to differ in value because they have a larger set of samples for the various detection methods to process.

The available detection methods (depending on the display) are:

- +Peak Each point on the trace is the result of detecting the positive peak value present in the set of IQ samples available to that trace point.
- -Peak Each point on the trace is the result of detecting the negative peak value present in the set of IQ samples available to that trace point.
- +/-Peak Selects the highest and lowest values of all the samples contained in two consecutive acquisition intervals.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the IQ samples available to the trace point. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results. When the averaging function is applied to a trace, the averaging is performed on the linear (Voltage) values, resulting in the correct average for RMS values.
- Sample The result is calculated based on the first sample available in the set of IQ samples for each trace point.

Trace Processing

Traces can be processed to display in different ways. The Function setting controls trace processing.

- Normal Each new trace is displayed and then replaced by the next trace. Each data point contains a single vertical value.
- Average Multiple traces are averaged together to generate the displayed trace. There is one vertical value for each underlying frequency data point. Once the specified number of traces have been acquired and averaged to generate the displayed trace, each new trace takes the place of the oldest trace in the calculation. The **Number of Traces** setting specifies how many traces averaged.
- Max Hold Displays the maximum value in the trace record for each display point. Each new trace display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons.
- Min Hold Displays the minimum value in the trace record for each display point. Each new trace display point is compared to the previous minimum value and the lesser value is retained for display and subsequent comparisons.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save icon . This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Select the trace into which the recalled trace will be loaded, from the Trace drop-down list.
- 2. Check the Show check box.
- 3. Click the ... button to display the Open dialog box.

Show recalled trace	

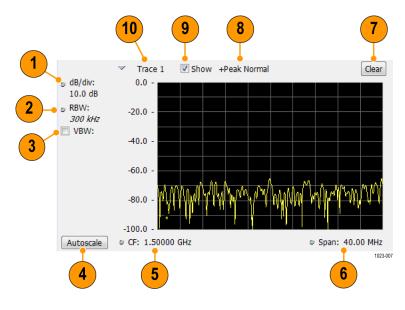
- 4. Navigate to the desired file and click Open.
- 5. Check the Show Recalled Trace check box.
- 6. Verify that the trace's **Show** check box is selected (either on this tab or next to the drop-down list located at the top-left corner of the graph).

Spectrum Display

To display a spectrum:

- 1. Click the **Displays** button or select **Setup** > **Displays**.
- 2. From the Measurements box, select General Signal Viewing.
- **3.** Double-click the **Spectrum** icon in the **Available displays** box. This adds the Spectrum icon to the **Selected displays** box (and removes it from the Available displays box). Alternatively, you can click the Spectrum icon and then click the Add button to select Spectrum for display.
- 4. Click the **OK** button.

Elements of the Spectrum Display



ltem	Display element	Description	
1	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.	
2	RBW	Sets the resolution bandwidth. Note that when the RBW is set to Auto, its value is italicized.	
3	VBW	Enables the VBW (Video Bandwidth) filter. See Setup > Settings > <u>BW Tab</u> (see page 71).	
4	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen.	
5	Position	Default function is CF - center frequency (equivalent to the Freq setting). If Horizontal scaling has been manually adjusted in Settings > Scale, then Offset will replace CF as the setting at the bottom-left corner of the screen.	
6	Span / Scale	Default function is Span - frequency difference between the left edge of the display and the right edge. If Horizontal scaling has been manually adjusted in Settings > Scale, then Scale will replace Span as the setting at the bottom-right corner of the screen.	
7	Clear	Restarts multi-trace functions (Avg, Hold).	
8	Function	Readout of the Detection and Function selections for the selected trace.	
9	Show	Controls whether the selected Trace is visible or not. When trace is Off, the box is not checked.	
10	Trace	Selects a trace. Touching here pops up a context menu listing the available traces, whether they are enabled or not. If user selects a trace that is not currently enabled, it will be made enabled.	

Changing the Spectrum Display Settings (see page 51)

Spectrum Settings

Menu Bar: Setup > Settings

Application Toolbar: 🗳

The settings for the Spectrum display are shown in the following table.

Settings tab	Description
Freq & Span (see page 67)	Sets frequency and span parameters for the Spectrum Analysis display.
BW (see page 71)	Sets Resolution Bandwidth and windowing parameters.
Traces (see page 68)	Sets Trace display parameters.
Traces (Math) (see page 71)	Sets the traces used to create the Math trace.
Scale Tab (see page 52)	Sets vertical and horizontal scale and position parameters.
Prefs Tab (see page 74)	Specifies whether or not certain display elements are shown.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Freq & Span BW	/ Traces Scale	Prefs		
Vertical			Horizontal	
Scale:	100.00 dB		Scale:	50.0 MHz
Position:	0.00 dBm	Reset Scale	Position:	1.9000 GHz
	Autoscale		🗖 Log	Autoscale

Setting	Description
Vertical	
Scale	Changes the vertical scale.
Position	Vertical Position adjusts the top of graph amplitude value. This control allows you to move ("pan") the traces up and down in the graph without changing the Reference Level.
Autoscale	Resets the Offset so that the trace appears below the top of the graph.
Horizontal	
Scale	Allows you to change the range of frequencies shown in the graph without changing the span or measurement frequency.
Position	Allows you pan the graph.
Autoscale	Resets Scale to the Span setting.
Reset Scale	Resets all settings to their default values.
Log scale	Resets the display to show the frequency axis in a logarithmic scale.

Spectrogram Display

The Spectrogram is a display with the vertical axis (time) composed of successive spectral displays, each having the amplitude represented by color or intensity. The horizontal axis represents frequency. The most recently acquired spectrum results are added to the bottom of the spectrogram. The addition of a new spectrum can occur at the fastest rate that new spectra can be plotted, or, if you choose, new spectra can be added at a timed rate. The spectrogram view is well-suited to displaying long-term trends of spectral data. The maximum number of lines that can be displayed in a spectrogram is 125,000.

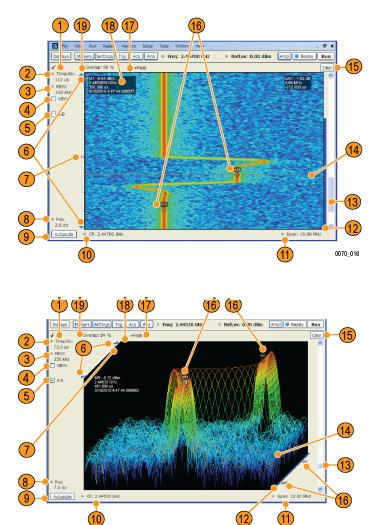
The spectrogram can also be displayed in a 3-D waterfall format. In the 3-D waterfall format, the spectrogram displays the time axis along a simulated Z-axis.

NOTE.

To display a Spectrogram:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This displays the **Select Displays** dialog box.
- 2. From the Measurements box, select General Signal Viewing.
- **3.** Double-click the **Spectrogram** icon in the **Available Displays** box. This adds the Spectrogram icon to the Selected displays box.
- 4. Click the OK button. This displays the spectrogram view.
- 5. To display a 3-D version of the spectrogram, select the 3-D checkbox.

Elements of the Spectrogram Display



Item	Display element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Spectrogram display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Time/div	Sets the length of time represented by each vertical division. Divisions are indicated by tick marks along the left edge of the graph.
3	RBW	Sets the resolution bandwidth. Note that when the RBW is set to Auto, its value is italicized.
4	VBW	Enables the VBW (Video Bandwidth) filter. See Setup > Settings > <u>BW Tab</u> (see page 71).
5	3-D checkbox	Enables and disables the 3-D view.
6	Selected records indicators	Shows the positions of the start and stop records selected on the Select data records tab. Drag the indicators to select which records will be played by Replay All. Note that these are not visible while acquisitions are running; the instrument must be stopped for the indicators to be visible.
7	Т	Trigger indicator. This icon indicates the trigger point within the current acquisition.
8	Pos	Position indicates the bottom line visible in graph. Changing this setting scrolls the window up and down through the displayed acquisition records.
9	Autoscale	Resets Vertical and Horizontal scale and Pos to default values.
10	CF	Sets the Center Frequency.
11	Span	Sets the span of the spectrogram display.
12	Current data record indicator	A blue line indicates the current data record. When the analysis length is short, the blue line appears as a thin line much like the selected indicator line. When the analysis length is relatively long, the blue line appears more like a blue bar.
13	Position scroll bar	Changes the position of the trace in the window. Changing the position scroll bar is the same as adjusting the Pos setting.
14	Selected indicator	This inverse-colored line indicates the Spectrogram line that will appear in the Spectrum display when the Spectrogram trace is enabled. This line is attached to the selected marker.
15	Clear	Clears the spectrogram display; however, data records in acquisition history remain in memory and are available for replay. To clear memory, select File > Acquisition Data Info > Delete All Data .
16	Marker indicators	These icons indicate the position of markers in the spectrogram. You can move markers by dragging the desired marker indicator.
17	Detection setting	Displays the selected Detection method (see <u>Settings > Trace (see page 56)</u> tab).

ltem	Display element	Description
18	Marker readout	Marker readout for the selected marker. In the Spectrogram display, the marker readout includes a date and timestamp. The time is displayed in a 24-hour format. The timestamp readout can be shown or hidden independently of the other marker readouts (see <u>Settings > Prefs (see page 74)</u>).
19	Time Scale status readout	Three readouts can appear here depending on settings: Time/update, Spectrums/line, and Overlap. See Time Scale Status Readout (see page 55).

Time Scale Status Readout

Three types of readouts can appear in the display depending on settings:

- Time/update Displays minutes:seconds when Spectrum Monitor is selected in the Settings > Time & Freq Scale tab in the Vertical (Time) section.
- Spectrums/line Displays an integer number when vertical scale is Normal and each line contains the results from one or more frequency transforms (whether zoomed out or not).
- Overlap Displays the overlap percentage when vertical scale is Normal and each line's transform shares some points with the transforms of lines before and after it (zoomed in). Overlap can only be done when the Analysis Length > 2x RBW frame length.

The Spectrogram can show results from one or multiple acquisitions and it can show one or multiple lines for each acquisition.

Changing the Spectrogram Display Settings (see page 55)

Spectrogram Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The Setup settings for the Spectrogram display are visible when Spectrogram is the selected display.

Settings tab	Description
Freq & Span (see page 67)	Sets frequency and span parameters for the Spectrogram display.
BW (see page 71)	Sets Resolution Bandwidth and windowing parameters.
Trace (see page 56)	Sets Trace display parameters.
Amplitude Scale (see page 57)	Selects between 2-D and 3-D, sets height scale, position and orientation for 3-D display. Sets color parameters for the spectrogram trace.
Time & Freq Scale (see page 57)	Sets the vertical and horizontal scale parameters for the spectrogram trace. The Spectrum Monitor controls are also on this tab.
Prefs (see page 74)	Specifies whether or not certain display elements are shown.

Trace Tab

The Spectrogram Trace tab controls let you specify the Detection method, save traces, and recall saved traces for display. The Spectrogram Trace tab does not have all the controls that other Trace tabs contain, however, it does have a unique display element, the Selected Line readout. For details on Detection, Freeze, and saving and recalling traces, see the <u>Traces Tab (see page 68)</u>.

Freq & Span BW Trace	Amplitude Scale	Time & Freq Scale	Prefs		
Selected Line: 6/30/2006		E Freeze		Save Trace As	
Detection: +Peak	•			Show recalled trace	

Selected Line

Displays the time at the Selected Line. If Markers are enabled, the selected line is positioned by the selected marker. If no markers are enabled, the selected line is the first line in the current analysis period.

Amplitude Scale Tab

The Amplitude Scale tab allows you to change the vertical and horizontal scale settings, enable the 3-D Waterfall display, and set the color scheme used for the spectrogram trace.

Freq & Span BW Trac	e Amplitude Scale	Time & Freq Scale	Prefs			
Height (3-D only)			ſ	Color (F	Power)	
Scale: 100.00 dB		🗸 3-D Waterfall		Color:	Temperature	•
Position: -5.00 dBm		Northeast 🔹 👻		Max:	0.00 dBm	
Autosca	le	Reset Scale		Min:	-100.00 dBm	

Setting	ng Description	
Height (3-D only)		
Scale	Changes the vertical scale for trace Amplitude in the graph (not the vertical scale for Time).	
Position	Specifies the level displayed at the bottom edge of the graph. (Bottom front edge in the 3-D view).	
Autoscale	Adjusts the vertical position and scale of the trace lines to bring them into the visible portion of the graph.	
3–D Waterfall	Displays the spectrogram in a 3-D format.	
Northeast	Shifts the perspective of the 3-D graph so that the oldest traces move back and to the right.	
Northwest	Shifts the perspective of the 3-D graph so that the oldest traces move back and to the left.	
Reset Scale	Resets the Height and Color settings to their default values.	
Color (Power)		
Color Displays a drop-down list that allows you to set the color scheme used for the spectrogram trace.		
Max	Sets the maximum power level represented by the top of the color scale.	
Min	Sets the minimum power level represented by the bottom of the color scale.	

Time & Freq Scale Tab

The Time and Freq Scale tab allows you to change the vertical and horizontal scale settings, enable the 3-D Waterfall display, and set the color scheme used for the spectrogram trace.

Freq & Span BW	Trace Amplitud	le Scale 🛛 Time	e & Freq Scale Prefs		
Vertical (Time)				-Horizontal (F	requency)
Normal		Time/div:	72.0 us	Scale:	10.00 MHz
Overlap:	94 %	Visible elapsed	time: 396.7 us		
		Position:	12.3 div	Position:	2.44530 GHz
Spectrum Moni	tor	Time at pos	ition: 1.261 ms		
Time/update:	0 m ; 1 s	Reset Scale	Autoscale		Autoscale

Setting Description		
Vertical (Time)		
Normal	For most Spectrogram applications. Primary time scale control is Time/div. Time scale can be zoomed in or out.	
Spectrum Monitor	For long-term signal monitoring applications. In spectrum monitor mode, each line in the spectrogram represents the period of time specified by the Time/update parameter. Time scale can be zoomed out, but not zoomed in (no overlap).	
Time/update	Sets the time, in minutes and seconds, represented by each line of the spectrogram. Only available in Spectrum Monitor.	
Reset Scale	Resets the Time/div and Pos settings to their default values.	
Autoscale	Scales the vertical (time) axis to compress all existing trace lines into the visible area of the graph. Resets the Position value to zero, placing the most recent spectrogram line at the bottom of the spectrogram display. Only Position is affected by Autoscale when Spectrum Monitor is selected.	
Time/div	Sets the time displayed per division.	
Visible elapsed time	Displays the length of time visible in the display. This does not represent the total time available to view.	
Position	Adjusts vertical position of the trace within the graph area. Setting represents the offset, in divisions, between the bottom of the graph and the bottom (most recent) line in the results trace.	
Time at position	Displays the time of the spectrogram line shown at the bottom of the graph. This time is relative to the Time Zero Reference of the current acquisition.	
Horizontal (Frequency)		
Scale	Sets the frequency range of the graph without changing the Span value.	
Position Sets the frequency displayed at the center of the graph. Changing this value does in change the Freq setting.		
Autoscale	Sets the frequency scale to the Spectrogram Span value.	

Spectrum Monitor

Spectrum Monitor performs long term monitoring. The monitor mode compresses time into each line of the spectrogram, which enables you to monitor long periods of time (from 1 second per line up to 600 minutes per line). With extended memory (Option 53) installed in the instrument, you can capture up to 125,000 lines. With standard memory installed in the instrument, the maximum number of lines you can capture is 31,250.

During each line's collection period, spectrum transforms are computed for each acquisition taken by the instrument. As each transform completes, it is incorporated into the current spectrogram line. How each

line of the spectrogram is created in spectrum monitor mode depends on the detection setting (Settings > Trace). For example, if Detection is set to +Peak, each spectrogram line is effectively a peak hold display of all the spectral data captured since the prior line.

Amplitude Vs Time Display

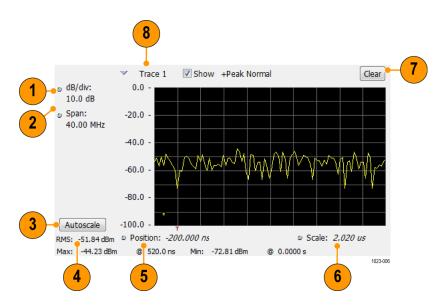
The Amplitude vs. Time display plots the signal amplitude against time. The amplitude appears on the vertical axis while time is plotted along the horizontal axis.

Note that the trace(s) in the Amplitude vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export. You can set the Max trace points on the **Settings** > **Prefs** tab.

To show Amplitude vs. Time display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select General Signal Viewing in the Measurements box.
- **3.** In the **Available displays** box, double-click the **Amplitude vs. Time** icon or select the icon and click **Add**. The Amplitude vs. Time icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK.

Elements of the Display



ltem	Display element	Description	
1	Vertical scale adjustment	Adjusts the vertical scaling.	
2	Span	Adjust the bandwidth of the data to be analyzed. (Not the period of time shown in the display.)	
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.	
4	Offset	Adjust the horizontal offset.	
5	Max and Min readouts	Displays the maximum and minimum amplitudes, as well as when those values occur.	
6	Scale	Sets the time spanned by the graph.	
7	Clear button	Restarts multi-trace functions (Avg, Hold).	
8	Trace function	Displays the current trace function setting (Settings > Trace tab > Function).	

Reference. Changing Amplitude vs Time Display Settings (see page 60)

Amplitude Vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The settings for the Amplitude vs. Time display are shown in the following table.

Settings tab	Description
Freq & BW (see page 60)	Sets the Bandwidth Method used for setting the measurement bandwidth.
Traces (see page 68)	Allows you to select the type of trace to display and their functions.
Traces (Math) (see page 71)	Sets the traces used to create the Math trace.
Scale (see page 73)	Sets the vertical and horizontal scale parameters.
Prefs (see page 74)	Specifies whether certain display elements are visible.

Freq & BW Tab

The Freq & BW (Bandwidth) tab allows you to specify the bandwidth parameters used for setting measurement bandwidth. This determines what Acq BW the measurement will request. Settings Description

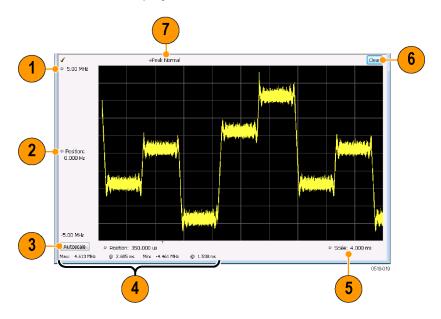
Frequency Vs Time Display

The Frequency vs. Time Display shows how the signal frequency varies with time.

Note that the trace(s) in the Frequency vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export. You can set the Max trace points on the **Settings** > **Prefs** tab.

To display the Frequency vs. Time Display:

- 1. Select the **Displays** button or **Setup** > **Displays**.
- 2. In the Select Displays dialog, select General Signal Viewing in the Measurements box.
- **3.** In the **Available displays** box, double-click the **Frequency vs. Time** icon or select the icon and click **Add**. The Frequency vs. Time icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to display the Freq vs. Time display.



Elements of the Display

ltem	Display element	Description
1	Top of graph adjustment	Use the knob to adjust the frequency range displayed on the vertical axis.
2	Offset adjustment	Adjusts the frequency shown at the center of the display.
3	Autoscale button	Adjusts the offset and range for both vertical and horizontal to provide the best display.
4	Maximum and Minimum frequency readouts	Displays the maximum and minimum values, as well as when those values occur.
5	Horizontal Scale	Sets the time spanned by the graph.
6	Clear button	Restarts Average trace.
7	Trace function	Displays the current trace function setting (Settings > Trace > Function).

Changing Frequency vs Time Display Settings (see page 62)

Frequency Vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The Setup settings for Frequency vs. Time are shown in the following table.

Settings tab	Description
Freq & BW (see page 66)	Sets the frequency and bandwidth parameters.
Trace (see page 68)	Sets the trace display parameters.
Scale (see page 73)	Sets the Vertical and Horizontal scale and offset parameters.
Prefs (see page 74)	Specifies whether certain display elements are visible.

Phase Vs Time Display

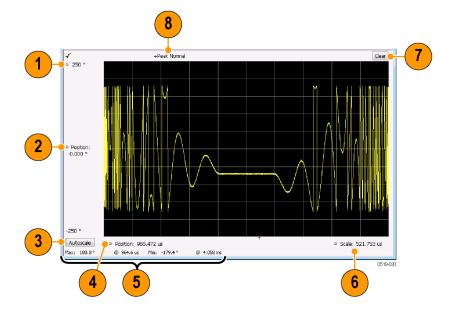
The Phase vs. Time display plots the signal phase against time. The phase appears on the vertical axis while time is plotted along the horizontal axis.

Note that the trace(s) in the Phase vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export. You can set the Max trace points on the **Settings** > **Prefs** tab.

To display Phase vs. Time:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select General Signal Viewing in the Measurements box.
- 3. In the Available displays box, double-click the Phase vs. Time icon or select the icon and click Add. The Phase vs. Time icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click OK to show the Phase vs. Time display.

Elements of the Display



Display element	Description	
Top of graph adjustment	Adjusts the vertical scale. Use the knob to adjust the value of the top of the graph.	
Vertical offset adjustment	Adjusts the phase error shown at the vertical center of the display.	
Autoscale button	Adjusts the vertical and horizontal settings so that the entire trace fits in the view.	
Horizontal Offset	Adjusts the horizontal position of the trace.	
Max and Min readouts	Displays the maximum and minimum value of the phase error within the analysis times and the times at which they occurred.	
Horizontal Scale	Sets the time spanned by the graph.	
Clear button	Restarts multi-trace functions (Avg, Hold).	
Trace function	Shows the trace function as set on the Settings > Trace tab.	
	Top of graph adjustment Vertical offset adjustment Autoscale button Horizontal Offset Max and Min readouts Horizontal Scale Clear button	

Changing the Phase vs Time Display Settings (see page 64)

Phase Vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the Phase vs. Time display are shown in the following table.

Settings tab	Description
Freq & BW (see page 66)	Sets the frequency and bandwidth parameters.
Trace (see page 68)	Sets the trace display parameters.
Scale (see page 73)	Sets the Vertical and Horizontal scale and offset parameters.
Prefs (see page 74)	Specifies whether certain display elements are visible.

RF I & Q vs Time Display

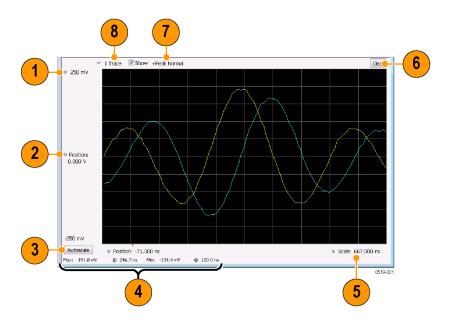
This is a plot of the baseband In-Phase (I) and Quadrature (Q) components of a modulated carrier. The plot is in the time domain, with I and/or Q values the Y-axis.

Note that the trace(s) in the RF I & Q vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export. You can set the Max trace points on the **Settings** > **Prefs** tab.

To display an RF I & Q vs. Time display:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select General Signal Viewing.
- **3.** Double-click the **RF I&Q vs. Time** icon in the **Available Displays** box. This adds the RF I & Q vs. Time icon to the **Selected displays** box.
- 4. Click the OK button.

Elements of the Display



ltem	Display element	Description
1	Top of Graph adjustment	Use the knob to adjust the vertical scaling.
2	Vertical offset adjustment	Adjusts the level shown at the center of the display.
3	Autoscale button	Adjusts the offset and scale for both vertical and horizontal to provide the best display.
4	Maximum and Minimum level readouts	Displays the maximum and minimum values, within the Analysis Time, as well as the times at which they occurred.
5	Scale	Sets the time spanned by the graph.
6	Clear button	Restarts multi-trace functions (Avg, Hold).
7	Trace function	Displays the current trace function setting (Settings > Trace > Function). If the traces are averaged, the number of averages is displayed.
8	Trace Control	Selects which trace is displayed (using the drop-down list) and which trace is active (click on the trace name to display a menu).

Changing the RF I & Q vs Time Display Settings (see page 65)

RFI&QvsTimeSettings

Menu Bar: Setup > Settings

Application Toolbar: 鄻

The Setup settings for RF I&Q vs. Time are shown in the following table.

Settings tab	Description
Freq & BW (see page 66)	Sets the frequency and bandwidth parameters.
Trace (see page 68)	Sets the trace display parameters.
Scale (see page 73)	Sets the Vertical and Horizontal scale and offset parameters.
Prefs (see page 74)	Specifies whether certain display elements are visible.

General Signal Viewing Shared Measurement Settings

The control panel tabs in this section are identical or very similar for each of the displays in the General Signal Viewing folder (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a couple of displays.

For some tabs, the control values are shared across all the General Signal Viewing displays. For other control values, each display has unique values for the controls. Details are provided for the specific tabs.

Common controls for general signal viewing displays

Settings tab	Description
Freq & Span (see page 67)	Sets the frequency and span parameters.
Trace (see page 68)	Sets the trace display parameters.
Traces – Math (see page 71)	Sets the traces used to create the Math trace.
BW (see page 71)	Sets the Bandwidth Method used for setting the measurement bandwidth.
Scale (see page 73)	Sets the Vertical and Horizontal scale and offset parameters.
Prefs (see page 74)	Specifies whether certain display elements are visible.

Freq & BW Tab — Freq vsTime, Phase vs Time, RF I & Q vs Time Display

The Freq & BW tab provides access to settings that control frequency settings for the Freq vs Time, Phase vs Time, RF I & Q vs Time display.

Freq & BW Traces So	cale Prefs		
	Measurement BW, no filter:	500 MHz	🔲 Link to Span
Measurement Freq: 1.000 GHz		Set to max BW]

Setting	Description
Measurement Freq	The frequency at the which measurements are made. This value is the same as the setting for Frequency in the Application bar.
Measurement BW	This control limits the bandwidth of measurements. You use the measurement bandwidth setting to improve the signal-to-noise ratio of the measurement, resulting in lower measurement uncertainty. However, if the measurement bandwidth is set too low, resulting in fewer samples per second, it can reduce the number of points within the measurement length below the 256 stable samples required, thus causing the analysis to fail.
Link to Span	When enabled, the measurement bandwidth of the RF I & Q display is determined by the span of the analyzer. When unchecked, the measurement bandwidth is specified by the user, and no additional filter is applied.
Set to max BW	Sets the measurement bandwidth to the maximum acquisition bandwidth of the instrument.

Freq & Span Tab

The Freq & Span tab provides access to settings that control frequency settings for the trace display. The control values set in this tab are shared by all the General Signal Viewing displays.

Setting	Description
Center	The frequency at the center of the selected Span.
Start	The lowest frequency in the span.
Stop	The highest frequency in the span.
Step Size	Sets the increment/decrement size for Center, Start and Stop values.
Span	The difference between the start and stop frequencies. This is the measurement bandwidth for the general signal viewing displays.
Max Span	Sets the Span to the maximum value.

Center, Start, Stop, and Span Frequencies Are Correlated

Changing the values for Center frequency, Start frequency, Stop frequency or Span will change the values for the other settings, depending on which setting you change. For example, if you change the Center frequency, the Start and Stop frequencies will be adjusted automatically to maintain the same Span.

Note however that if the Start and Stop frequencies are changed so that they are closer than the minimum span setting, the Start and Stop frequencies will be adjusted to maintain the minimum Span setting.

Setting Changed Manually	Settings Changed Automatically As a Result	Setting Not Automatically Changed
Start	Center, Span	Stop
Stop	Center, Span	Start
Center	Start, Stop	Span
Span	Start, Stop	Center

Traces Tab

The Traces Tab allows you to set the display characteristics of displayed traces.

Freq & Span	BW Traces S	cale Prefs			
Trace:	Trace 1 🔹	Show	Freeze	Save Trace As	
Detection:	+Peak 🔻]		Show recalled trace	
Function:	Normal 👻]			

Setting	Description
Trace	Selects a trace. (This setting is not present for every display.)
Show	Shows / hides the selected trace.
Function	Selects the trace processing method. Available settings are: Normal, Average, Max Hold, and Min Hold.
Count	Sets the number of traces averaged to generate the displayed trace. (Present only when Function is set to Average, Min Hold, or Max Hold.)
Freeze	Halts updates to the selected trace.
Save Trace As	Saves the selected trace to a file for later recall and analysis.
Show Recalled trace	Displays a saved trace instead of a live trace.

Trace

Available traces for Spectrum are: Trace 1, Trace 2, Trace 3, Math, and Spectrogram. Other displays support fewer traces. Traces 1-3 are based on the input signal and enable you to display the input signal using different processing. For example, you could display Trace 1 with Function set to Normal, Trace 2 with Function set to Max Hold and Trace 3 with Function set to Min Hold.

The Math trace is the result of subtracting one trace from another.

The Spectrogram trace applies only to the Spectrum display and is available only if the Spectrogram display is shown. The Spectrogram trace shows the trace selected in the Spectrogram as a spectrum trace.

Detection

Trace Detection is used to reduce the results of a measurement to the desired number of trace points. For example, if the maximum number of trace points is 100,000, and a measurement over the selected analysis length yields 200,000 points, the measurement must decimate these 200,000 trace points by 2 to prevent exceeding the 100,000 trace point limit. Since only one value can be represented for each trace point, an algorithm must be used to select (detect) the appropriate value to use.

The results array from an analysis can be detected (or "decimated") in a variety of ways. The number of results points produced for each trace point varies with both analysis length and trace length. For

example, the frequency transform used for the Spectrum display produces just one output value for each desired trace point. In this case, the detection method chosen has no effect, as no decimation is required. Increasing the Analysis Length (or for the Spectrum display, the Spectrum Length), causes the available detection method's output traces to differ from each other because they have a larger set of samples for the various detection methods to process.

The available detection methods (depending on the display) are:

- +Peak The highest value is selected from the results to be compressed into a trace point.
- **Peak** The lowest value is selected from the results to be compressed into a trace point.
- +/-Peak Both the highest and lowest values are selected from the results to be compressed into a trace point.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the results values it includes. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results.
- Avg (of logs) The detector is used to emulate legacy spectrum analyzer results and for the specification of displayed average noise level. In older swept analyzers, a voltage envelope detector is used in the process of measuring signal level, and the result is then converted to Watts and then to dBm. Averaging is then applied to the resultant traces.

For CW signals, this method results in an accurate power measurement. However, with random noise and digitally modulated carriers, errors result from this 'average of logs' method. For random noise, the average of logs methods results in power levels -2.51 dB lower than that measured with a power meter, or with a signal analyzer that measures the rms value of a signal, and performs averaging on the calculated power in Watts and not dBm or other log-power units.

This detector should be used when following a measurement procedure that specifies it, or when checking the Displayed Averaged Noise Level (DANL) of the instrument. The 'average of logs' detection and trace function is used for DANL specification to provide similar results to other spectrum/signal analyzers for comparison purposes. Use of the Average of Logs method of measurement is not recommended for digitally modulated carriers, as power measurement errors will occur.

NOTE. The Detection setting does not affect the trace until the spectrum length is longer than the Auto setting.

- Sample The first value is selected from the set of results to be compressed into a trace point.
- CISPR Peak The trace value is calculated by the methods described for peak detectors in the CISPR documents.

Trace Processing

Traces can be processed to display in different ways. The Function setting controls trace processing.

- Normal Each new trace is displayed and then replaced by the next trace. Each data point contains a single vertical value.
- Average Multiple traces are averaged together to generate the displayed trace, which will contain just one vertical value for each underlying frequency data point. Once the specified number of traces have been acquired and averaged to generate the displayed trace, additional traces contribute to the running average, except in Single Sequence run mode. In the case of Single Sequence, the instrument stops running after the specified number of traces have been averaged together. The Number of Traces setting specifies how many traces are averaged. The averaging is performed on the linear (Voltage) values, resulting in the correct RMS average).
- Max Hold Displays the maximum value in the trace record for each display point. Each new trace's display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons.
- Min Hold Displays the minimum value in the trace record for each display point. Each new trace's display point is compared to the previous minimum value and the lesser value is retained for display and subsequent comparisons.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Select the trace into which the recalled trace will be loaded, from the Trace drop-down list.
- 2. Check the Show check box.
- 3. Click the ... button to display the Open dialog box.

Show recalled trace	

4. Navigate to the desired file and click **Open**.

- 5. Check the Show Recalled Trace check box.
- 6. Verify that the trace's **Show** check box is selected (either on this tab or next to the drop-down list located at the top-left corner of the graph).

Traces Tab - Math Trace

This tab is not a distinct tab, it is just how the Traces tab appears when Math is selected in the Traces drop-down list.

Freq & Span BW Traces	Scale Prefs	
Trace: Math	▼ Show Freeze	Save Trace As
		Show recalled trace
Trace2	→ minus Trace1 →	

Trace 4 is a mathematically-derived trace defined as Trace A minus Trace B. You can select Trace 1, 2, or 3 to serve as either Trace A or Trace B.

Setting	Description	
Trace	When set to Trace 4 (Math), this tab is displayed.	
Show	Shows / hides the selected trace.	
Freeze	Halts updates to the selected trace.	
Save Trace As	Saves the selected trace to a file for later recall and analysis.	
Trace minus Trace	Selects which traces serve as Trace A and Trace B.	

BW Tab

The BW (bandwidth) tab allows you to change Resolution Bandwidth and Video Bandwidth settings, and set the windowing method used by the transform process by selecting a filter shape (not present for all displays).

Setting	Description
RBW	Sets the Resolution Bandwidth value to be used in the spectrum analysis view. The value is italicized when Auto is selected.
Auto	When Auto is checked, the RBW is calculated as a percentage of the Span. Kaiser is selected as the windowing method. When Auto is unchecked, the RBW is set by the user. Selecting any Window other than Kaiser changes the RBW setting to manual.
Span/RBW ratio	If Auto is checked, this value is used to calculate the RBW. If Auto is unchecked, this setting is not selectable.
Filter Shape	Specifies the windowing method used for the transform (when Auto is unchecked). (Spectrum and Spectrogram displays only.)
VBW	Adjusts the VBW (Video Bandwidth) value. (Spectrum and Spectrogram displays only.)

Filter Shape Settings

In the analyzer, computationally efficient discrete Fourier transform algorithms such as FFT (Fast Fourier Transform) or CZT (Chirp-Z Transform) are generally employed to transform time-domain signals into frequency-domain spectra. There is an assumption inherent in the mathematics of Discrete Fourier Transforms that the data to be processed is a single period of a periodically repeating signal. The discontinuities between successive frames will generally occur when the periodic extension is made to the signal. These artificial discontinuities generate spurious responses not present in the original signal, which can make it impossible to detect small signals in the presence of nearby large ones. This phenomenon is called spectral leakage.

Applying a filter, such as Kaiser, to the signal to be transformed is an effective method to combat the spectral leakage problem. Generally the filter has a bell shape. Multiplying the transform frame by the filter function eliminates or reduces the discontinuities at the ends of the frame, however, at the expense of increased RBW.

Filter Shape Characteristics

The choice of filter shape depends on its frequency response characteristics such as side-lobe level, equivalent noise bandwidth and maximum amplitude error. Use the following guidelines to select the best filter shape.

Filter Shape	Characteristics
Kaiser (RBW)	Best side-lobe level, shape factor closest to the traditional Gaussian RBW.
-6dB RBW (MIL)	These filters are specified for bandwidth at their -6 dB point, as required by military EMI regulations.
CISPR	These filters comply with the requirements specified in the P-CISPR 16 -1-1 document for EMI measurements.
Blackman-Harris 4B	Good side-lobe level.
Uniform (None)	Best frequency resolution, poor side-lobe level and amplitude accuracy.
Flat-Top	Best amplitude accuracy, best representation of brief events captured near the beginning or end of the time-domain data frame, poor frequency resolution.
Hanning	Good frequency resolution, high side-lobe roll-off rate.

VBW

The VBW setting enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers.

The maximum VBW value is the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting. VBW is disabled when the Filter shape is set to CISPR.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

The Scale tab values are unique to each display. Also, note that each display uses horizontal and vertical units that are appropriate for the display. For example, for the Spectrum display uses power (dBm) units and frequency (Hz) units; the Amplitude vs. Time display uses power (dBm) and time (seconds) units; and the Phase vs. Time display uses phase (degrees) and time (seconds) units.

Freq & Span BW	/ Traces Scale	Prefs		
Vertical			Horizontal	
Scale:	100.00 dB		Zoom Start:	1.857 GHz
Position:	0.00 dBm	Reset Scale	Zoom Stop:	1.942 GHz
	Autoscale		🔲 Log	Autoscale

Setting	Description			
Vertical Controls the vertical position and scale of the trace display.				
Scale	Changes the vertical scale.			
Offset	Vertical Offset adjusts the reference level away from top of the graph.			
Autoscale	Resets the scale of the vertical axis to contain the complete trace.			
Horizontal Controls the span of the trace display and position of the trace.				
Zoom Start	Sets the starting frequency for			
Zoom Stop	Sets the stop frequency for			
Log	Resets the scale of the horizontal axis to contain the complete trace.			
Reset Scale	Resets all settings to their default values.			

Prefs Tab

The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display, but include such items as enabling/disabling Marker Readout, switching the Graticule display on/off, and Marker Noise mode.

Each of the General Signal Viewing displays maintains its own separate values for the controls that appear on the Prefs tab. Some parameters appear with most displays while others appear with only one display.

For example, in the following image, the Show Marker readout in graph check box appears in the Prefs tab for every display. However, the Show Power Trigger level check box only appears on the Amplitude vs Time Prefs tab.

Freq & Span BW Traces Scale	Prefs
Show: Start, Stop 👻	Trace points: 801 -
📝 Show graticule	Show Marker readout in graph (selected marker)
Show trace legend	Marker Noise mode (Requires dBm Ampl units and Average trace detect)

The following image shows the Prefs tab for the Time Overview display.

Scale Trace Prefs	
Navigator View	Max trace points: 100K 🔹
Show graticule	Show Marker readout in graph (selected marker)
Show trace legend	

The following table explains the controls that can appear on the Prefs tab.

Setting	Description			
Show:	Selects the horizontal settings that appear below the graph area. You can choose Start, Stop or Center, Span.			
Trace points	Sets the number of trace points used for marker measurements and for results export.			
Max trace points (Time Overview Display only)	Sets the maximum number of trace points used for marker measurements and for results export.			
Show trace legend	Enables display of a legend in the measurements area that shows the Detection method and Function setting for displayed traces. The color of the legend text matches the color of the associated trace.			
Show graticule	Select to display or hide the graticule.			
Navigator View	Places the Time Overview display across the top of the application window, above all other active displays.			
(Time Overview Display only)				
Show Parameter Readouts	For the DPX display, enables/disables the display of DPX parameters. The parameters readout shows 100% Probability of Intercept, Transforms/s, and FFT Points.			
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.			
Show timestamp in graph (selected line)	For spectrogram displays, this readout shows or hides the timestamp associated with the selected line or marker position.			
Show Power Trigger Level	Displays or hides a green line in the graph that indicates the level at which the power trigger is set. The line is not displayed if Trigger is set to Free Run.			
Marker Noise mode	Select to enable or disable the Marker Noise mode. Use this mode to measure noise on the trace. See Using Noise Markers in the Spectrum Display (see page 461).			

Overview

The displays in Analog Modulation (Displays > Measurements > Analog Modulation) are:

- AM
- **FM**
- PM

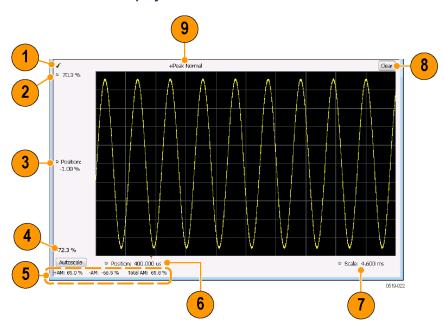
The Analog Modulation displays provide measurements and time-domain trace displays.

AM Display

The Amplitude Modulation Display is a graph of Modulation Factor vs Time. The AM display includes three numeric readouts.

To show the AM display:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select Analog Modulation.
- **3.** Double-click the **AM** icon in the **Available Displays** box. This adds the AM icon to the **Selected displays** box.
- 4. Click the OK button. This shows the AM display.



Elements of the Display

ltem	Element	Description			
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the AM display is the optimized display.			
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.			
2	Top of Graph	Sets the %AM indicated at the top of the graph by increasing or decreasing the vertical scale. Changing the top value affects the bottom of graph value because the graph scales about vertical center. Also, note that the top of graph setting interacts with the internal vertical scale setting (which is not user settable).			
3	Position	Specifies the %AM shown at the center of the graph display.			
4	Bottom Readout	Displays the value of the modulation factor shown at the bottom of graph.			
5	Measurement readouts	Displays numeric values for the +AM (positive modulation factor), –AM (negative modulation factor), and Total AM.			
6	Position	Specifies the horizontal position of the trace on the graph display.			
7	Scale	Adjusts the horizontal range of the graph. By decreasing the scale (time across the entire graph), the graph essentially becomes a window that you can move over the trace by adjusting the position.			
8	Clear	Erases the trace from the graph.			
9	Trace Detection readout	Displays the Settings > Trace > Detection setting.			

Changing the AM Settings (see page 78)

AM Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕸

The AM Settings control panel provides access to settings that control parameters of the AM Display.

Parameters Trace Scale Prefs		
Carrier Amplitude Detection		
Average	Measurement BW:	10.00 MHz
🔘 Median		

Setting	Description
Parameters (see page 79)	Sets the Carrier Amplitude Detection method. You can choose either Average or Median.
Trace (see page 80)	Sets Trace display parameters.
Scale (see page 82)	Sets vertical and horizontal scale and position parameters.
Prefs (see page 83)	Specifies whether or not certain display elements are shown. Specifies the maximum number of points shown in the display graph.

Parameters Tab

The Parameters tab enables you to specify two parameters that control the carrier amplitude detection.

Parameters Trace Scale Prefs	
Carrier Amplitude Detection	
Average	Measurement BW: 10.00 MHz
🔘 Median	

Setting	Description	
Average	Selects the Average method for computing the average baseline for measurements.	
Median Selects the Median method for computing the average baseline for measurements		
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made.	

AM Modulation

An amplitude modulated carrier can be described mathematically by: $X(t) = [A + a(t)] \cos \omega_0 t$

A, in the above equation, represents the carrier amplitude, a(t) represents the time-varying modulation and ω_0 represents the carrier frequency.

The signal modulation envelope is given by: $E_{M}(t) = A + a(t)$

There are several ways to express the AM modulation depth, expressed as a percentage.

 $\begin{array}{l} \textit{Peak method} \\ \textit{AMM odulationDepth} = \frac{Max\left[A + a\left(t\right)\right]}{A} \\ \hline \textit{Trough Method} \\ \textit{AMM odulationDepth} = \frac{Min\left[A + a\left(t\right)\right]}{A} \end{array}$

Max-Min Method

$$AMM odulation Depth = \frac{Max \left[A + a\left(t\right)\right] - Min \left[A + a\left(t\right)\right]}{2A}$$

In each case, the value of the carrier amplitude, A, needs to be estimated from the input signal.

The instrument represents signals in a sampled form. The sampled envelope can be expressed as a function of sample index K and sampling period T as: $E_M [KT] = A + a [KT]$

The instrument allows the choice of two methods for estimating the carrier amplitude:

```
Average Method

A = Average \{E_M [KT]\}

Median Method

A = Median \{E_M [KT]\}
```

In both cases, the instrument computes the average and the median over the analysis period. It should be noted that the two methods give the same result for sinusoidal modulation where the sampling frequency is much higher than the modulation frequency.

Trace Tab

The Trace Tab allows you to set the display characteristics of a trace.

Parameters 7	Frace 🤉	Scale	Prefs					
				Show 🗹	[Freeze	Save Trace As	
Detection:	+Peak	<	•				Show recalled trace	
Function:	Norma	al	•					

Setting Description					
Show	Shows/hides the trace. If the instrument continues to run, the measurement results below the graph display continue to update even if the trace is hidden.				
Detection	Sets the Detection method used for the trace. Available detection methods are +Pea -Peak, and Avg (VRMS). Not available for saved traces.				
Function	Selects the trace processing method. The only available setting is Normal.				
Freeze	Halts updates to the trace.				
Save Trace As	Saves the trace to a file for later recall and analysis.				
Show recalled trace	Displays a saved trace instead of a live trace.				

Detection

Detection refers to the method of processing the data acquisition points when creating a trace. The IQ samples in a data acquisition can be detected in a variety of ways. The number of IQ samples available to each trace point varies with both analysis length and trace length. For example, with Spectrum Length set to 'Auto' in the Analysis menu, the instrument analyzes just enough samples to produce one IQ sample pair per trace point. In this case, the detection method chosen has very little effect, as the +Peak, -Peak, and Avg (VRMS) are all equal. Changing the Spectrum Length causes the available detection methods to differ in value because they have a larger set of samples for the various detection methods to process.

The available detection methods are:

- +Peak Each point on the trace is the result of detecting the positive peak value present in the set of IQ samples available to that trace point.
- -Peak Each point on the trace is the result of detecting the negative peak value present in the set of IQ samples available to that trace point.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the IQ samples available to the trace point. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results. When the averaging function is applied to a trace, the averaging is performed on the linear (Voltage) values, resulting in the correct average for RMS values.

Trace Processing

Traces can be processed to display in different ways. The Detection setting controls trace decimation, when needed. When the trace points each cover more than one sample data point, the vertical results values for multiple data points are combined into each trace point. Each trace point ends up with a single vertical value.

- Average Each trace point is computed by averaging together the multiple results points it represents.
- +Peak Each trace point represents the highest vertical value among the results it includes.
- -Peak Each trace point represents the lowest vertical value among the results it includes.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Click the ... button to display the Open dialog box.
- 2. Navigate to the desired file and click Open.
- 3. Check the Show Recalled Trace check box.
- 4. Verify that the Show check box is selected.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Parameters Trace	Scale Prefs		
Vertical		Horizontal	
Scale:	143 %	Scale:	4.600 ms
Position:	-1.00 %	Position:	400.000 us
	Autoscale		Autoscale

Description	
Changes the range shown between the top and bottom of the graph.	
Adjusts the level shown at the center of the graph.	
Resets the Position so that the entire trace is in the graph.	
Changes the range shown between the left and right sides of the graph.	
Adjusts the position of the acquisition record shown at the left edge of the graph.	
Resets the Scale and Position settings to provide the optimum display.	

Prefs Tab

The Prefs tab enables you to change appearance characteristics of the AM display.

Parameters Trace Scale Prefs	
☑ Show graticule	Max trace points: 100K Show Marker readout in graph (selected marker)

Setting	Description Shows or hides the graticule.		
Show graticule			
how Marker readout in graph Shows or hides the readout for the selected marker in the graph area. elected marker)			
Max trace points	The trace in the AM display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 500,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export.		

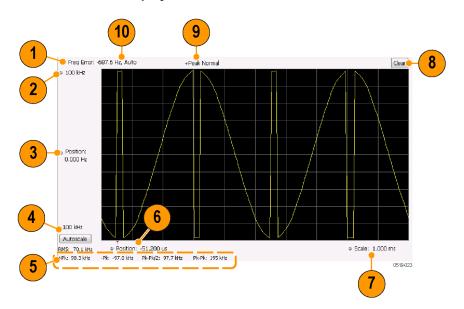
FM Display

The Frequency Modulation Display shows Frequency Deviation vs. Time. The vertical axis units are Hertz and the horizontal axis units are seconds. When taking measurements, only the first burst in the Analysis period is analyzed. No trace points are shown for data outside the first detected burst, nor are measurements made on data outside the first detected burst.

To show the FM display:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select Analog Modulation.
- **3.** Double-click the **FM** icon in the **Available Displays** box. This adds the FM icon to the **Selected displays** box.
- 4. Click the OK button. This shows the FM display.

Elements of the Display



ltem	Element	Description		
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the FM display is the optimized display.		
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.		
2	Top of Graph control	Sets the frequency indicated at the top of the graph. Since the Position value at the vertical center of this graph remains constant as the Top of Graph value is adjusted, the Vertical Scale increases as the Top of Graph value increases, which also affects the bottom of graph readout. Vertical Scale can also be controlled from the Settings control panel's Scale tab.		
3	Position	Specifies the frequency shown at the center of the graph display. Changing this value moves the trace up and down in the graph, which affects the Top of Graph and Bottom of Graph values as well.		
4	Bottom of Graph Readout	Displays the frequency value at the bottom of the graph.		
5	Measurement readouts	Displays numeric values for the +Pk (positive frequency deviation), –Pk (negative frequency deviation), RMS (RMS value of the deviation), Pk-Pk (peak-to-peak frequency deviation), and Pk-Pk/2 (peak-to-peak frequency deviation divided by two).		
6	Position	Specifies the horizontal position of the trace on the graph display.		
7	Scale	Adjusts the time range of the graph. By decreasing the scale (full-scale time over 10 divisions), the graph essentially becomes a window that you can move over the acquisition record by adjusting the horizontal position.		
8	Clear	Clears the trace and numeric measurement results.		
9	Trace Detection readout	Displays the Settings > Trace > Detection setting.		
10	Freq Error	This readout can show Freq Error or Freq Offset. When it displays Freq Error, it shows the difference between the instrument Frequency setting and the measured value of the signal's carrier frequency. When it displays Freq Offset, it shows the frequency offset specified on the Settings > Parameters tab. If Freq Error is displayed, it also indicates that the Carrier frequency detection setting is Auto. If Freq Offset is displayed, it indicates that the Carrier frequency detection setting is manual.		

Changing the FM Settings (see page 85)

FM Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The FM Settings control panel provides access to settings that control parameters of the FM Display.

Parameters Trace Scale	Prefs	
Burst detect threshold:	-100 dBc	
	Frequency offset	
Measurement BW:	100.0 kHz	Load from marker

Setting	Description			
Parameters (see page 395)	Sets the burst detection threshold, measurement bandwidth, and carrier frequency detection method.			
Trace (see page 88)	Sets Trace display parameters.			
Scale (see page 90)	Sets vertical and horizontal scale and position parameters.			
Prefs (see page 91)	Specifies whether or not certain display elements are shown. Specifies the maximum number of points shown in the display graph.			

Parameters Tab

The Parameters tab enables you to specify parameters for carrier detection.

Parameters Trace Scale	Prefs		
Burst detect threshold:	-100 dBc		
		Frequency offset:	-50.54 Hz 🛛 🛛 Auto
Measurement BW:	100.0 kHz		Load from marker

Setting	Description			
Burst detect threshold	This parameter specifies the power level used to determine whether a burst is present. A valid burst is required to take measurements. The burst detected first is used for the analysis. The units for burst detect threshold are dBc, relative to the maximum acquisition sample data points level.			
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made.			
Frequency offset	Displays the carrier signal's offset from the instrument's measurement frequency. Auto is used to select the method for determining the carrier frequency. When Auto is selected, the instrument determines the carrier frequency by analyzing the signal. When Auto is deselected, you can set the carrier frequency offset using Frequency Offset.			
Load from Marker	Pressing this button sets the frequency offset to the frequency offset of the selected marker. (Pressing this button automatically deselects Auto.)			

Frequency Offset

In Auto (Auto is selected), the instrument scans the measurement bandwidth about the measurement frequency and looks for the highest-powered signal. This is defined as the carrier frequency. In Manual (Auto is deselected), the carrier frequency is specified by adding/subtracting the specified Frequency offset from the measurement frequency. Range: -(Measurement BW*1.1)/2 to +(Measurement BW*1.1)/2. If the Load from Marker button is pressed, the frequency offset is determined from the phase difference between the two markers on screen compared to the time between the two markers. This function is useful for removing frequency slope from the phase modulated signal.

Load from Marker

When the Auto check box is selected, the instrument scans the measurement bandwidth about the center frequency and looks for the highest-powered signal. This is defined as the carrier frequency. When the Auto check box is deselected, the carrier frequency is specified by adding/subtracting the specified Frequency offset from the center frequency. Pressing the Load from Marker button loads the marker frequency into the Frequency offset box.

Trace Tab

The Trace Tab allows you to set the display characteristics of displayed traces.

Parameters Trace Scale Prefs			
	🗹 Show	E Freeze	Save Trace As
Detection: +Peak 🔹			Show recalled trace
Function: Normal 🗸			

Setting Description			
Show	Shows / hides the trace. If the instrument continues to run, the measurement results below the graph display continue to update even if the trace is hidden.		
Detection	Sets the Detection method used for the trace. Available detection methods are +Peak -Peak, and Avg (VRMS). Not available for saved traces.		
Function	Selects the trace processing method. The only available setting is Normal.		
Freeze	Halts updates to the trace.		
Save Trace As	Saves the trace to a file for later recall and analysis.		
Show Recalled trace	Displays a saved trace instead of a live trace.		

Detection

Detection refers to the method of processing the data acquisition points when creating a trace. The IQ samples in a data acquisition can be detected in a variety of ways. The number of IQ samples available to each trace point varies with both analysis length and trace length. For example, with Spectrum Length set to 'Auto' in the Analysis menu, the instrument analyzes just enough samples to produce one IQ sample pair per trace point. In this case, the detection method chosen has very little effect, as the +Peak, -Peak, and Avg (VRMS) are all equal. Changing the Spectrum Length causes the available detection methods to differ in value because they have a larger set of samples for the various detection methods to process.

The available detection methods are:

- +Peak Each point on the trace is the result of detecting the positive peak value present in the set of IQ samples available to that trace point.
- -Peak Each point on the trace is the result of detecting the negative peak value present in the set of IQ samples available to that trace point.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the IQ samples available to the trace point. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results. When the averaging function is applied to a trace, the averaging is performed on the linear (Voltage) values, resulting in the correct average for RMS values.

Trace Processing

Traces can be processed to display in different ways. The Function setting controls trace processing.

- Normal Each new trace is displayed and then replaced by the next trace. Each data point contains a single vertical value.
- Average Each trace point is computed by averaging together the multiple results points it represents.
- **+Peak** Each trace point represents the highest vertical value among the results it includes.
- **Peak** Each trace point represents the lowest vertical value among the results it includes.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click **Save**.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Click the ... button to display the Open dialog box.
- 2. Navigate to the desired file and click Open.
- 3. Check the Show Recalled Trace check box.
- 4. Verify that the Show check box is selected.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Parameters Trace	Scale Prefs			
Vertical		Hor	rizontal	
Scale:	10.0 kHz		Scale:	35.280 us
Position:	0.000 Hz		Position:	92.160 us
	Autoscale			Autoscale

Setting	Description	
Vertical		
Scale	Changes the range shown between the top and bottom of the graph.	
Position	Adjusts the frequency shown at the center of the graph.	
Autoscale	Resets the Position so that the entire trace fits within the graph.	
Horizontal		
Scale	Changes the range shown between the left and right sides of the graph.	
Position	Adjusts the position of the acquisition record shown at the left edge of the graph.	
Autoscale	Resets the Scale and Position settings to provide the optimum display.	

Prefs Tab

The Prefs tab enables you to change appearance characteristics of the FM display.

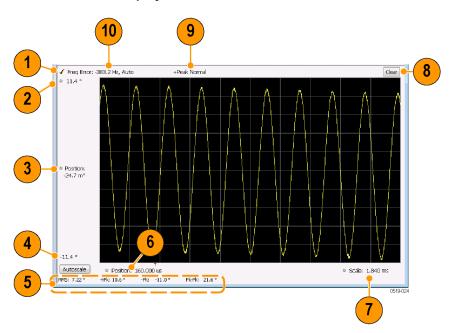
Parameters Trace Scale Prefs	
✓ Show graticule	Max trace points: 100K

Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Max trace points	The trace in the FM display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 500,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export.

PM Display

The Phase Modulation Display shows Phase vs. Time. The vertical axis units are degrees and the horizontal axis units are seconds. When taking measurements, only the first burst in the Analysis period is analyzed. No trace points are shown for data outside the first detected burst, nor are measurements made on data outside the first detected burst.

Elements of the Display



ltem	Element	Description		
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the PM display is the optimized display.		
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.		
2	Top of Graph control	Sets the phase value indicated at the top of the graph. Since the Position value at the vertical center of this graph remains constant as the Top of Graph value is adjusted, the Vertical Scale increases as the Top of Graph value increases, which also affects the bottom of graph readout. Vertical Scale can also be controlled from the Settings control panel's Scale tab.		
3	Position	Specifies the phase shown at the center of the graph display. Changing this value moves the trace up and down in the graph, which affects the Top of Graph and Bottom of Graph values as well.		
4	Bottom of Graph Readout	Displays the phase value at the bottom of the graph.		
5	Measurement readouts	Displays numeric values for the +Pk (positive phase deviation), –Pk (negative phase deviation), Pk-Pk (peak-to-peak phase deviation), and RMS (RMS value of the phase deviation).		
6	Position	Specifies the horizontal position of the trace on the graph display.		
7	Scale	Adjusts the time range of the graph. By decreasing the scale (full-scale time over 10 divisions), the graph essentially becomes a window that you can move over the acquisition record by adjusting the horizontal position.		
8	Clear	Clears the measurement results.		
9	Trace Detection readout	Displays the Trace Detection setting (see Settings > Trace > Detection).		
10	Freq Error	This readout can show Freq Error or Freq Offset. When it displays Freq Error, it shows the difference between the instrument Frequency setting and the measured value of the signal's carrier frequency. When it displays Freq Offset, it shows the frequency offset specified on the Settings > Parameters tab. If Freq Error is displayed, it also indicates that the Carrier frequency detection setting is Auto. If Freq Offset is displayed, it indicates that the Carrier frequency detection setting is manual.		

Changing the PM Settings (see page 93)

PM Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕸

The PM Settings control panel provides access to settings that control parameters of the PM Display.

Parameters Trace Scale	Prefs		
		Frequency offset:	-383.2 Hz 🔲 Auto
Burst detect threshold:	-100 dBc		Load Δ from marker
Measurement BW:	1.000 MHz	Phase offset:	128 ° 🗖 Auto
Measurement Bwy:	1.000 MH2		Load from marker

Setting	Description
Parameters (see page 94)	Sets the Carrier Frequency Detection method. You can choose either Automatic or Manual. Sets burst threshold and phase detection method.
Trace (see page 95)	Sets Trace display parameters.
Scale (see page 98)	Sets vertical and horizontal scale and position parameters.
Prefs (see page 99)	Specifies whether or not certain display elements are shown. Specifies the maximum number of points shown in the display graph.

Parameters Tab

The Parameters tab enables you to specify parameters that control the carrier frequency and phase detection.

Parameters Trace Scale Prefs	
	Frequency offset: -383.2 Hz 🔲 Auto
Burst detect threshold: -100 dBc	Load Δ from marker
Measurement BW: 1.000 MHz	Phase offset: 128 °
Measurement BW, 1.000 MHz	Load from marker

Setting	Description	
Burst detect threshold	Specifies the power level used to determine whether a burst is present. A valid burst is required to take measurements. The burst detected first is used for the analysis. The units for burst detect threshold are dBc, relative to the maximum acquisition sample data points level.	
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made.	
Frequency offset	Displays the carrier signal's frequency offset from the instrument's Measurement Frequency. Auto is used to select the method for determining the carrier frequency. When Auto is selected, the instrument determines the carrier frequency by analyzing the signal. When Auto is deselected, you can set the carrier frequency offset using Frequency Offset.	
Load Δ from Marker	Pressing this button disables the Auto Frequency Offset function and sets the Freque offset to the frequency offset calculated from the difference between MR (the marke reference) and the selected marker (or M1 if MR is currently the selected marker).	
Phase offset Displays the phase offset. When Auto is selected, the instrument determines the offset. When Auto is deselected, the user sets the phase offset with this control		
Load from marker	Pressing this button sets the phase offset to the phase offset of the selected marker. (Pressing this button automatically deselects Auto.)	

Frequency Offset

In Auto (Auto is selected), the instrument scans the measurement bandwidth about the Measurement Frequency and looks for the highest-powered signal. This is defined as the carrier frequency. In Manual (Auto is deselected), the carrier frequency is specified by adding/subtracting the specified Frequency offset from the Measurement Frequency. Range: -(Measurement BW*1.1)/2 to +(Measurement BW*1.1)/2. If the Load Δ from marker button is pressed, the frequency offset is determined from the phase difference between the two markers on screen compared to the time between the two markers. This function is useful for removing frequency slope from the phase modulated signal.

Phase Offset

In Auto (Auto is selected), the instrument sets the phase offset to fit the waveform to the screen centering 0° phase on the vertical axis. The actual phase offset is indicated on the Phase Offset readout. In Manual (Auto is deselected), the instrument sets the phase offset using the value specified in Phase offset. For example, when Phase offset is set to 10° , the waveform shifts upward by 10° on screen. Selecting Load from marker sets the phase offset to the value of the selected marker. Range: -180 to $+180^{\circ}$.

Trace Tab

The Traces Tab allows you to set the display characteristics of displayed traces.

Parameters Trace Scale Pre	fs		
	Show	Freeze	Save Trace As
Detection: +Peak -]		Show recalled trace
Function: Normal 🗸]		

Setting	Description	
Show	Shows / hides the trace. If the instrument continues to run, the measurement results below the graph display continue to update even if the trace is hidden.	
Detection	Sets the Detection method used for the trace. Available detection methods are +Peak, -Peak, and Avg (VRMS). Not available for saved traces.	
Function	Selects the trace processing method. The only available setting is Normal.	
Freeze	Halts updates to the trace.	
Save Trace As Saves the trace to a file for later recall and analysis.		
Show Recalled trace	Displays a saved trace instead of a live trace.	

Detection

Detection refers to the method of processing the data acquisition points when creating a trace. The IQ samples in a data acquisition can be detected in a variety of ways. The number of IQ samples available to each trace point varies with both analysis length and trace length. For example, with Spectrum Length set to 'Auto' in the Analysis menu, the instrument analyzes just enough samples to produce one IQ sample pair per trace point. In this case, the detection method chosen has very little effect, as the +Peak, -Peak, and Avg (VRMS) are all equal. Changing the Spectrum Length causes the available detection methods to differ in value because they have a larger set of samples for the various detection methods to process.

The available detection methods are:

- +Peak Each point on the trace is the result of detecting the positive peak value present in the set of IQ samples available to that trace point.
- -Peak Each point on the trace is the result of detecting the negative peak value present in the set of IQ samples available to that trace point.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the IQ samples available to the trace point. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results. When the averaging function is applied to a trace, the averaging is performed on the linear (Voltage) values, resulting in the correct average for RMS values.

Trace Processing

Traces can be processed to display in different ways. The Function setting controls trace processing.

- Normal Each new trace is displayed and then replaced by the next trace. Each data point contains a single vertical value.
- Average Each trace point is computed by averaging together the multiple results points it represents.
- **+Peak** Each trace point is represents the highest vertical value among the results it includes.
- **Peak** Each trace point is represents the lowest vertical value among the results it includes.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Click the ... button to display the Open dialog box.
- 2. Navigate to the desired file and click **Open**.
- 3. Check the Show Recalled Trace check box.
- 4. Verify that the Show check box is selected.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Parameters Trace	Scale Prefs		
Vertical		Horizontal	
Scale:	22.8 °	Scale:	1.840 ms
Position:	-24.7 m°	Position:	160.000 us
	Autoscale		Autoscale

Description	
Changes the range shown between the top and bottom of the graph.	
Adjusts the phase shown at the center of the graph.	
Resets the Position so that the entire trace in the graph.	
Changes the range shown between the left and right sides of the graph.	
Adjusts the phase shown at the left edge of the graph.	
le Resets the Scale and Position settings to show the entire trace within the graph.	

Prefs Tab

The Prefs tab enables you to change appearance characteristics of the PM display.

Parameters Trace Scale Prefs	
✓ Show graticule	Max trace points: 100K Show Marker readout in graph (selected marker)

Setting	Description	
Show graticule	Shows or hides the graticule.	
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.	
Max trace points	The trace in the PM display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 500,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export.	

Overview

The displays in RF Measurements (Displays > Measurements > RF Measurements) are:

- CCDF
- MCPR
- Occupied Bandwidth
- Spurious

The RF Measurements power measurements and signal statistics help you characterize components and systems.

Power Measurements

Measurement	Description	
Channel Power	The total RF power in the selected channel (located in the ACPR display).	
Adjacent Channel Power Ratio	Measure of the signal power leaking from the main channel into adjacent channels.	
Multi-Carrier Power Ratio	The ratio of the signal power in the reference channel or group of channels to the power in adjacent channels.	
Peak/Avg Ratio	Ratio of the peak power in the transmitted signal to the average power in the transmitted signal (located in the CCDF display).	
CCDF	The <i>Complementary Cumulative Distribution Function</i> (CCDF). CCDF shows how much time a signal spends at or above a given power level relative to the average power of a measured signal.	

MCPR (Multiple Carrier Power Ratio) Display

Use the MCPR measurement to measure adjacent channel power ratio for multiple main channels or when adjacent channel pairs have different offsets and/or bandwidths. The MCPR display show the Reference Power and the ratio of each adjacent channel to the Reference Power. You can select whether the Reference Power is the total of all active channels or a single channel.

Measuring Multiple Carrier Power Ratio

- 1. Press the front-panel **Displays** button.
- 2. From the Select Displays window, select RF Measurements or P25 Analysis from the Measurements box.
- 3. Double-click the MCPR icon in the Available displays box. Click OK to complete your selection.
- 4. Press the front-panel **Freq** button and use the front panel keypad or knob to adjust the frequency to that of the main channel. Select **Meas. Freq** to set the measurement frequency. Use the front panel knob to adjust the frequency.

5. Press the Settings button. This displays the control panel for MCPR (the tab displayed will be the tab displayed the last time the Settings panel was opened).

req & RBW	Measuremen	t Params Chan	nels Scale Prefs						
Main Chan	inels	Inactive	Adj Chans	Chan	BW	Offset	L.Limit	U.Limit	-
Number:	1	M1	Add	M1	12.500 kHz	0.000 Hz			
				A1	6.000 kHz	+/-12.500 kHz	-67.00 dB	-67.00 dB	Ξ
BW:	12.500 kHz		Edit	A2	6.000 kHz	+/-62.500 kHz	-67.00 dB	-67.00 dB	
				A3	6.000 kHz	+/-87.500 kHz	-67.00 dB	-67.00 dB	
Spacing:	12.500 kHz		Delete	A4	6.000 kHz	+/-150.000	-67.00 dB	-67.00 dB	
				15	6 000 647	1/ 250 000	67 00 dp	67 00 dp	-

6. Click on the **Channels** tab. To set the number of Main channels, enter the number of Main channels in the **Number** text entry box under **Main Channels**.

NOTE. *As you add channels, the span of the display will be adjusted so that all the channels can be seen.*

- 7. To set the bandwidth of all main channels, enter a value in the **BW** value box.
- 8. To set the spacing between the main channels, enter a value in the Spacing value box.
- **9.** To prevent a main channel power level from being included in the Power Reference (Total) calculation, select the channel to be excluded in the **Inactive** box.
- 10. To add adjacent channels, click the Add button under Adj Chans.

💀 Edit Channel Parameters	
Frequency Offset 262.5 kHz	Close
	Settings for:
 Bandwidth 6.000 kHz 	A6
 LowerLimit -80.00 dB 	
 UpperLimit -80.00 dB 	
Enable Power Limits	

11. To edit Frequency Offset or Bandwidth, click within the value box and use the front-panel knob or your keyboard to set the value. Click **Close** to save your changes.

NOTE. Frequency Offset is the difference between the center frequency of the selected channel and the Measurement Frequency. All channels (Main or Adjacent) are specified by their offset from the Measurement Frequency.

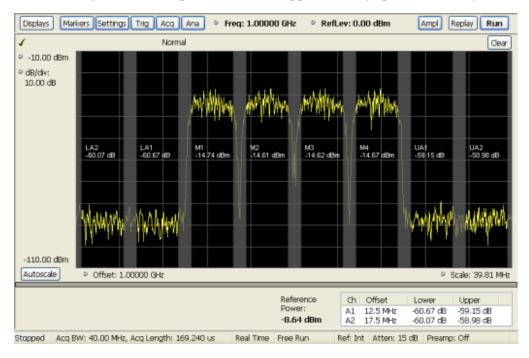
12. To enable and define power limits, check the **Enable Power Limits** box and enter the desired Upper and Lower limits. You can read more about power limits here (see page 104).

🖳 Ed	lit Channel Parameters	
	Frequency Offset 262.500 kHz	Close
		Settings for:
•	Bandwidth 6.000 kHz	A6
6	-80.00 dB	
	UpperLimit -80.00 dB	
] Enable Power Limits	

13. After you have configured the Main and Adjacent channels, click the close button (

Viewing Results

MCPR measurement results are displayed both in the spectrum graph and in a table below the spectrum display. Individual Main channel power measurements appear in the graph under their channel identifiers. Individual adjacent channel power ratios also appear in the graph under the adjacent channel identifier.



Heading	Description
Ch	Identifies the adjacent channels. Adjacent channels are numbered according to their offset from the Main channel. The closest channel is numbered 1. The next closet channel is numbered 2; and so forth. The prefix "L" means lower; "U" means upper.
Offset The offset is the difference in frequency between the Measurement Frequency of the channel.	
Lower	Displays the ratio of the lower adjacent channel power to the Power Reference.
Upper	Displays the ratio of the upper adjacent channel power to the Power Reference.
L. Limit	Displays the lower power limit.
U. Limit	Displays the upper power limit.
Power Reference	Depending on the selected Power Ref, this readout displays either the power of the selected main channel or the total power in the active main channels.

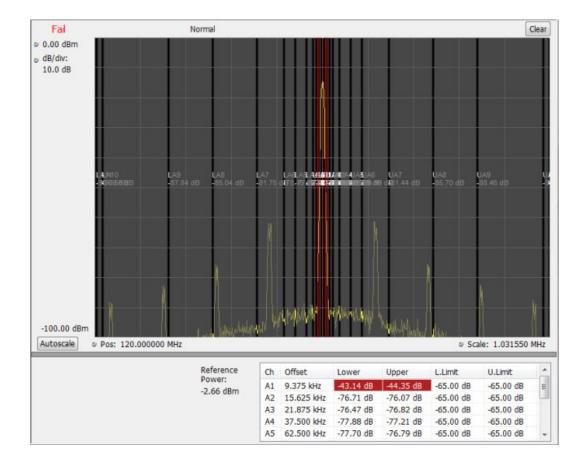
The following table details the entries in the results table.

Depending on the number of adjacent channels, to see all the measurements, you might need to drag the divider bar between the main display and the results table at the bottom of the window to change the height of the results table.

Setting MCPR Measurement Parameters (see page 107)

Setting Power Limits

When power limits are enabled (Settings > Channels > Add), the comparison of the actual results of an adjacent channel is done against the limits. If there is a failure, the Lower and Upper power cells in the MCPR table will be red and the failure segments of the trace display will be red. The words Fail in red will also appear in the top left corner of the display (even if one adjacent band fails). See the following image for an example.



Multiple Carrier Power Ratio

The ratio of the signal power in an adjacent channel to the power in one or more main channels.

MCPR Settings

Menu Bar: Setup > Settings

The Setup control panel tabs for MCPR (Multiple Carrier Power Ratio) are:

req & RBW	Measurement Para	ams Channels	Scale Prefs						
Main Chan		active	Adj Chans	Chan	BW	Offset	L.Limit	U.Limit	-
Number:	1	M1	Add	M1	12.500 kHz	0.000 Hz			
				A1	6.000 kHz	+/-12.500 kHz	-67.00 dB	-67.00 dB	Ξ
BW:	12.500 kHz		Edit	A2	6.000 kHz	+/-62.500 kHz	-67.00 dB	-67.00 dB	
				A3	6.000 kHz	+/-87.500 kHz	-67.00 dB	-67.00 dB	
Spacing:	12.500 kHz		Delete	A4	6.000 kHz	+/-150.000	-67.00 dB	-67.00 dB	
				15	6 000 kH4	1/ 250 000	67 00 dp	67 00 dp	*

Settings tab	Description
Freq & RBW (see page 106)	Specify the frequency and resolution bandwidth used for the MCPR measurements.
Measurement Params (see page 107)	Specifies parameters controlling how the MCPR measurement is made.
Channels (see page 107)	Specifies the parameters of the channels to be measured.
Scale (see page 153)	Specifies the vertical and horizontal scale and offset values.
Prefs (see page 154)	Specifies whether or not certain display elements are shown.

Restore defaults. Sets parameters for a 4-carrier WCDMA measurement.

Freq & RBW Tab for ACPR and MCPR Displays

The Freq & RBW tab specifies frequency parameters for the Channel Power & ACPR measurements and MCPR measurement.

Freq & RBW Mea	surement Params	Channels	Scale	Prefs			
Meas Freq:	1.00000 GHz			RBW:	30.000 kHz	📝 Auto	
Step:	2.0000 MHz	🔽 Auto		VBW:			

Setting	Description
Meas Freq	Specifies the center/measurement frequency.
Step	
RBW	Select Auto or Manual. Adjusts the RBW for the entire measurement. This setting is Independent of the Spectrum view's RBW setting.
VBW	Adjusts the VBW (Video Bandwidth) value. VBW Maximum = current RBW value. VBW Minimum = 1/10,000 RBW setting.

NOTE. While the center frequency and step settings on this control tab are shared between ACPR, MCPR and Occupied Bandwidth, the RBW setting is not shared. The RBW setting is unique for each measurement.

VBW

The VBW setting enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers.

The maximum VBW value is the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.

Measurement Params for ACPR and MCPR Displays

The Measurement Params tab is where you set parameters that control the ACPR and MCPR measurements.

Parameter	Description							
Average	Enables/disables measurement averaging. Averaging can be enabled in either the Frequency Domain or Time Domain.							
Frequency-domain	This setting takes the average linear value of the traces (so that rms values are preserved). The number of averages is user-defined. Frequency domain averaging is available in spans larger (or smaller) than the maximum real time bandwidth. This is the mode to use unless you need to extract maximum dynamic range from an ACPR measurement.							
Time-domain	This setting takes the average linear value of the traces. It is useful if you need to extract maximum dynamic range from an ACPR measurement. The number of traces is user defined. But, the signals must be triggered and repeating. That is, the signal needs to be exactly the same for each acquisition. When this condition is met, each waveform contains the same signal, but the random noise changes from acquisition to acquisition and the average value of the random noise is lowered, while the signal value remains constant. Time domain averaging is not available in spans wider than the maximum real-time bandwidth.							
Number	Specifies the number of acquisitions to be averaged when Averaging is set to Frequency Domain. Specifies the number of successive capture records that are averaged when Averaging is set to Time Domain.							
Power Reference	Specifies power against which the results are compared. Choices available are each of the existing main channels and "Total (active channels".							
	Only present when MCPR is the selected display.							
Channel Filter	Specify the channel filter used. Select between None (default) and Root-raised Cosine.							
Filter Parameter	Value entry box for the Root-raised Cosine filter Adjacent Channel Filter.							
	Present only when the Channel Filter is set to Root-raised Cosine.							
	Value entry box for the Root-raised Cosine chip rate.							
	Present only when the Channel Filter is set to Root-raised Cosine.							

Channels Tab for MCPR

Path: Setup > Settings > Channels

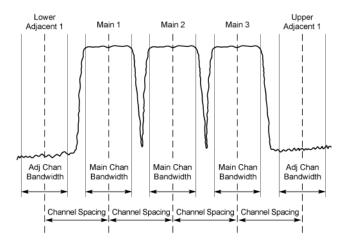
Application Toolbar / Front Panel: Settings

The Channels tab is where you specify the parameters for the channels measured in the MCPR display.

eq & RBW	Measuremen	t Params Chan	nels Scale Prefs	6					
Main Chan	nels	Inactive	Adj Chans	Chan	BW	Offset	L.Limit	U.Limit	
Number:	1	M1	Add	M1	12.500 kHz	0.000 Hz			
				A1	6.000 kHz	+/-12.500 kHz	-67.00 dB	-67.00 dB	=
BW:	12.500 kHz		Edit	A2	6.000 kHz	+/-62.500 kHz	-67.00 dB	-67.00 dB	
				A3	6.000 kHz	+/-87.500 kHz	-67.00 dB	-67.00 dB	
Spacing:	12.500 kHz		Delete	A4	6.000 kHz	+/-150.000	-67.00 dB	-67.00 dB	
				45	6 000 647	1/ 250 000	67 00 dp	67 00 dp	*

Description
Sets the number of Main channels.
Sets the bandwidth of the Main channels.
Sets the frequency difference between the centers of the Main channels.
Selected channels are ignored by the measurement routine.
Opens the Edit Channel Parameters dialog, which you use to specify the parameters of a new pair of adjacent channels. You can add up to 50 adjacent channel pairs.
Opens the Edit Channel Parameters dialog box. (You must first select a channel to enable the Edit button.)
Deletes the selected main channel or adjacent channel pair.
A table of the parameters for every channel. Offset is the frequency difference between the Center Frequency and center of the selected channel. Nothing in the table is editable directly. You can set the upper and lower limits by clicking on the Add button.

The following figure illustrates the settings controlled from the Channels tab.



Editing Channel Parameters

To edit the offset or bandwidth of a Main channel:

- 1. Select the value in the BW or Spacing number entry boxes.
- 2. Adjust the value as required. All the Main channels share the same BW and Spacing.
- 3. Select the appropriate check box to make a channel Inactive, as appropriate.
- 4. Click the Close button when you have finished making changes.

To edit the offset or bandwidth of an Adjacent channel:

- 1. Select the channel to be edited in the channel definition table.
- 2. Select Edit. This displays the Edit Channel Parameters dialog box.
- 3. Adjust the values for the Frequency Offset, Bandwidth, and upper and lower Limits, as required.
- 4. Click the Close button when you have finished making changes.

Adding Channels

To add a main channel:

- 1. Select the Number entry box.
- 2. Use the knob to enter a value for the desired number of Main channels.
- 3. Click the Close button when you have finished making changes.

To add an adjacent channel pair:

- 1. Select Add. This displays the Edit Channel Parameters dialog box.
- 2. Use the knob to enter values for the **Frequency Offset**, **Bandwidth**, and upper and lower **Limits**, as required. The Frequency Offset is measured from the Meas Frequency of the Main channels.
- 3. Click the Close button when you have finished making changes.

Deleting Channels

To delete a main channel:

- 1. Select the Number entry box.
- 2. Use the knob to reduce the number of channels or enter a new value using the front-panel keypad.
- **3.** Click the Close button when you have finished making changes.

To delete an adjacent channel:

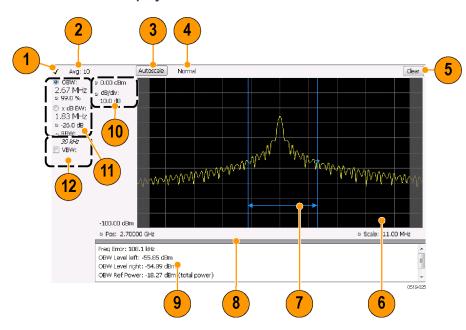
- 1. Select the channel to be deleted in the channel definition table.
- 2. Select **Delete**. This removes the selected channel from the channel table.
- 3. Click the Close button when you have finished making changes.

Occupied BW & x dB BW Display

The Occupied BW display shows the bandwidth within which 99% (a user-defined value, the default is 99%) of the power transmitted within the measurement bandwidth falls.

To show the Occupied BW display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select RF Measurements in the Measurements box.
- **3.** In the **Available displays** box, double-click the **Occupied Bandwidth** icon or select the icon and click **Add**. The Occupied Bandwidth icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to display the Occupied Bandwidth.



Elements of the Display

ltem	Display element	Description
1	Check mark indicator	The check mark indicator denotes the display for which the acquisition hardware is optimized. This indictor appears only when the display is the selected display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Averaging readout	Appears when averaging is enabled (Settings > Parameters tab > Average results). Displays "Avg: n of m" while averaging the results and "Avg: m" once the requested number of results have been averaged.
3	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.
4	Trace function readout	Displays either Normal or MaxHold to indicate trace function.
5	Clear	Resets count for Average and MaxHold functions. Enabled only when Averaging or MaxHold is enabled. Pressing Clear will clear the trace and, if acquisition is running, restart the averaging or hold process.
6	Graph	Displays the input signal. Shaded areas indicate the measurement bandwidth (Settings > Parameters tab > Measurement BW).
7	Blue lines	The blue lines indicate where the selected results (selected in the Main results area) are being measured on the trace.
8	Grid divider	Determines the portion of the display allocated to the graph and detailed results area. You can move the grid divider all the way to the top or bottom and any position in between.
9	Detailed results area	Displays additional measurements results.
10	Position and dB/div	Position sets the top of graph value. The dB/div setting is the vertical scale value.
11	Main results area	Displays results for Occupied Bandwidth (OBW) and x dB bandwidth. Use the two radio buttons to select which of the two results are illustrated in the graph with the blue lines and arrows. There are also controls for adjusting OBW % Power, x dB BW, and RBW.
12	VBW	Enables the VBW (Video Bandwidth) filter. Displays current VBW filter setting. See Setup > Settings > Freq & RBW tab (see page 106).

Detailed Results Readouts

Measurement	Description
Freq Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the analyzer.
OBW Level left	The signal level at the left edge of the occupied bandwidth.
OBW Level right	The signal level at the right edge of the occupied bandwidth.
OBW Ref Power	The total power measured within the measurement bandwidth.
x dB BW Ref Power	The peak power measured within the measurement bandwidth.

Changing the Occupied Bandwidth Settings (see page 112)

Occupied Bandwidth

Bandwidth within which some defined percentage of the power transmitted on a single channel lies.

Occupied BW & x dB BW Settings

Menu Bar: Setup > Settings

The control panel tabs for the Occupied Bandwidth display are shown in the following table.

Settings tab	Description
Freq & RBW (see page 149)	Allows you to specify the Center Frequency, Step size and RBW.
Parameters (see page 113)	Allows you to specify the Occupied BW % Power, x dB level, Measurement BW, enable averaging and the Max Hold function.
Scale (see page 153)	Allows you to set the vertical and horizontal scale parameters.
Prefs (see page 154)	The Prefs tab enables you to set characteristics of the measurement display.

Parameters Tab

The Parameters tab enables you to specify parameters that control the Occupied BW measurement.

Freq & RBW Parameters Sc	ale Prefs		
Occupied BW % Power:	99.0 %		
		📃 Max Hold spectral c	lata
x dB level:	-26.0 dB		
			Count:
Measurement BW:	10.00 MHz	Average results	10
-icasorement by.	201001116		

Setting	Description					
Occupied BW % Power	Specifies the proportion of power within the occupied bandwidth (referenced against the total power in the measurement bandwidth).					
x dB level	x dB level defines the x dB BW level search threshold.					
Measurement BW	Specifies the frequency range used by the measurement.					
Max Hold spectral data	Enables the Max Hold function.					
Average results Enables/disables results averaging. Note that this is not an averaging of the tra averaging of the results.						
Count	Specifies the number of results averaged to calculate the Occupied BW. Range: 2 to 10,000.					

x dB Level

The x dB level determines the x dB BW. The instrument analyzes the spectrum trace to locate the frequencies at which the level is x dB down from the peak level calculated over the measurement bandwidth. The frequency difference between the upper and lower crossing thresholds is the x dB BW.

Range: -80.0 to -1.0 dB; Resolution: 0.1%; Inc/dec small: 0.1%, large: 1%; Default: -26 dB

Max Hold Spectral Data

Max Hold displays the maximum value in the acquisition record for each display point. Each new trace display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons.

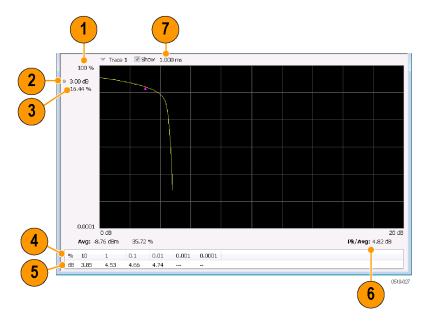
CCDF Display

The CCDF (Complementary Cumulative Distribution Function) is a statistical characterization that plots power level on the x-axis and probability on the y-axis of a graph. Each point on the CCDF curve shows what percentage of time a signal spends at or above a given power level. The power level is expressed in dB relative to the average signal power level. The CCDF Display also shows the Average power level and the Peak/Average ratio.

To show the CCDF display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select RF Measurements.
- **3.** Double-click the **CCDF** icon in the **Available Displays** box. This adds the CCDF icon to the **Selected displays** box.
- 4. Click the **OK** button.

Elements of the CCDF Display



ltem	Display element	Description The top of the graph represents the 100% probability that the signal will be at or above the average signal level.				
1	100%					
2	Power level select	Adjust to display the value of the CCDF curve at a specific power level. The selected power level is indicated by a small triangle on the CCDF curve.				
3	CCDF value	Readout of the value of the CCDF curve at the selected power level.				
4	Avg	Readout of the Average power level and the CCDF value at the Average power level.				
5	Readout Table	Readout of the CCDF curve at six points.				
6	Pk / Avg	Readout of the Peak to Average power ratio.				
7	Measurement time	Readout of the length of time used for the measurement. Displays s when the Measurement time is set to continuous.				

Changing the CCDF Display Settings (see page 115)

CCDF Settings

Menu Bar: Setup > Settings

Application Toolbar: 🗳

The control panel tabs for the CCDF Display are shown in the following table.

Settings tab	Description
Parameters (see page 116)	Specifies the time to be measured.
Traces (see page 150)	Select the trace to be measured and select reference trace for display.
Prefs (see page 154)	Specifies whether on not certain display elements are shown.

Restore defaults. Sets the CCDF parameters to their default values.

Parameters Tab

The Parameters tab enables you to specify several parameters that control signal acquisition for the CCDF Display.

Parameters	Traces P	refs						
Measure	Measurement Time							
) Sir	Single (use Analysis Length)							
© та	otal Time:	20.000 ms	Span:	85.0 MHz				
© Ca	ontinuous							

Setting	Description		
Single	When Single is selected, the CCDF measurement is based on the Analysis Time parameters set on Analysis control panel (Setup > Analysis > Analysis Time), shared by all displays. In Single, CCDF is time-correlated with the other open displays.		
Total Time When Total Time is selected, you can adjust its value. The value set here does the Analysis Length value set in the Analysis control panel. If the Total Time values than the Analysis Length, CCDF uses multiple acquisitions to collect sign			
Continuous When Continuous is selected, the CCDF measurement combines each new (Actual Analysis Length) into the existing result. It does not erase and start ouser presses STOP or CLEAR.			
Span	Specifies the range of frequencies used for analysis.		

Single

To have statistically meaningful results, CCDF works best when calculated on at least 1 ms of data. Depending on the Analysis Time setting, the CCDF display may present error messages:

- If the Actual Analysis Time is greater than 1 ms, the CCDF Display will calculate the trace without any problems.
- If the Actual Analysis time is less than 1 ms, the CCDF Display will measure the data as best if can, but if it receives fewer than 20 samples, the CCDF display will clear the trace and report "Not enough samples".

Settling Time Measurement Overview

Measurement Definitions

Settling time. The time measured from a reference point to when the signal of interest settles to within user-defined tolerance.

Settled frequency. The final reference frequency, determined automatically or manually. The tolerance band is centered about this settled frequency.

Settled phase. The final reference phase, determined automatically or manually. The tolerance band is centered about this settled phase.

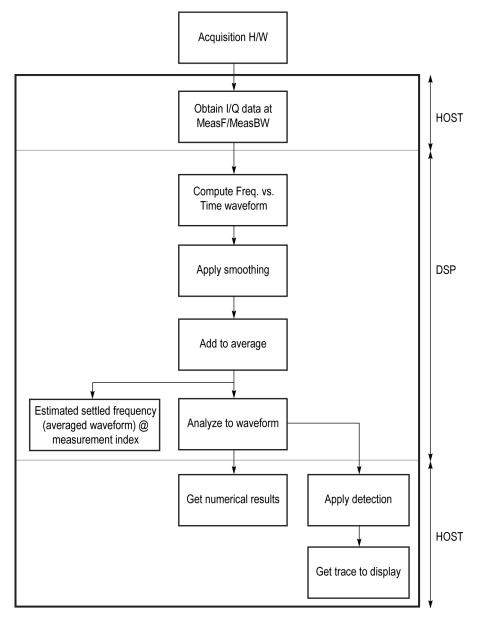
Mask Testing

Mask testing is a tool to automatically determine the pass/fail state of the Device-Under-Test. The mask is defined over three or fewer user-defined time zones, with an independent limit band for each time zone. If the mask is violated, the area of violation is highlighted in red on screen, and a Fail message is displayed. The pass/fail status of the mask test can be queried over GPIB for rapid results. To configure Mask testing, see the Mask tab (see page 133).

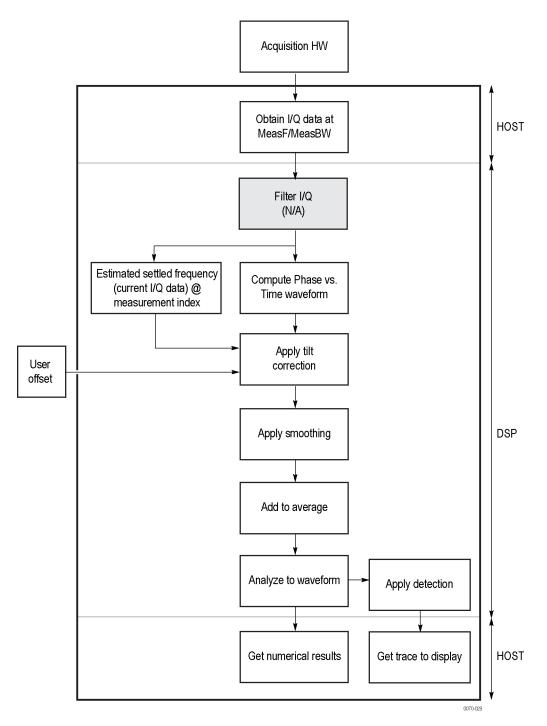
The instrument's Search function can watch the Settling Time measurement for either pass or fail results, and perform actions such as stopping or saving data when the defined condition occurs. See <u>Mask Test</u> Limits Settings (see page 463) for details on configuring Mask Test.

Frequency Settling Time Theory of Operation

The following paragraphs describe how a frequency and phase settling measurement is made.



Frequency settling time flow diagram



Phase settling time flow diagram

Acquisition hardware collects I and Q samples at the measurement frequency. Sample Rate is based on the measurement bandwidth setting.

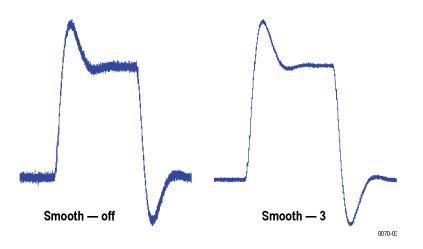
The instantaneous phase is computed as:

$$Ph_{(n)} = atan\left(\frac{Q_{(n)}}{I_{(n)}}\right)$$

The instantaneous frequency is the derivative of the phase:

$$Fr_{(n)} = \left(Ph_{(n-1)} - Ph_{(n+1)}\right) \times \left(\frac{F_{sampling}}{(2 \times 2PI)}\right)$$

Data smoothing is applied (if selected by the user). This filtering method uses $\pm n$ adjacent samples to produce an average value that is used to replace the values of the original 2n samples. An example is shown below.

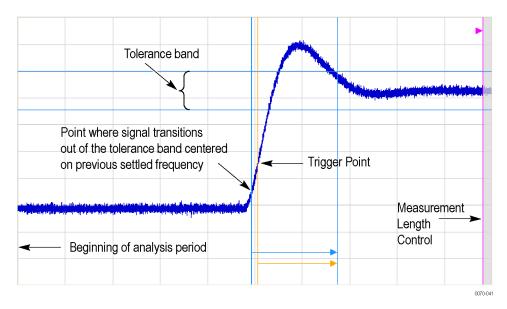


If averaging is turned on, the smoothed data array is averaged with data arrays of previous acquisitions on a point-by-point basis. Smoothing has the advantage of reducing noise-like variations in the measurement, but carries the risk of masking real measurement data. The amount of smoothing applied must be determined by evaluating the waveform you see for artifacts that result from the process.

Next, Settled Frequency is calculated. Settled frequency is the average frequency determined by looking back in time from the point set by the Measurement Length control over a minimum of 256 samples. This value is used to determine the frequency level about which to center the Tolerance range. The measurement then searches backward through the data until it finds the first point that exceeds the tolerance range. A maximum of 20 million acquisition data samples can be processed by the measurement.

Settling Time is measured as the time from the start reference to the point where the frequency remains within the tolerance band. The start reference can be any of three points:

- The trigger point
- The beginning of the analysis period. This result can only be computed when the instrument can find a previous settled state within the measurement period
- The point at the end of the previous frequency hop where the frequency first leaves the tolerance band. This result can only be computed when the instrument can find a previous settled state within the measurement period.



Settling time start reference points

All measurements are now complete and the numeric settling time values can be sent to the display. However, no result traces have been produced yet. Detection is used to reduce the measured points (which can number up to 10 million) to a number more easily processed by the display processor. +/- Peak detection is always used, preserving the maximum positive and negative excursions for display. Reducing the number of points in the result reduces the time resolution of the markers. If averaging is on, the measurement results are computed on the average of the undecimated results.

Phase Settling Time Overview

Phase settling time is determined, as described previously, with the addition of tilt correction.

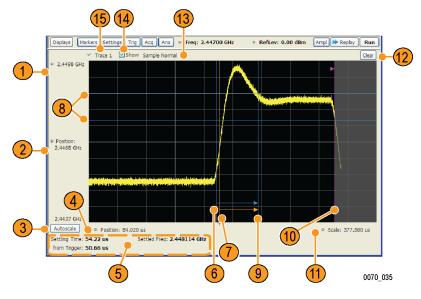
The instrument estimates tilt (or slope of the phase) using linear least square fitting over (at least) 256 samples of the phase vs. time waveform, looking backwards from the point set by the Measurement Length. The instrument adjusts the phase waveform so that its phase is of zero value at the point set by the Measurement Length.

Settling Time Displays

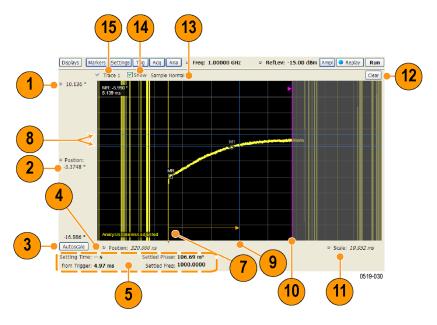
The Frequency Settling Time measurement is used to measure the frequency settling time of frequency-agile oscillators and subsystems. The Phase Settling Time measurement is used to measure the phase settling time of phase-agile oscillators and subsystems. Automated measurements can reduce user-to-user measurement variations, improving repeatability and measurement confidence and saving time in gathering results. To measure phase settling, a phase reference is required. This means that the measurement tool must be frequency- referenced to the device under test, or must act as the frequency reference to the device under test. To lock the reference to an external source, go to Setup > Configure In/Out > Frequency Reference and choose **External**. Values from 1 MHz to 25 MHz in 1 MHz steps can be used as an external reference.

To show a Settling Time display:

- 1. Click the **Displays** button or select **Setup** > **Displays**.
- 2. From the Measurements box, select RF Measurements.
- 3. Double-click the **Freq Settling** icon or the **Phase Settling** icon in the **Available displays** box. This adds the selected display to the **Selected displays** box (and removes it from the Available displays box).
- 4. Click the **OK** button.



Frequency settling time display



Phase settling time display

Elements of the Display

ltem	Display element	Description					
1	Top of graph	Sets the frequency/phase that appears at the top of the graph. However, note that the top of graph setting, vertical scale setting (Settings > Scale tab), and Vertical Position settings interact. Adjusting this value changes the frequency/phase at the top of the graph by adjusting the scale setting.					
		Phase Settling Time: Sets					
2	Vertical Position	Sets the frequency/phase value at the vertical center of the graph.					
3	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen.					
4	Horizontal Position	Sets the horizontal position of the trace on the graph.					
5	Measurement readouts	Displays measurement results. See Measurement Readout Text Color below.					
6	Signal transition start indicator	A blue vertical line that indicates the staring point of the Settling Time measurement that is based on the signal transition away from the previous settled state, if a previous settled state is found within the measurement period.					
7	Trigger point indicator	An orange line and "T" (which appears below the graph) that indicates the location of the trigger point in time.					
8	+/- Tolerance indicators	A pair of blue horizontal lines that show the tolerance range.					
9	Settled time indicator	A blue vertical bar that shows the point on the trace at which the measurement has determined the signal frequency or phase to be settled.					
10	Measurement length indicator	A magenta vertical line that specifies the end of the allowed measurement period. This is a control, not a result.					
11	Scale	Adjusts the horizontal (time) scale of the graph.					
12	Clear	Restarts multi-trace functions (Avg, Hold) and erases the trace.					
13	Function	Displays the Detection and Function selections for the selected trace. (Detection is always +/-Peak for Settling Time measurements.)					
14	Show	Controls whether the selected Trace is visible or not. When trace is Off, the box is not checked.					
15	Trace	Selects a trace. Touching here displays a menu that shows the available traces and whether they are enabled or not. If you select a trace that is not currently enabled, it will be enabled.					

Measurement Readout Text Color

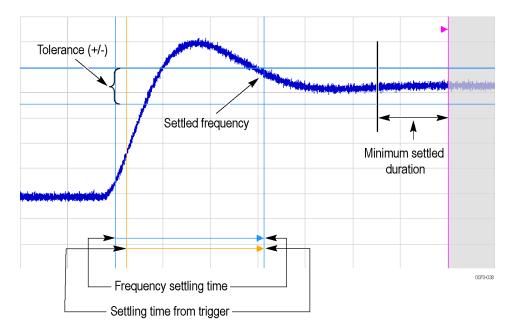
The measurement readouts can appear in either black text or red text. Measurement results that appear in black text indicate:

- the signal is settled AND
- the signal is settled longer than the minimum settled duration AND
- the settling time is valid OR the settling time from trigger is valid

If any of the conditions listed are not met, the measurement results text is red.

Elements of the Frequency Settling Time Graph

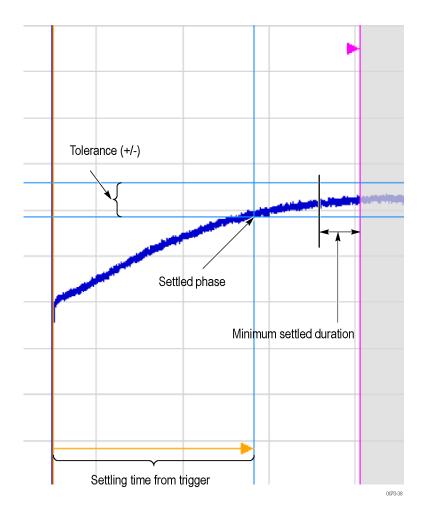
The following illustration shows the various indicators that appear in the Frequency Settling Time graph.



NOTE. The blue vertical bar that indicates the end of the previous settled state may not always appear. For frequency settling time, this can happen because the starting frequency is outside the measurement bandwidth.

Elements of the Phase Settling Time Graph

The following illustration shows the various indicators that appear in the Phase Settling Time graph. For most phase settling time measurements, there is not a previous settled state within the measurement period, making it impossible to measure the settling time from the previous settled value. However, the settling time from trigger is typically available.



NOTE. The blue vertical bar indicating the measurement start time may not appear. Zero phase is referenced to the measured hop, as the phase will not typically have a settled value during the previous hop.

Measuring Settling Time

- 1. Select the **Displays** button.
- 2. Select RF Measurements from the Measurements box.
- **3.** Double-click the **Freq Settling** icon or **Phase Settling** icon in the Available displays box. Click **OK** to complete your selection.
- 4. Select General Signal Viewing from the Measurements box.
- **5.** Double-click the **Time Overview** icon in the Available displays box. Click **OK** to complete your selection.
- 6. Press the front-panel **Freq** button and use the front-panel keypad or knob to adjust the frequency to that of the signal you want to measure.

- 7. Select the Trig button.
- **8.** In the Trigger control panel, select Triggered. Configure the trigger settings an needed to achieve a triggered signal.

For the next step in measuring settling time, you must set the starting point of the measurement. To do this, you will use the Time Overview display.

- 9. Select the Time Overview display.
- **10.** At the left edge of the graph, drag across the graph to adjust the analysis offset. Adjust the Analysis Offset to locate the start of the settling time measurement just ahead of the signal transition where you want to measure the settling time. Any portion of the signal in the gray area will be excluded from the settling time measurement.

A S-	- 106.19	4 us				+Pe	ak Normal	Clear
◎ 0.00 dBm ◎ dB/div:								
1.40 dB								
-14.00 dBm			т					
Autoscale	Position:	0.000 s	1				 Scale 	e: 1.020 ms

Setting the starting point of the settling time measurement

Even if the signal transition is difficult to see on the Time Overview display, you can set the starting point based on the location of the Trigger indicator below the graph. Or open the Frequency vs. Time graph to see the frequency transition.

- 11. Click in the Settling Time display to select it.
- 12. Select the Settings button to display the Settling Time Settings control panel.
- 13. On the Define tab, adjust the Meas BW (see page 130) to improve the signal-to-noise ratio as appropriate. Make sure the bandwidth covers the settled frequency, particularly when the instrument Measurement Frequency is not locked to the spectrum Center Frequency (Analysis control panel > Frequency tab).
- 14. Set the <u>Target reference (see page 130)</u> to Auto or Meas freq as appropriate. If you select Meas freq, also set Offset to fine-tune the measurement frequency if necessary.
- 15. Set the Tolerance (see page 131) as required for your measurement.

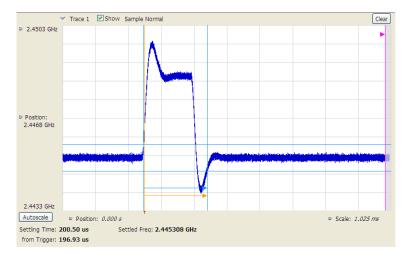
If your signal must be settled for a period of time before it is considered settled, you can specify a minimum settled duration for the settling time measurement.

16. Select the Time Params tab. Adjust the Min settled duration (see page 132) as required.

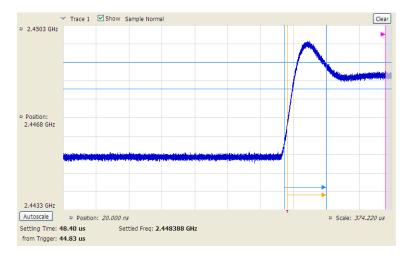
To get the measurement made in the correct location on the signal, you must adjust the measurement length. You do this by dragging the magenta line in the Settling Time graph.

17. Drag the measurement length indicator (magenta line) to the correct location on the signal. Choose a point at which the signal appears to be well settled. The measurement will then find the exact time at which the signal actually settled to within the specified tolerance.

Note the difference in the settling time in the two illustrations that follow. In both examples, the Target reference is set to Auto. The only difference is the measurement length, as shown by the magenta line.



Frequency settling time display before setting the measurement length



Frequency settling time display after setting the measurement length

Settling Time Settings

Application Toolbar: 🥨

Settings tab	Description
Define (see page 130)	Sets the measurement parameters that characterize the settling time measurement.
Time Params (see page 132)	Sets measurement end-time and minimum settled duration parameters.
Mask (see page 133)	Enable or disables mask testing and sets the parameters that specify the three zones used for mask testing.
Trace (see page 133)	Specifies trace display characteristics and which traces are displayed.
Scale (see page 153)	Sets vertical and horizontal scale and position parameters.
Prefs (see page 154)	Specifies whether or not to show certain display elements, the maximum number of points in the exported trace, and the displayed precision of the settling time measurement.

Settling Time Displays Shared Measurement Settings

The control panel tabs in this section are shared by the Frequency and Phase Settling Time displays. These control panel tabs are not shared with other RF Measurement displays. With few exceptions, each display shares values for each of the controls on these tabs. For example, Vertical Scale values are independent for each of the displays (degrees for Phase Settling Time and Hertz for Frequency Settling Time).

Settings tab	Description
Define (see page 130)	Specifies the parameters that characterize the settling time measurement.
Time Params (see page 132)	Specifies the Measurement length and minimum settled duration for the settling time measurement.
<u>Mask (see page 133)</u>	Specifies the parameters used for Mask testing.
Trace (see page 133)	Specify which traces to show and how they are computed.
Scale (see page 136)	Specifies the vertical and horizontal scale settings.
Prefs (see page 137)	Specifies display parameters of the Settling Time displays.

Common controls for settling time measurement displays

Define Tab for Settling Time Displays

The Define tab for the Frequency Settling Time measurement controls several parameters that affect how the measurement is made.

Define Time Par	ams Mask Trace	Scale Prefs	
Meas Freq:	2.44700 GHz	Target reference: Auto 👻	Offset: 0.0000 Hz
Meas BW:	40.00 MHz	Tolerance (+/-): 500.0 kHz	
actual: 40.00 MHz			

Meas Freq

Select the frequency of the signal to be measured. Measurement Frequency can be selected as the target frequency (see *Target Reference*).

NOTE. If Lock Center Frequency of Spectrum Display to Measurement Frequency is unchecked, then Measurement Frequency is independent of Center Frequency) Range: Entire input frequency of the instrument

Meas BW

Target Reference

The target reference is a calculated or user-specified value of final settled frequency within the measurement period. When set to **Auto**, the instrument determines this value by averaging at least the last 256 samples at the end of the measurement period. When set to **Meas freq**, the Target Reference is set to the Measurement Frequency of the instrument. You can enter a manual offset from the target frequency to fine-tune the Target Reference when **Meas freq** is selected.

Tolerance(+/-)

The Tolerance is the frequency or phase range within which the signal must remain to be considered settled. This is set as $a \pm value$ by the user. In the frequency settling time measurement, the tolerance band is centered about the target value. In the phase settling time measurement, the tolerance band is centered about the settled phase value.

The target frequency depends on the Target reference value setting:

- If Target Reference is set to AUTO, then the target value is the settled value (the frequency at which the signal is considered settled).
- If Target Reference is set to MeasFreq, then the Target value = Meas Frequency + Offset.

Offset

Offset is used for fine-tuning the Target Reference when **Meas freq** is selected. The value for Offset is entered manually.

Time Params Tab for Settling Time Displays

The Time Params tab is used to set the Measurement length and minimum settled duration parameters.

Define	Time Params	Mask	Trace	Scale	Pref	5
M	easurement len	igth:	1.000 ms			(from Analysis Offset to End of Measurement Marker)
			actual: 93	38.4 us		
M	1in settled dura	tion:	0.0000 s			(from Settled Point to End of Measurement Marker)

Measurement Length

Measurement length locates the end of the measurement period for settling time. This value is set independently of the analysis period for other measurements in the analyzer. This allows other measurements to display multiple frequency hops during an analysis, while focusing the settling time analysis on a single hop. You can set the measurement length either by entering a value in the entry box, or by dragging the magenta bar to the desired location in the graph. Traces and the display to the right of the measurement time are shown in grey to indicate that this section of the waveform is not being used in the measurement. If your signal does not settle to within your tolerance band, make sure that the measurement time ends during the settled portion of the waveform. The beginning of the settling time measurement is set with the analysis offset control, the same as other measurements in the instrument. Use analysis offset to exclude earlier hops from the measurement. See <u>Analysis Time (see page 471)</u> for setting the analysis offset control.

If there is more than one phase or frequency hop in the signal to be analyzed, use the Measurement Length control to instruct the analyzer which hop to measure. First, adjust the main Analysis Offset control to a point in time slightly earlier than the transition you wish to measure. Do this in the Time Overview display or the Analysis Settings control panel. Then adjust the Measurement Length so the end of the Settling Time measurement falls within the apparent settled period after the signal transition. The reason it is important for the user to set this control is that the Settling Time measurements start at this point and look backwards in time (towards the signal transition) to find the latest trace point that is not inside the tolerance band.

NOTE. If your signal does not settle to within your tolerance bands, make sure that the measurement time ends during the settled portion of the waveform.

Min Settled Duration

The minimum settled duration is the amount of time the signal must remain within the tolerance band to be considered settled. Some user specifications require that the signal be settled for a minimum period. If this is not required in your application, set this value to the default of 0 seconds.

Mask Tab for Settling Time Displays

The Mask tab is used to specify the parameters used for Mask testing.

Define Time Params Mas	k Trace Scale Prefs			
	Mask time reference —		Time	Limit (+/-)
🗖 Enable mask test	Triagor	Start 1:	0.0000 s	500.0 kHz
	Trigger	Start 2:	100.0 us	500.0 kHz
	Signal transition	Start 3:	1.000 ms	500.0 kHz
		Stop:	13.18 ms]

Enable Mask Test

Enables or disables mask testing.

Start 1, 2, 3

Sets the starting point for the time zone of interest. If you don't want to use all three zones, set the Start Time for the unneeded zones to a time after the end of the Measurement Length.

Stop

Sets the end point for the final time zone of interest.

Limit (+/-)

Sets the mask violation limits for each time zone.

Mask Time Reference

When mask testing is enabled, the Mask time reference selection specifies the starting point of the mask. You can choose to start the mask test at the trigger point or at the point on the trace where the signal began its transition from its previous settled frequency or phase level to the level you intend to measure.

This capability is useful because some applications do not have a trigger signal available. For those situations where a trigger signal is available, the specification for the device-under-test may require that measurements be referenced to that signal.

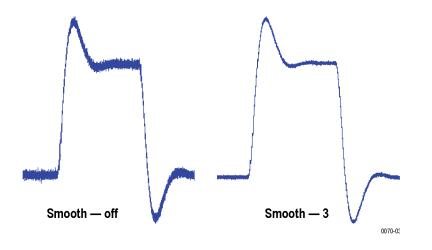
Trace Tab for Settling Time Displays

The Traces Tab allows you to set the display characteristics of displayed traces.

Define Time Para	ams Mask Trace	Scale Prefs		
Smooth: (points)	2	Trace: Trace 1 🔹	📝 Show	Freeze
Average: (count)	2	Show recalled trace		
		Save Trace As		

Smooth

Smooth is a low-pass filter function that uses n points in the trace to determine the smoothed value. For example, in the case of n=3, 3 consecutive points are averaged to determine the result of the smoothed output. This is very useful for single-shot signals that contain significant noise where multiple trace averages cannot be used. However, smoothing does have limits, and the user should visually determine whether smoothing is removing noise from the measurement, or if it is affecting the signal. The following illustration shows the effect smoothing has on the displayed trace.



The range for the Smooth function is 2-1000. The setting resolution is 1. The knob increments this value by 1, and the arrow keys increment it in steps of 1, 2, 5, 10. When smoothing is enabled, it applies to both traces. Smooth is turned off by default.

Average

This sets the number of acquisitions to be averaged together to produce the result. Averaging reduces random variations but maintains the correct waveshape for repeating signal aberrations. To use averaging, the signal must be repetitive. For example, the tuning direction must always be same for each measurement

to be averaged. Signals that vary in tuning direction will tend to average positive-going effects with negative-going effects and the settling time characteristics will cancel out.

The range for the Average function is 2-10000. The resolution is 1. The knob increments this value by 1, and the arrow keys increment it in steps of 1, 2, 5, 10. When averaging is enabled, it applies to both traces. Average is turned off by default.

Trace

Selects a trace for display. Choices are Trace 1 and 2. Either trace can be a recalled trace.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Select the trace into which the recalled trace will be loaded, from the Trace drop-down list.
- 2. Check the Show check box.
- 3. Click the ... button to display the Open dialog box.

Show recalled trace	
---------------------	--

- 4. Navigate to the desired file and click Open.
- 5. Check the Show Recalled Trace check box.
- 6. Verify that the trace's **Show** check box is selected (either on this tab or next to the drop-down list located at the top-left corner of the graph).

Scale Tab for Settling Time Displays

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Defin	e Time Params I	Mask Trace Scale	Prefs		
ſ	Vertical			Horizontal	
	Scale:	7.0000 MHz		Scale:	1.020 ms
	Position:	-200.00 kHz		Position:	81.602 us
	🔽 Relative Freq	Autoscale		🔽 Auto	Autoscale

Setting	Description	
Vertical		
Scale	Changes the vertical scale or span of the graph.	
Position	Sets the frequency (or phase) at the vertical center of the graph.	
Relative Freq	Sets the vertical (position) display readouts to show frequency values relative to the center frequency or as absolute values.	
Autoscale	Resets the Scale and Position to center the trace in the graph.	
Horizontal		
Scale	Sets the range of time shown in the graph.	
Position	Allows you to pan the graph left and right.	
Autoscale	Resets Scale and Position to the automatically determined settings.	

Prefs Tab for Settling Time Displays

The Prefs tab allows you to change display parameters of the Settling Time displays.

Define Time Params Mask	Trace Scale Prefs
	Max trace points: 100K 🔻
📝 Show graticule	✓ Show Marker readout in graph (selected marker)
	Settling Time decimal places: 2

The following table explains the controls that can appear on the Prefs tab.

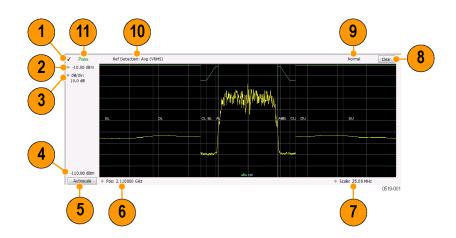
Setting	Description
Max trace points	Sets the number of trace points used for marker measurements and for results export.
Show graticule	Select to display or hide the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Settling Time decimal places	Specifies the precision of the settling time measurement readout that appears below the graph. This setting does not affect the precision of internal calculations.

SEM Display

The SEM (Spectrum Emission Mask) display measures out-of-band emissions immediately outside the channel bandwidth that result from the modulation process and non-linearity in the transmitter. The Spectrum Emission Mask display allows you to define up to six pair of masks, or offsets, that specify the limits for out-of-band emissions and performs a pass/fail tests of the signal against the defined offsets and limits.

To show the Spectrum Emission Mask display:

- 1. Select **Displays** or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select RF Measurements or WLAN Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **SEM** icon or select the icon and click **Add**. The SEM icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click OK to show the Spectrum Emission Mask display.



ltem	Display element	Description
1	Check mark indicator	Indicates the display for which the acquisition hardware is optimized.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Top-of-graph setting	Sets the level that appears at the top of the graph.
3	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.
4	Bottom-of-graph readout	Indicates the amplitude at the bottom of the graph. This value changes with the dB/div and Vertical Position settings.
5	Autoscale	Properly offsets the peak of the display from the top of the screen.
		If the screen has been enlarged through a manual vertical (dB/div) setting entry, the view is not vertically rescaled when Autoscale is used.
6	CF / Pos	Default function is CF - center frequency (equivalent to the Measurement Freq setting). If Horizontal scaling has been manually adjusted in Setup > Settings > Scale, then Pos replaces CF as the setting at the bottom-left corner of the screen. Adjusting Pos shifts the trace left or right in the graph, but does not change the measurement frequency.
7	Span / Scale	Default function is Span - frequency difference between the left edge of the display and the right edge. If Horizontal scaling has been manually adjusted in Settings > Scale, then Scale will replace Span as the setting at the bottom-right corner of the screen.
8	Clear	Erases the current results from the display.
9	Function readout	Readout of the Function selection for the Reference channel (Setup > Processing > Function).
		Spurious
10	Detection readout	Readout of the Detection selection for the Reference channel (Setup > Processing > Detection).
11	Pass / Fail readout	Readout indicating whether any part of the trace has exceeded the any of the limits defined in the Offsets & Limits table (Setup > Settings > Offsets & Limits Table).

Elements of the Display

Pass / Fail Readout

This readout displays either **Pass** or **Fail XX%**. When the signal exceeds the mask in any offset, it is considered a mask violation, and results in **Fail XX%** being displayed. If there are no mask violations, **Pass** is displayed.

How the fail percentage is determined. Each offset has two sides, one lower and one upper. For example, Offset A has two sides: AL (lower side) and AU (upper side). In the SEM display, there is a maximum of six offsets (A-F) and each offset can have a maximum of two sides (if Both is selected for Side in the Offsets & Limits table). This results in a total of six offsets multiplied by two sides per offset, which results in 12 offsets. Mask violations can occur in any of these offsets. The failure percentage is calculated as follows:

Fail percentage = Number of offsets with mask violations x 100 / Total number of enabled offsets

For example: Assume there are three enabled offsets: A, B, C, and all these offsets have both lower and upper sides. Thus, the total number of enabled offsets is equal to six. Suppose there are mask violations in the offsets AL and CU, then the number of offsets having mask violations is equal to 2. Therefore, Fail percentage = 2 * 100 / 6 = 33%.

Results Display

The Results Display shows the measurement results for the SEM display.

Row	Offset	Start Freq	Stop Freq	Peak Abs (dBm)	Margin Abs (dB)	Peak Rel (dBc)	Margin Rel (dB)	@Freq	Integ Abs (dBm)	í
1	EL	-12.500 MHz	-8.000 MHz	-73.83	-62.33	-91.81	-	-8.010000 MHz	-68.44	
2	DL	-8.000 MHz	-4.000 MHz	-73.17	-61.67	-91.16	-	-7.460000 MHz	-67.61	
3	CL	-4.000 MHz	-3.515 MHz	-87.63	-63.13	-105.62	-	-3.965444 MHz	-77.11	1
4	BL	-3.515 MHz	-2.715 MHz	-87.77	-75.17	-105.76	-	-2.722000 MHz	-75.14	
5	AL	-2.715 MHz	-2.515 MHz	-70.18	-57.68	-88.16	-	-2.515000 MHz	-70.74	
6	AU	2.515 MHz	2.715 MHz	-70.73	-58.23	-87.67	-	2.515000 MHz	-70.54	
7	BU	2.715 MHz	3.515 MHz	-87.66	-67.24	-104.59	-	3.243000 MHz	-74.72	
8	CU	3.515 MHz	4.000 MHz	-88.01	-63.51	-106	-	3.976356 MHz	-77.04	
	1 2 3 4 5 6 7	1 EL 2 DL 3 CL 4 BL 5 AL 6 AU 7 BU	EL -12.500 MHz 2 DL 8.000 MHz 3 CL 4.000 MHz 4 BL 3.515 MHz 5 AL -2.715 MHz 6 AU 2.515 MHz 7 BU 2.715 MHz	EL 12 500 MHz 8 000 MHz 2 DL 8 000 MHz 4 000 MHz 3 CL 4 000 MHz 3 515 MHz 4 BL 3 315 MHz 2 715 MHz 5 AL 2 715 MHz 2 715 MHz 6 AU 2 715 MHz 2 75 MHz 7 BU 2 715 MHz 3 515 MHz	How Othest San Freq Stop Freq (dBw) 1 EL 12 500 MHz 8.000 MHz 7.83 2 DL 8.000 MHz 4.000 MHz 7.83 3 CL 4.000 MHz 3.515 MHz 4783 4 BL 3.515 MHz 2.715 MHz 4777 5 AL 2.715 MHz 2.515 MHz 70.18 6 AJ 2.515 MHz 2.515 MHz 70.73 7 BU 2.715 MHz 3.515 MHz 4.76	Now Offset Star Freq Stor Freq (dB) (dB) (dB) 1 EL 0.2500 Mts 0.000 Mts 7.38.3 6.23.3 2 DL 0.5000 Mts 4.000 Mts 7.38.3 6.23.3 3 CL 4.000 Mts 3.515 Mts 47.63 45.13 4 BL 3.515 Mts 2.715 Mts 87.77 75.17 5 AL 2.715 Mts 2.515 Mts 70.18 57.83 6 AL 2.515 Mts 2.715 Mts 20.73 56.23 7 BU 2.715 Mts 3.515 Mts 45.76 45.24	How Othest San Freq Sop Trea (pb) (pb) (pb) (pb) 1 EL 2500 MHz 4.000 MHz 7.735 4.233 9.181 2 DL 4.000 MHz 4.000 MHz 7.345 4.233 9.181 3 CL 4.000 MHz 3.315 MHz 47.83 4.313 -105.62 4 EL 3.515 MHz 2.715 MHz 9.777 7.737 4.0576 5 AL 2.715 MHz 2.215 MHz 70.18 57.88 48.16 6 AU 2.515 MHz 2.315 MHz 37.67 56.23 47.67 7 BU 2.715 MHz 3.715 MHz 37.66 47.24 .104.59	Now Othest Stop Freq (dB) (dB) (dB) (dB) (dB) 1 EL 12500 MHz 6000 MHz 7383 66.23 9181 - 2 DL 4.000 MHz 4.000 MHz 7317 61.67 91.16 - 3 CL 4.000 MHz 3.515 MHz 87.67 75.17 105.62 - 4 BL 3.515 MHz 2.715 MHz 87.77 77.17 105.76 - 5 AL 2.715 MHz 2.515 MHz 70.18 57.68 88.16 - 6 AL 2.515 MHz 2.515 MHz 70.73 50.22 47.67 - 7 BU 2.715 MHz 3.515 MHz 47.64 47.64 - -	Now Offset Start Freq Stop Freq (dB) (dB)	Now Offset Star Freq Stor Freq (db) (db)

Readout	Description
Ref:	A two-part readout to the left of the table that displays information about the Reference Channel. The first part of the readout displays the Measurement Type selected on the Parameters tab. The second part of the readout displays the measurement result for the Reference channel.
Row	A sequence number for ordering the offsets. Click to organize by row number, resort rows from high to low or low to high.
Offset	The Offset name. A combination of the offset (A-F) and the location (U for upper and L for Lower).
Start Freq	The start frequency of the offset (relative to the Measurement Freq).
Stop Freq	The stop frequency of the offset (relative to the Measurement Freq).
Peak Abs	Absolute power peak power at worst case margin of the offset
Margin Abs	The worst case difference between the trace and the absolute limit line. Note that an offset can have different start and stop levels, thus, the margin can vary if the offset start and stop levels are different.
Peak Rel	Relative peak power of worst case margin of the offset. Relative with respect to the reference power level.
Margin Rel	The worst-case difference between the trace and the relative limit line. Because an offset can have different start and stop levels, the margin can vary if the offset start and stop levels are different.
@Freq	The frequency at which the worst margin occurs.
Integ Abs	The absolute integrated power of the offset.
Integ Rel	The relative integrated power of the offset (with respect to the reference power).

Reordering results in the results table. You can sort the results in the Results table by clicking the column heading containing the values you want to sort on. You can sort results for the following columns: Row, Offset, Start Frequency, Stop Frequency, Peak Abs, and Peak Rel.

Rearranging columns in the results table. You can rearrange the order of the columns and their size. To rearrange columns, select the column heading you want to move and drag it to the new position; the new location is indicated by a dark blue bar that appears between column headings.

You can resize the columns by selecting the divider between columns and dragging it to a new position.

Spectrum Emission Mask Settings

Application Toolbar: 🕸

The settings for the Spectrum Emission Mask display are visible when SEM is the selected display. To display the SEM Settings, select **Setup** > **Settings**.

Settings tab	Description
Parameters Tab (see page 142)	Specifies several characteristics that control how the measurement is made.
Processing Tab (see page 143)	Specifies settings for detection on the Reference channel and the offsets. Specifies the function setting.
Ref Channel Tab (see page 144)	Specifies how the measurements on the reference channel are performed.
Offsets & Limits Table (see page 144)	Specifies characteristics of offsets and mask limits.
Scale Tab (see page 147)	Specifies the vertical and horizontal scale settings.
Prefs Tab (see page 148)	Specifies the appearance features of the graph area and the maximum trace points.

Parameters Tab - SEM

The Parameters tab specifies several characteristics that control how the Spectrum Emission Mask measurements are made.

Setting	Description
Meas Freq	Specify the frequency of the signal to be measured.
Step	Sets the increment size when changing the Frequency using the knob or mouse wheel.
Auto	When Auto is enabled, the step size is adjusted automatically based on the span setting.
Real-Time	When Real-Time mode is enabled, the entire SEM span is measured using a real-time/contiguous acquisition. Not all described parameters are available in Real-Time mode.
Measurement Type	Specifies the type of measurement for the reference channel; used as a reference for the offsets.
Total Power	Sets the reference to the integrated power of the reference channel within the reference's integration bandwidth.
PSD	Sets the reference to the mean of the power spectral density (dBm/Hz) of the reference channel. The trace and the absolute and relative limits line are also in dBm/Hz
Peak	Sets the reference to the Peak power of the reference channel.
Offset definition	Defines the relative position of the start/stop frequency of an offset. Choose the offset definition based on the standard.
Ref center to OS center	Specifies that the start/stop frequencies are defined from the center frequency of the reference channel to the center of the filter BW.
Ref center to OS edge	Specifies that the start/stop frequencies are defined from the center frequency of the reference channel to the center of the (inner) edge of the filter BW of the offset.
Ref Edge to OS center	Specifies that the start/stop frequencies are defined from the edge of the reference channel to the center of the filter BW of the offset.
Ref Edge to OS edge	Specifies that the start/stop frequencies are defined from the edge of the reference channel to the (inner) edge of the filter BW of the offset.
Filter Shape	Specifies the shape of the filter determined by the window that is applied to the data record, in the spectrum analysis, to reduce spectral leakage. 3GPP specifies a Gaussian window shape be applied to the reference channel measurements.
Gaussian	This filter shape provides optimal localization in the frequency domain.
Rectangular	This filter shape provides the best frequency, worst magnitude resolution. This is essentially the same as no window.

Processing Tab - SEM

The Processing tab controls the Detection settings for the Reference Channel and Offsets, as well as selecting the Function.

Parameters Processing Ref Ch	nannel Offsets & Limits Table Scale Prefs
Detection (in each record Ref Channel: Avg (VRM	
Offsets: Avg (VRM	s) •
Process	ng settings affect all SEM numeric and trace results.

Settings tab	Description				
Detection (in each sweep)					
Ref Channel	Specifies the Detection method used for the Reference Channel. Detection is used to produce the desired measurement result (peak or average) and to reduce the results of a measurement to the desired number of trace points.				
Avg (VRMS)	For each sweep, each point of the trace is the result of determining the RMS voltage value for the last 'n counts' of the collected traces for the same point. When 'n count' has not been reached, partial averaging results are displayed.				
+Peak	Selects the +Peak detection method. With this method, the highest value is selected from the results to be compressed into a trace point.				
Offsets	Specifies the detection method used for the offsets.				
Avg (VRMS)	Selects the Average Vrms detection method. With this method, each point on the trace in each offset is the result of determining the RMS Voltage value for all of the results values it includes.				
+Peak	Selects the +Peak detection method. With this method, the highest value in each offset i selected from the results to be compressed into a trace point.				
Function (across multiple sweeps)					
Function	Selects the trace processing method. Available settings are: Normal, Avg (VRMS), and Hold.				
Normal	When a new trace has been computed, it replaces the previous trace.				
Max Hold	With each sweep, each trace point in the new trace is compared to the point's value in the old trace and the greater value is retained for display and subsequent comparisons.				
Avg (VRMS)	For each sweep, each point on the trace is the result of determining the RMS Voltage value for all of the collected traces' values for the same point.				

Ref Channel Tab

The Ref Channel tab controls how the measurement of the Reference channel is performed.

Parameters Pr	ocessing Ref Chan	nel Offsets &	Limits Table Scale Pr	efs
Power Reference:	-10.02 dBm	🔽 Auto	Channel width:	Channel Filter:
			8.500 MHz	Root-raised Cosine 🛛 👻
RBW:	100.000 kHz]	Integration BW:	Filter param: 0.220
VBW:	30.000 kHz]	2.125 MHz	Chip rate: 3.84 MHz

Settings tab	Description
Power Reference	The value used to calculate relative measurements.
Auto	When Auto is unchecked, you can enter a value for the reference power, and the measured reference power is not used or displayed
RBW	Sets the RBW for the Reference Channel.
VBW	Enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers. When the checkbox next to VBW is not checked, the VBW filter is not applied. SEM standards specify what value of VBW should be applied, if any.
Channel width	Specifies the width of the reference channel.
Integration BW	Specifies the integration bandwidth used to compute the total power in the reference channel.
Channel Filter	Specifies the measurement filter used in the Reference Channel. Choices are None and Root-raised Cosine.
Filter param	Specifies the alpha value (or roll-off factor) of the Root-raised cosine filter. Present only when Channel Filter is set to Root-raised Cosine.
Chip rate	Specifies the chip rate used for the Root-raised Cosine filter. Present only when Channel Filter is set to Root-raised Cosine.

Offsets & Limits Table Tab - SEM

The Offsets & Limits Table tab is used to specify parameters that define Offsets and masks.

		On	Start (Hz)	Stop (Hz)	Side	RBW (Hz)	n (RBWs)	Filter BW (n × RBW)	VBW (Hz)	VBW On	Mask	Reset layou
Þ	А	$\neg \sqrt{-}$	9.000000M	11.000000M	Both	100.000k	1	100.000k	30.000k	√	Rel	
	в	√	11.000000M	20.000000M	Both	100.000k	1	100.000k	30.000k	√	Rel	Load
	С	√	20.00000M	30.00000M	Both	100.000k	1	100.000k	30.000k	√	Rel	
	D	√	30.00000M	50.00000M	Both	100.000k	1	100.000k	30.000k	√	Rel	Save As
	Е		50.00000M	100.000000M	Both	100.000k	1	100.000k	30.000k	√	Rel	
	F		100.000000M	150.00000M	Both	100.000k	1	100.000k	30.000k	√	Rel	Done

Expanded display of Offsets & Limits Table

Setting	Description					
Buttons						
Expand	Displays the Offsets & Limits Table in a new, resizeable window.					
Reset Layout	You can reorder columns in the Offsets & Limits Table by dragging the columns to a new position. Clicking Reset Layout returns the column order to the factory default order.					
Load	Click to load a saved Offsets & Limits table from a file.					
Save As	Click to save the current Offsets & Limits table to a file.					
Done	When the table is expanded, click Done when you have finished editing the table to save your changes and close the expanded table display.					
Table columns						
On	Specifies whether or not measurements are taken in the specified offset.					
Start (Hz)	Start Frequency of the selected offset.					
Stop (Hz)	Stop Frequency of the selected offset.					
Side	Specifies whether the specified range appears on both side of the carrier frequency or just one side (left or right).					
RBW (Hz)	Specifies the RBW for the selected range.					
n (RBWS)	An integer value that specifies how many times to multiply the RBW to set the Filter bandwidth.					
Filter BW (n x RBW)	Displays the Filter BW. Filter BW is the equivalent BW of each point in the offset. When n > 1, an integration technique is used to achieve the Filter BW using narrower RBWs. For most SEM measurements, this value is set to 1. The 3GPP standard suggests n greater than 1.					
VBW (Hz)	Adjusts the VBW (Video Bandwidth) value. VBW Maximum: RBW current value; VBW Minimum: 1/10,000 RBW setting.					
VBW On	Specifies whether the VBW filter is applied.					
Mask	Select the type of limits used for Pass/Fail testing. Signal excursions that exceed the mask settings are considered violations. The available choices are shown below.					
Abs Start (dBm)	Specifies the mask level at the inner edge of the selected offset.					
Abs Stop (dBm)	Specifies the mask level at the outer edge of the selected offset.					
Abs Same	Specifies whether the value for the inner and outer edges of the offset must be the same value. When enabled, the Abs Stop cell is grayed-out and set to the value of the Abs Start cell.					
Rel Start (dBm)	Specifies the mask level for the Relative mask at the inner edge of the selected offset.					
Rel Stop (dBm)	Specifies the mask level for the Relative mask at the outer edge of the selected offset.					
Rel Same	Specifies whether the inner and outer edges of the offset must be the same value. When enabled, the Rel Stop cell is grayed-out and its value is set to the value of the Rel Start cell.					

Scale Tab - SEM

Use the Scale tab to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display. In effect, these controls operate like pan and zoom controls.

Parameters Proce	ssing Ref Channel (Offsets & Limits Table Sc	ale Prefs	
Vertical			Horizontal	
Scale:	100.00 dB		Scale:	100.0 MHz
Position:	0.00 dBm	Reset Scale	Position:	1.5000 GHz
	Autoscale			Autoscale

Setting Description			
Vertical	Controls the vertical position and scale of the trace display.		
Scale	Changes the vertical scale units.		
Position Adjusts the reference level away from top of the graph.			
Autoscale	Resets the scale of the vertical axis to contain the complete trace.		
Horizontal	Controls the span of the trace display and position of the trace.		
Scale Specifies the frequency range displayed in the graph			
Position Specifies the frequency shown at the center of the graph.			
Autoscale Resets the scale of the horizontal axis to optimize the display of the trace.			
Reset Scale Resets all settings to their default values.			

Prefs Tab - SEM

The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display, but include such items as enabling/disabling Marker Readout, switching the Graticule display on/off, and Marker Noise mode. Some parameters appear with most displays while others appear with only one display.

Parameters Processing	Ref Channel Offsets & Limits Table Scale Prefs
	Max Trace points: 801 • (per range)
📝 Show graticule	Show Marker readout in graph (selected marker)
	Show limits: Line only

Setting	Description	
Show graticule	Controls the vertical position and scale of the trace display.	
Max Trace points (per range)	When the spectrum analysis produces more than the selected maximum number of points, the method specified in Detection control is used to decimate the result. This setting applies to both the Reference channel and offsets.	
Show Marker readout in graph	Adjusts the reference level away from top of the graph.	
Show limits	Controls the appearance of mask limits in the graph.	
Shaded	Shows limits using a shaded area. Green shading is used to identify Absolute limits. shading is used to indicate Relative limits.	
Line only Shows limits using only a line. A green line is used to identify Absolute limits.		
None	No lines or shading are used to indicate limits in the graph. Violations of the mask are still identified by red shading.	

RF Measurements Shared Measurement Settings

The control panel tabs in this section are shared by multiple displays in the RF Measurement folder (Setup > Displays). With few exceptions, each display maintains separate values for each of the controls on these tabs. For example, Scale values are independent for each of the displays.

Settings tab	Description	
Freq & RBW (see page 149)	Allows you to specify the Center Frequency, Step size and RBW.	
Traces (see page 150)	Specifies trace parameters such as detection method and whether smoothing is enabled. Traces can also be saved and loaded for reference from this tab.	
Scale (see page 153)	Specify vertical and horizontal scale settings.	
Prefs (see page 154)	Specify appearance features of the graph area.	

Common controls for RF measurement displays

Freq & RBW Tab

The Freq & RBW tab specifies frequency parameters for some of the RF Measurements displays.

Freq & RBW Mea	asurement Params	Channels S	cale Prefs		
Meas Freq:	1.00000 GHz		RBW:	30.000 kHz	🔽 Auto
Step:	2.0000 MHz	🔽 Auto	VBW:		

Setting	Description	
Meas Freq	Specifies the measurement frequency.	
Step		
RBW Select Auto or Manual. Adjusts the RBW for the entire measurement. Th Independent of the Spectrum view's RBW setting.		
VBW	Adjusts the VBW (Video Bandwidth) value.	

NOTE. While the measurement frequency and step settings on this control tab are shared between ACPR, MCPR and Occupied Bandwidth, the RBW setting is not shared. The RBW setting is unique for each measurement.

VBW

The VBW setting enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers.

The maximum VBW value is the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.

Traces Tab

The Traces tab enables you to select traces for display. You can choose to display live traces and/or recalled traces. The <u>Trace tab (see page 133)</u> for Settling Time displays is described in the Settling Time controls section.

NOTE. Not all RF Measurements support multiple traces and/or save and recall of traces.

Parameters Traces Prefs			
Trace: Trace 1 -	🗹 Show	E Freeze	Save Trace As
			Show recalled trace

Setting	Description
Trace	Selects a trace for display. Choices are Trace 1, 2, and Gaussian (CCDF display only). Trace 1 and 2 can be recalled traces.
Show	Shows / hides the selected trace.
Freeze	Halts updates to the selected trace.
Save Trace As	Saves the selected trace to a file for later recall and analysis.
Show recalled trace	Used to select a saved trace for display.
Detection (Phase Noise only)	Sets the Detector used for the trace. Only +/- Peak and Avg (VRMS) are available for the Phase Noise display. This setting is not available for saved traces. +/-Peak detection results in a trace with two Y values for each X location, with shading between.
Function	Selects the trace processing method (Spurious display only). Possible settings are: Normal, Average (VRMS), Avg (of logs), and Max Hold.
Smoothing (Phase Noise only)	When enabled, diminishes point-to-point trace variations. Smoothing +/- Peak traces treats + and - lines independently. The smoothing value adjusts how many points are in each filter set. Range: 1 - 20; Default: 5.
Smooth: (points)	Available for Phase and Frequency Settling Time displays only.
Average: (count)	Smooth is a low-pass filter function that uses n points in the trace to determine the smoothed value.
	Average sets the number of acquisitions to be averaged together to produce the result.
	See <u>Trace Tab for Settling Time Displays (see page 133)</u> for complete details.

Trace Processing

The trace can be processed to display in different ways. The Function setting controls trace processing.

- Max Hold Displays the maximum value in the trace record for each display point. Each new trace display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons.
- **Normal** Displays the trace record for each display point without additional processing.
- Avg (VRMS) [Average V_{RMS}] Each point on the trace is the result of determining the RMS Voltage value for all of the IQ samples available to the trace point. When displayed in either linear (Volts, Watts) or Log (dB, dBm), the correct RMS value results. When the averaging function is applied to a trace, the averaging is performed on the linear (Voltage) values, resulting in the correct average for RMS values.
- Avg (of logs) This is a trace function used to emulate legacy spectrum analyzer results and for the specification of displayed average noise level. In older swept analyzers, a voltage envelope detector is used in the process of measuring signal level, and the result is then converted to Watts and then to dBm. Averaging is then applied to the resultant traces.

For CW signals, this method results in an accurate power measurement. However, with random noise and digitally modulated carriers, errors result from this 'average of logs' method. For random noise, the average of logs methods results in power levels -2.51 dB lower than that measured with a power meter, or with a spectrum analyzer that measures the rms value of a signal, and performs averaging on the calculated power in Watts and not dBm or other log-power units.

This detector should be used when following a measurement procedure that specifies it, or when checking the Displayed Averaged Noise Level (DANL) of the instrument. The 'average of logs' detection and trace function is used for DANL specification to provide similar results to other spectrum/signal analyzers for comparison purposes. Use of the Average of Logs method of measurement is not recommended for digitally modulated carriers, as power measurement errors will occur.

NOTE. The Detection setting does not affect the trace until the spectrum length is longer than the Auto setting.

Saving Traces

To save a trace for later analysis:

- 1. Select the Save Trace As button. This displays the Save As dialog box.
- 2. Navigate to the desired folder or use the default.
- 3. Type a name for the saved trace and click Save.

Recalling Traces

You can recall a previously saved trace for analysis or comparison to a live trace.

To select a trace for recall:

- 1. Select the trace into which the recalled trace will be loaded, from the Trace drop-down list.
- 2. Check the Show check box.
- 3. Click the ... button to display the Open dialog box.

Show recalled trace	

- 1. Navigate to the desired file and click Open.
- 2. Check the Show Recalled Trace check box.
- **3.** Verify that the trace's **Show** check box is selected (either on this tab or next to the drop-down list located at the top-left corner of the graph).

Gaussian Trace

The Gaussian trace is a reference trace that you can compare your trace against. Because the Gaussian trace is for reference, there are no settings for the trace other than whether or not it is shown.

Parameters Traces Prefs
Trace: Gaussian 👻 🔲 Show

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Center Frequency.

Freq & RBW Meas	surement Params Cha	annels Scale Prefs		
Vertical			Horizontal	
Scale:	100.00 dB		Scale:	39.00 MHz
Position:	0.00 dBm	Reset Scale	Position:	1.50000 GHz
	Autoscale			Autoscale

Setting	Description		
Vertical	Controls the vertical position and scale of the trace display.		
Scale	Changes the vertical scale units. This is only accessible when the vertical units are set to dBm.		
Offset	Adjusts the Reference Level away from the top of the trace display.		
Autoscale	Resets the scale of the vertical axis to contain the complete trace.		
Horizontal	Controls the span of the trace display and position of the trace.		
Scale	Allows you to, in effect, change the span.		
Offset	Allows you to pan a zoomed trace without changing the Measurement Frequency. Offset is only enabled when the span, as specified by Freq / div, is less than the acquisition bandwidth.		
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.		
Log (Spurious only)	Resets the display to show the frequency axis in a logarithmic scale.		

Prefs Tab

The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display, but include such items as enabling/disabling Marker Readout, switching the Graticule display on/off, and Marker Noise mode. Some parameters appear with most displays while others appear with only one display.

Freq & Span BW Traces Scale	Prefs
Show: Start, Stop 🗸	Trace points: 801 -
Show graticule	Show Marker readout in graph (selected marker)
✓ Show trace legend	Marker Noise mode (Requires dBm Ampl units and Average trace detect)

Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Max trace points	In general, time-domain traces can include up to 100K points and frequency-domain traces can include up to 10K points. When the analysis produces a results array longer than the selected trace length, the trace is decimated (using the method specified with the Detection control) to be equal to or less than the Max trace points setting (except when Max trace points is set to Never Decimate). This decimated (or undecimated) trace is what is used for marker measurements and for results export.
Settling Time decimal places (Frequency and Phase Settling Time displays only)	Specifies the number of decimal places shown in the results readout below the graph. This setting does not affect the precision of internal calculations.
Show trace legend (CCDF (Complementary Cumulative Distribution Function) display only)	Displays or hides the trace legend.

WLAN Overview

The WLAN Analysis option allows you to evaluate WLAN signals, performing standards based transmitter measurements in the time, frequency, and modulation domains. WLAN measurements can be made on signals defined by 802.11a/b/g/j/n/p (standard IEEE 802.11-2012) and 802.11ac (draft IEEE P802.11ac-D4.0 or later). User controls allow you to modify signal parameters for analysis of signals. The analysis results give multiple views of WLAN signal characteristics to allow the diagnosis of signal imperfections and impairments quickly and easily. Display controls allow you to selectively display the analysis results to help locate trouble-spots in the signal.

WLAN Standards

The following options support the given standards:

- **Option SV23**: Supports IEEE 802.11a, g, j, and p OFDM signals and 802.11b DSSS/CCK signals
- Option SV24: Supports IEEE 802.11n signals with bandwidths of 20 MHz and 40 MHz
- Option SV25: Supports IEEE 802.11ac signals with bandwidths of 20, 40, 80, and 160 MHz

WLAN Standards Presets

The **Standards Presets** button located on the WLAN Settings Control Panel allows you to recall preconfigured displays for the standards and bandwidths that you select. You can also access these presets from **Presets** on the display menu bar. You can read more information about the <u>Standards Presets (see page 20)</u>.

The following table shows the center frequency and displays that are automatically loaded for each of the listed standards and bandwidths. SEM masks are also loaded and are explained here (see page 261).

Standard	Bandwidth (MHz)	Center frequency (GHz)	Displays loaded
802.11a	20	5.18	SEM, Time Overview, WLAN Constellation, WLAN
802.11g	20	2.412	Summary
802.11j	10	5.18	
	20		
802.11p	5	5.8	
	10		
	20		
802.11n	20	2.412	
	40		
802.11ac	20	5.18	
	40	5.19	
	80	5.21	
	160	5.25	
802.11b		2.412	

Table 1: WLAN presets standards, bandwidths, center frequencies, and displays

SEM mask parameters. The SEM wireless standard masks that are applied to the WLAN signal depend on the standard you select when you configure the preset. Once you select a standard and bandwidth, the application will automatically load the mask that best fits the signal for which the standard applies. All mask parameters are derived from IEEE standards and loaded for you. This provides you the assurance that you are evaluating the signal with the most appropriate mask.

WLAN Displays

The displays in WLAN Analysis (Setup > Displays > Measurements) are:

- <u>SEM (see page 137)</u>
- WLAN Channel Response (see page 157)
- WLAN Constellation (see page 160)
- WLAN EVM (see page 162)
- WLAN Magnitude Error (see page 164)
- WLAN Phase Error (see page 166)
- WLAN Power versus Time (see page 168)
- WLAN Spectral Flatness (see page 171)

- WLAN Summary (see page 173)
- WLAN Symbol Table (see page 178)

WLAN Channel Response Display

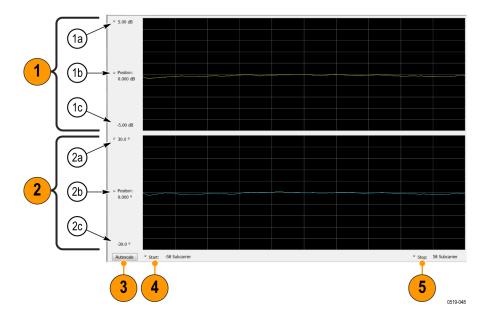
The WLAN Channel Response display plots the channel response (magnitude and phase) versus the subcarrier or frequency. Here, the channel refers to all sources of signal frequency response impairment up to the analyzer input, including the transmitter itself, as well as any transmission medium through which the signal travels between the transmitter and the analyzer.

NOTE. WLAN Channel Response is only available for OFDM (non-802.11b) signals.

To show the WLAN Channel Response display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN Chan Response** icon or select the icon and click **Add**. The WLAN Chan Response icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN Chan Response display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the Modulation Params tab. Set the Standard, Guard Interval, Subcarrier Spacing, and Bandwidth controls as appropriate for the input signal.

Elements of the Display



ltem	Display element	Description
1	Magnitude graph (top graph)	
1a	Top of graph	Sets the level that appears at the top of the magnitude graph. This is only a visual control for panning the graph. The Reference Level is adjusted in the Toolbar and the Ampl control panel. By default, Vert Position = Ref Level.
1b	Position (dB)	Sets the vertical position value. The maximum value is 20.00 dB. The readout indicates the subcarrier (for non-b standards only) or frequency shown at the bottom of the display.
1c	Bottom of graph readout	Indicates the magnitude at the bottom of the top graph. This value changes with the dB and vertical Position settings.
2	Phase graph (bottom graph)	
2a	Top of graph	Sets the phase value indicated at the top of the graph. Since the Position value at the vertical center of this graph remains constant as the Top of Graph value is adjusted, the Vertical Scale increases as the Top of Graph value increases, which also affects the bottom of graph readout.
2b	Position (°)	Specifies the phase shown at the center of the graph display. Changing this value moves the trace up and down in the graph, which affects the Top of Graph and Bottom of Graph values as well.
2c	Bottom of bottom graph readout	Indicates the phase at the bottom of the bottom graph. This value changes with the Position setting.
}	Autoscale	Adjusts the Vertical and Horizontal scaling to optimize the trace display on screen.
ļ	Start (Position)	Shifts the trace left or right in the graph. The readout indicates the subcarrier (for non-b standards only) or frequency shown at the left edge of the display.
5	Stop (Scale)	Specifies the number of subcarriers (for non-b standards only) shown in the graph.

WLAN Channel Response Settings

The WLAN Channel Response Settings control panel provides access to settings that control parameters of the Channel Response Display.

Settings tab	Description
Modulation Params (see page 181)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range Tab (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the time units (Symbols or Seconds) for WLAN Analysis displays.

Settings tab	Description
Traces Tab (see page 186)	Enables you to select from magnitude or phase trace, save a trace, and recall an trace
Scale Tab (see page 187)	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

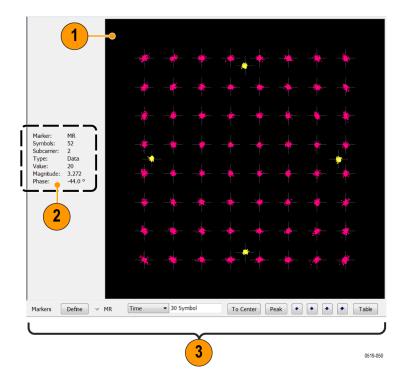
WLAN Constellation Display

The WLAN Constellation Display shows the WLAN signal modulation amplitude and phase in I (horizontal) versus Q (vertical) form. For multicarrier WLAN OFDM signals, the points show all data symbol subcarriers' modulation. For single-carrier 802.11b, each point corresponds to a single modulated chip.

To show the WLAN Constellation display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Constellation in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN Constellation** icon or select the icon and click **Add**. The WLAN Constellation icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN Constellation display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Channel Bandwidth, and Subcarrier Spacing controls as appropriate for the input signal.

Elements of the Display



ltem	Display element	Description
1	Plot	Constellation graph.
2	Marker readout	If markers are enabled, the marker readout shows the selected Marker, Symbol, Subcarrier, Type, Value, Magnitude, and Phase for the symbol at the marker location. Located to the left of the constellation plot or below it, depending on the size of the window.
3	Marker controls	Define and position markers.

WLAN Constellation Settings

Application Toolbar: 🕮

The WLAN Constellation Settings control panel provides access to settings that control parameters of the Constellation Display.

Settings tab	Description
Modulation Params (see page 181)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Trace Tab (see page 186)	Enables you to freeze the display or hide the measurement or average trace.
Scale Tab (see page 187)	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN EVM Display

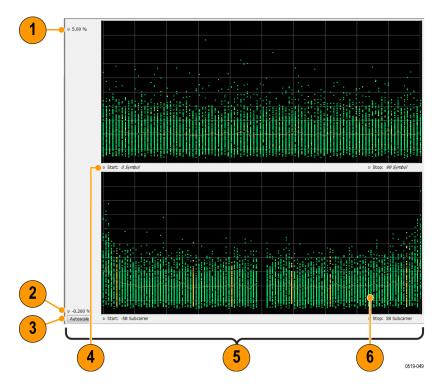
The WLAN EVM display shows the data symbols' individual subcarrier Error Vector Magnitude values versus symbol interval (time) and subcarrier (frequency).

NOTE. For 802.11b analysis, the subcarrier graph is not displayed.

To show the WLAN EVM display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN EVM in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN EVM** icon or select the icon and click **Add**. The WLAN EVM icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN EVM display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard as appropriate. Set the Standard, Guard Interval, Channel Bandwidth, and Subcarrier Spacing controls as appropriate for the input signal.

Elements of the Display



ltem	Display element	Description
1	Top of graph	Sets the EVM value that appears at the top of the graph. This is only a visual control for panning the graph.
2	Bottom of graph	Sets the EVM value that appears at the bottom of the graph. This is only a visual control for panning the graph.
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
4	Start (Position)	Specifies the horizontal position of the trace on the graph display.
5	Stop (Scale)	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.

WLAN EVM Settings

Application Toolbar: 鄻

The settings for the WLAN EVM display are shown in the following table.

Settings tab	Description
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Trace (see page 186)	Enables you to freeze the display or hide the measurement or average trace.
Scale (see page 187)	Specifies the vertical, subcarrier (for non-b standards only) and symbols scale and position settings.
Prefs (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

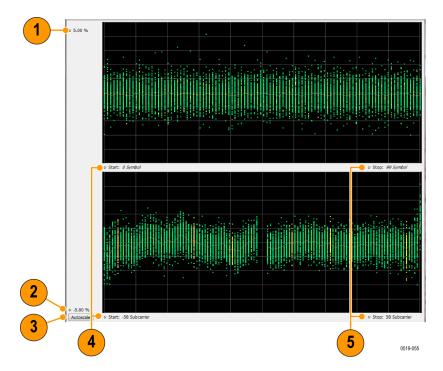
WLAN Magnitude Error Display

The WLAN Magnitude Error display shows the data symbols' individual subcarrier Magnitude Error values versus symbol interval (time) and subcarrier (frequency).

NOTE. For 802.11b analysis, the subcarrier graph is not displayed.

To show the WLAN Magnitude Error display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- 3. In the Available displays box, double-click the WLAN Mag Error icon or select the icon and click Add. The WLAN Mag Error icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click OK to show the WLAN Mag Error display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description Sets the Magnitude Error value that appears at the top of the graph. This is only a visual control for panning the graph.				
1	Top of graph					
2	Bottom of graph	Sets the Magnitude Error value that appears at the bottom of the graph. This is only a visual control for panning the graph.				
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.				
4	Pos	Specifies the horizontal position of the trace on the graph display.				
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.				

WLAN Magnitude Error Settings

Application Toolbar: 🕸

The settings for the WLAN Mag Error display are shown in the following table.

Settings tab	Description
<u>Modulation Params (see</u> page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Trace (see page 186)	Enables you to display or hide the measurement or average trace.
Scale Tab (see page 187)	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs Tab (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

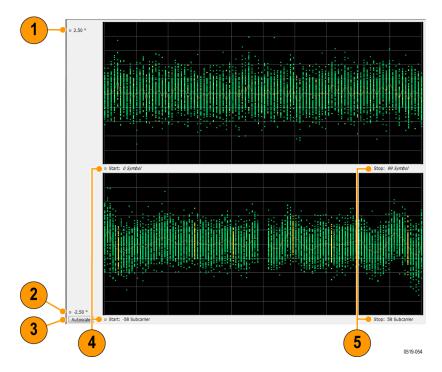
WLAN Phase Error Display

The WLAN Phase Error display shows the data symbols' individual subcarrier Phase Error values versus symbol interval (time) and subcarrier (frequency).

NOTE. For 802.11b analysis, the subcarrier graph is not displayed.

To show the WLAN Phase Error display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- 3. In the Available displays box, double-click the WLAN Phase Error icon or select the icon and click Add. The WLAN Phase Error icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN Phase Error display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description Sets the Phase Error value that appears at the top of the graph. This is only a visual control for panning the graph.				
1	Top of graph					
2	Bottom of graph	Sets the Phase Error value that appears at the bottom of the graph. This is only a visual control for panning the graph.				
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.				
4	Pos	Specifies the horizontal position of the trace on the graph display.				
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.				

WLAN Phase Error Settings

Application Toolbar: 虊

The settings for the WLAN Phase Error display are shown in the following table.

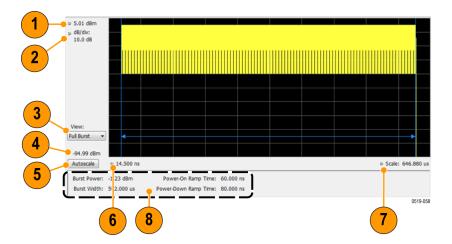
Settings tab	Description
<u>Modulation Params (see</u> page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Trace (see page 186)	Enables you to display or hide the measurement or average trace.
Scale Tab (see page 187)	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs Tab (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Power vs Time Display

The WLAN Power vs Time display shows the signal power amplitude versus time. For 802.11b signals, the packet Power-On and Power-Down ramp times are also measured.

To show the WLAN Power vs Time display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN Power vs Time** icon or select the icon and click **Add**. The WLAN Power vs Time icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN Power vs Time display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



Item	Display element	Description					
1	Top of graph, first settting	Sets the Power level that appears at the top of the graph, in dBm. This is only a visual control for panning the graph.					
2	Top of graph, second setting	Sets the vertical Scale of the graphs, in dB/div. This is only a visual control for panning the graph.					
3	View	Selects the specific view of the packet burst within the display:					
		 Full Burst displays the entire packet, with vertical lines indicating length of the packet 					
		 Rising Edge zooms the display into the interval around the packet rising edge, with vertical lines indicating the 10% to 90% Power-On Ramp time 					
		 Falling Edge zooms the display into the interval around the packet falling edge, with vertical lines indicating the 90% to 10% Power-Down Ramp time 					
4	Bottom of graph readout	Shows the Power level at the bottom of the graph in dBm.					
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.					
6	Bottom of graph, left side	Sets the starting time of the graph in seconds					
7	Bottom of graph, right side	Sets the scale (width) of the graph in seconds					
8	Table below graph	- Burst Power: Average power of the burst packet, in dBm					
		 Burst Width: Measured time width of the burst packet from Power-On to Power-Down (or end of waveform, if that occurs before Power-Down), in seconds 					
		NOTE. Power-On Ramp Time and Power-Down Ramp Time values are only available for 802.11b analysis.					
		- Power-On Ramp Time: Time interval for signal level to increase from 10% to 90% of maximum packet power, in seconds					
		 Power-Down Ramp Time: Time interval for signal level to decrease from 90% to 10% of maximum packet power, in seconds. This value is not available is the analysis record does not include the packet power-down portion. 					

WLAN Power vs Time Settings

Application Toolbar: 🕸

The settings for the WLAN Power vs Time display are shown in the following table.

Settings tab	Description
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Scale (see page 187)	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Spectral Flatness Display

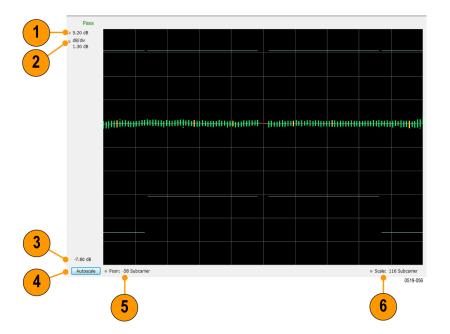
The WLAN Spectral Flatness display shows the average power levels of subcarriers across the signal bandwidth and indicates if they remain within the limits defined for a particular standard.

The averaged subcarrier level is shown as a line on the display, while the individual subcarrier levels are shown as points. The Pass or Fail result indicates whether the average line remains between the upper and lower limit mask boundaries.

NOTE. WLAN Spectral Flatness is only available for OFDM (non-802.11b) signals.

To show the WLAN Spectral Flatness display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN Flatness** icon or select the icon and click **Add**. The WLAN Flatness icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the WLAN Flatness display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Subcarrier Spacing, and Channel Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description					
1	Top of graph, first setting	Sets the Flatness value that appears at the top of the graph in dB. This is only a visual control for panning the graph.					
2	Top of graph, second setting	Sets the lower range of the Flatness value that appears at the top of the graph in dB/div. This is only a visual control for panning the graph.					
3	Bottom of graph	Shows the Flatness value set at the bottom of the graph.					
4	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.					
5	Posn	Specifies the horizontal position of the trace on the graph display.					
6	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.					

WLAN Spectral Flatness Settings

Application Toolbar: 💐

The settings for the WLAN Spectral Flatness display are shown in the following table.

Settings tab	Description				
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.				
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.				
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.				
Analysis Time Tab (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis.				
	NOTE. The Units control on this tab only affects the Analysis Length (AFAIK). Use the Units control in the Prefs tab to affect the displays.				
Trace (see page 186)	Enables you to display or hide the measurement or average trace.				
Scale Tab (see page 187)	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.				
Prefs Tab (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.				

WLAN Summary Display

The WLAN Summary display shows several measurements of WLAN signal quality. The summary display and it's contents will vary by standard selected. Not all of the display contents are provided in this section.

To show the WLAN Summary display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **WLAN Summary** icon or select the icon and click **Add**. The WLAN Summary icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to show the WLAN Summary display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

WLAN Summary Display for 802.11a/g/j/p/n/ac Signals

Burst Power:	-0.01 dBm	Peak-to-A	verage:	9.80 dB	L-SIG Data		Parity:	Pas
Burst Index:	1	IQ Origin O		-82.25 dB	Rate	13	Reserved	0
		Common Pilot Error: 0.337		0.337 %	Length	312	Parity	1
Symbol Clk Erro	r: -0.070 ppm				Tail	0		1
EVM					HT-SIG Data		CRC:	Pas
	All	Pilots	Data					
RMS	-39.91 dB	-40.40 dB	-39.89	dB	MCS	0	CBW	1
Peak	-27.33 dB	-31.09 dB	-27.33	dB	Length Not Sound	672 0	Smoothing Reserved	0
Pk@Sym/Sub	32 / 58	85 / 53	32 /	58	Aggregation	0	STBC	0
						0	Short GI	-
Avg RMS	-39.91 dB				FEC Coding		CRC	0
1 of 1	Bursts				Ness Tail	0	CRC	1
Max RMS	-39.91 dB				1311	0		
Packet Format:	HT_MF	Data Modu	lation: BP	SK				
		Guard Interval: 1/4		4				
S	ymbols	EVM	Avg Pov	wer				
L-STF	2	-44.57 dB	0.00 dBr	n				
L-LTF	2	-40.02 dB	-0.01 dB	m				
L-SIG	1	-40.43 dB	-0.26 dB	m				
HT-SIG	2	-40.34 dB	-0.47 dB	m				
HT-STF	1	-44.08 dB	-0.01 dB	m				
HT-LTF	1	-42.43 dB	0.00 dBr	n				

Elements of the Display for 802.11a/g/j/p/n/ac Signals

Measurement	Description					
Standard	Display of the standard selected on the Setup > Settings > Modulation Params tab.					
Bandwidth	Display of the channel bandwidth selected on Setup > Settings > Modulation Parameters tab.					
Burst Power	The average power of all symbols in the packet, including Preamble and Data segments.					
Peak-to-Average	The ratio of the highest instantaneous signal power level to the average signal power.					
Burst Index	The index of the analyzed packet within the analysis record.					
IQ Origin Offset	The average magnitude of the DC subcarrier level relative to total signal power. It indicates the level of carrier feedthrough detected at the center (DC) subcarrier.					
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the measurement frequency setting.					
Common Pilot Error	The RMS magnitude error of the pilots over all data symbols.					
Symbol Clk Error	The symbol clock error in parts per million.					
EVM	The RMS and Peak values of the normalized subcarrier Error Vector Magnitude values. The normalized subcarrier EVM values are calculated as the difference between the detected received signal subcarrier constellation points and ideal reference points estimated by the instrument from the received signal. Values are reported in units of percent or dB. Peak values include the symbol and subcarrier location.					
	RMS and Peak values are displayed for groupings of all subcarriers, Pilots only and Data only. Results are calculated over all Data symbols in the packet.					
	Average RMS and Peak RMS values are accumulated over multiple packet analysis cycles. The Clear button on the display resets these values by clearing the result memory.					
Packet Format	Displays the packet format: AG, HT_MF, HT_GF, VHT.					
Data Modulation	Displays the modulation used in the Data symbols: BPSK, QPSK, 16QAM, 64QAM, 256QAM.					
Guard Interval	Displays the Guard Interval used by the Data symbols: 1/4, 1/8.					
Symbols, EVM, Avg Power	Displays the type and number of symbols, EVM-RMS and average power of the Preamble and Data portions of the packet.					
SIG DataDisplays he decimal values of the received packet SIGNAL, HT-SIGNAL an VHT-SIGNAL symbols' fields. The Pass/Fail result in each heading line indica the calculated Parity or CRC value matches the received Parity or CRC value corresponding SIGNAL symbol grouping.VHT-SIG DataVHT-SIG Data						

WLAN Summary Display for 802.11b Signals

Burst Power:	-1.22 dBm	Peak-to-A	verage:	1.50 dB	Header Data		CRC:	Pass
Burst Index:	1	IQ Origin	Offset:	-39.12 dB	Signal	20	Service	0
Frequency Erro	r: -2.34 Hz				Length	400	CRC	17735
EVM								
	All	1k Chips						
RMS	-39.12 dB	-39.02 dB						
Peak	-30.29 dB	-30.32 dB						
Pk @ Chip	2992	66						
Avg RMS	-39.12 dB							
1 of 1	Bursts							
Max RMS	-39.12 dB							
Packet Format:	DSSS 2M	Data Modi	Jation: D	SSS 2M				
	Chips	EVM	Avg Pa	wer				
Preamble:	1584	-38.96 dB	-1.72 di	Bm				
Header:	528	-39.06 dB	-1.23 di	Bm				
Data:	4400	-39.19 dB	-1.23 di	Bm				

Elements of the Display for 802.11b Signals

Measurement	Description				
Standard	Display of the standard selected on the Setup > Settings > Modulation Parameters tab.				
Burst Power	The average power of the entire packet.				
Peak-to-Average	The ratio of the highest instantaneous packet signal power level to the average signal power.				
Burst Index	The index of the analyzed packet within the analysis record.				
IQ Origin Offset	The amount of power at the signal carrier frequency relative to the total power of the signal.				
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the measurement frequency setting.				
EVM	The RMS and Peak values of the normalized Error Vector Magnitudes taken at signal chip intervals. The normalized EVM values are calculated as the difference between the detected received signal constellation points and ideal reference points estimated by the instrument from the received signal. Values are reported in units of percent or dB. Peak values indicate the associated chip locations.				
	RMS and Peak values are displayed for groupings of All chips, and the first 1000 (1k) chips.				
	Average RMS and Peak RMS values are accumulated over multiple packet analysis cycles. The Clear button on the display resets these values by clearing the result memory.				
Packet Format	Displays the packet format: DSSS 1M, DSSS 2M, CCK 5.5M or CCK 11M.				
Data Modulation	Displays the modulation used in the PSDU/Data packet segment.				
Chips, EVM, Avg Power Displays the number of chips, EVM-RMS and average power of the Preamb and Data portions of the packet.					
Header Data	Displays he decimal values of the received packet Header's Signal, Service, Length, and CRC fields. The CRC Pass/Fail result indicates if the received CRC value is equal to the CRC value computed from the received Signal, Service and Length values.				

WLAN Summary Settings

Application Toolbar: 鄻

The settings for the WLAN Summary display are shown in the following table.

Settings tab	Description
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
EVM (see page 189)	Specifies the EVM units (dB or %) and Max Bursts to Avg. The EVM is generally measured on symbol or chip instants and is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed.
Prefs (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

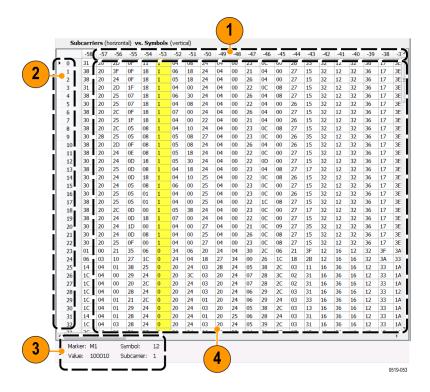
WLAN Symbol Table Display

The WLAN Symbol Table display shows decoded data values for each data symbol in the analyzed signal packet. For OFDM signals (all standards except 802.11b), results are presented with subcarrier (frequency) indices in the horizontal dimension and symbol (time) intervals in the vertical dimension. For 802.11b signals, the Preamble, Header, and Data (PSDU) symbol values are presented sequentially, with symbol indices in the left column.

To show the WLAN Symbol Table display:

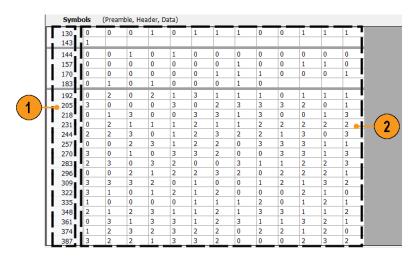
- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select WLAN Analysis in the Measurements box.
- 3. In the Available displays box, double-click the WLAN Symb Table icon or select the icon and click Add. The WLAN Symbol icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click OK to show the WLAN Symbol Table display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

WLAN Symbol Table for OFDM signals



ltem	Description	
1	Subcarrier identifiers (OFDM only). Yellow column indicates Pilot subcarrier locations.	
2	Symbol identifiers.	
3	Subcarrier data values.	
4	Marker readout when markers are enabled.	

WLAN Symbol Table for 802.11b signals



Item	Description
1	Symbol number index (from beginning of packet or segment) of first Symbol data value on the line.
2	Symbol values, with the value in column 2 of each row corresponding to the symbol number index in column 1, and then the symbol value in column 3 corresponding to the next symbol number index, etc., to the end of each row.
	For example: The symbol number index 130 = 0 in column 2. The symbol number index for column 3 is 131, which equals 0. The symbol number index for column 4 is 132, which equals 1. This pattern continues to the end of the row.

WLAN Symbol Table Settings

Application Toolbar: 💐

The settings for the WLAN Symbol Table display are shown in the following table.

Settings tab	Description
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Prefs (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Analysis Shared Measurement Settings

Application Toolbar: 🕸

The control panel tabs in this section are shared between the displays in the WLAN Analysis folder (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a subset of displays. The settings available on some tabs change depending on the selected display.

Settings tab	Description					
Modulation Params (see page 181)	Specifies the type of modulation used for the input signal and other parameters.					
Analysis Params (see page 182)	Specifies parameters used by the instrument to analyze the input signal.					
Data Range (see page 184)	Specifies which symbols and subcarriers of the signal to display.					
Analysis Time (see page 185)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.					
Trace (see page 186)	Enables you to display or hide the measurement or average trace.					
Scale (see page 187)	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.					
EVM (see page 189)	Specifies the EVM units and max burst averages.					
Prefs (see page 190)	Specifies the units of the display and whether elements of the graphs are displayed.					

Common controls for WLAN analysis displays

Modulation Params Tab - WLAN

The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that define the signal format.

Modulation Params	Analysis Params	Data Range	Analysis Time	Trace	Scale	Prefs		
Standar	rd: 802.11g	•	Gu	ard Inte	rval:	Auto froi	n SIG	•
Channel Bandwidth	1: 20 MHz	-	Subcar	rier Spac	ing:	312.500	kHz	Auto
FFT Sample Ra	te: 20.000 MS/	s		FFT Len	gth:	64		

Settings	Description
Standard	Specifies the standard used for the input signal. Choices are 802.11a/b/g/j/n/p/ac.
Guard Interval	Specifies the guard interval used in the input signal. You can select the following:
	 Auto from SIG uses the Guard Interval value extracted from the signal
	 – 1/8 allows setting the value manually
	 – 1/4 allows setting the value manually
Channel Bandwidth	Specifies the nominal channel bandwidth. This setting affects the Subcarrier Spacing value when the Subcarrier Spacing Auto box is checked.
Subcarrier Spacing	Specifies the spacing between subcarriers. When Auto is selected, this setting is automatically calculated according to the Channel Bandwidth value. If Auto is unchecked, a custom subcarrier spacing value can be entered for nonstandard signal definition.
FFT Sample Rate	Indicates the FFT sample rate, based on the bandwidth or subcarrier setting.
FFT Length	Indicates the fixed FFT length.

Analysis Params Tab - WLAN

The Analysis Params tab contains parameters that control the analysis of the input signal.

Modulation Params	Analysis Params	Data Range	Analysis Time	Traces	Scale	Prefs			
Burst Selection In	dex: 1			Equalize	er Traini	ing: P	reambl	e	•
Frequency E	error: 0.000 Hz	🗹 Au	to	Data M	4odulati	ion: A	uto De	tect	•
Symbol Analysis Of	fset: -50 %								
Swap I	& Q:			Pilot Tr	acking				
				🔽 Ph	ase	Ampli	tude	Timin	g

Settings	Description
Burst Selection Index	Allows specifying the burst you want to measure when multiple bursts are present in an acquisition. Index number of the first burst is 1, second burst is 2, etc.
Frequency Error	When the Auto box is checked, the analysis determines the Frequency Error and the measured Frequency Error is displayed. When the Auto box is unchecked, the entered value is used by the analysis as a fixed frequency offset. This is useful when the exact frequency offset of the signal is known.
Symbol Analysis Offset	Specifies the analysis offset in the symbol interval. This value is a percentage of the Guard Interval. The allowable range is -100% to 0%100% positions the FFT to start at the beginning of the Guard Interval, 0% positions it to start at the end of the Guard Interval. Default value is -50% which usually gives the best measurement results.
Swap I & Q	Select the checkbox to swap the I and Q components of a signal. This compensates the input signal for spectral inversion.
Equalizer Training	Specifies the method used to estimate channel frequency response and equalization. This control can be used to diagnose changes in frequency response over the signal packet.
Preamble	The instrument uses only the Preamble to estimate channel frequency response. This response is then used to equalize the entire signal packet.
Preamble + Data	The instrument makes an initial channel frequency response estimate from the Preamble. It then estimates the channel response for each data symbol using the decoded data content to derive equalization for each symbol individually. This allows compensation for time-varying channel response over the packet.
Data Modulation	Allows choice of automatic or manual method of data symbol modulation identification, as follows:
	 Auto Detect estimates the modulation from the data symbol IQ content.
	 Auto from SIG sets the modulation as indicated by the embedded SIG preamble symbol format data.
	 Manual allows specifying the modulation type regardless of the signal content.
Pilot tracking	Specifies if pilot subcarriers should be used to correct amplitude, phase, and symbol timing variations over the packet. The choices available are Phase, Amplitude, and Timing. The default setting is Phase correction enabled, Amplitude and Timing correction disabled
Subcarrier derotation	Allows some displays to show subcarriers with or without Gamma subcarrier phase rotation removed. Gamma phase rotation is applied to 802.11n and 802.11ac subcarriers in defined subranges depending on the selected Channel Bandwidth >40 MHz. Only Constellation and Symbol Table results are affected by this control.
	When the box is unchecked, the rotation is not removed, which provides a direct view of the physical modulation on the channel.
	When the box is checked, the rotation is removed, allowing easier decoding of the underlying data content.

Data Range Tab - WLAN

The Data Range tab enables you to control how much signal is analyzed, as well as specify the range of results that are displayed for the WLAN Constellation, EVM, Flatness, Magnitude Error, Phase Error, and Symbol Table graphs. The tab contents vary by standard.

Data Range tab for non-b standards.

Modulation Params Analysis Params	Data Range	Analysis Time	Traces	Scale	Prefs		
Displayed Results							
Symbols: All - Su	bcarriers: All						
	Deamers.	•					
			Ma	ax data :	symbols	to analyze:	50 Symbol

Settings	Description
Symbols	Specifies which symbols are displayed in the graphs.
All	Select All to display all symbols.
Range	Select Range to specify a subset of symbols for display.
Start	Specifies the first symbol to include in the display.
Stop	Specifies the last symbol to include in the display.
Single	Select Single to display a single symbol.
Index	Use Index to specify the symbol you want to display.
Subcarriers	Specifies which subcarriers are displayed.
All	Select All to display all subcarriers in the signal.
Pilots	Select Pilot to display only pilot subcarriers.
Data	Select Data to display only data subcarriers.
Single	Specifies a specific subcarrier for display.
Index	Specifies the specific subcarrier to be displayed.
Range	Specifies a range of subcarriers to be displayed.
Start	Specifies the start value of the range to be displayed.
Stop	Specifies the ending value of the range to be displayed.
Max symbols to analyze	Specifies how many symbols are analyzed. You can use this setting to speed analysis by limiting the number of symbols being analyzed.

Data Range tab for 802.11b standards.

Modulation Params	Analysis Params	Data Range	Analysis Time	Traces	Scale	Prefs		
Displayed Results								
Chips: All	•							
. [
				E Ma	ax no. o	f chips t	o analyze:	2500 Chip

Settings	Description					
Chips	Specifies which symbols are displayed in the graphs.					
All	Select All to display all chips.					
Preamble Only	Select to include only the Preamble in the display.					
Header Only	Select to include only the Header in the display.					
Data Only	Select to include only the Data in the display.					
Max number of chips to analyze	Specifies how many chips are analyzed. You can use this setting to speed analysis by limiting the number of chips being analyzed. Check this box and then enter the maximum number of chips to analyze.					

Analysis Time Tab - WLAN

The Analysis Time tab contains parameters that define how the signal is analyzed in the WLAN Analysis displays.

Modulation Params	Analysis Params Data	Range Analysis Time	EVM Prefs	
Analysis Length	a: 200.000 Symbol	V Auto	Units:	Symbols 🔻

Settings	Description
Analysis Length	Specifies the length of the analysis period to use in measurements. Length is specified in either symbols or seconds, depending on the Units setting.
	Use this to specify how long a period of time is analyzed.
	 Range: minimum value depends on modulation type
	– Resolution: 1 symbol
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.
Units	Specifies the units of the Analysis Length in either Symbols or Seconds.

Trace Tab - WLAN

The Trace tab allows you to set the trace display characteristics of the selected display. This tab is not available for all WLAN displays.

Modulation Params	Analysis Params	Data Range	Analysis T	Time	Trace	Scale	Prefs
Trace: Avera	ae 🔻 🔽 S	how 🔲	Freeze				
Avera	ge 🔻 🗹 S		TTEEZE				

Settings	Description
Trace	Use this drop-down list to select whether or not the Average trace or the measurement trace is displayed. The measurement trace depends on the selected display.
Show Symbols	Select or deselect this checkbox to show or hide symbols.
Freeze	Selecting Freeze halts updates to the symbols.

Traces Tab - WLAN Channel Response

The Traces tab allows you to set the trace display characteristics of the WLAN Channel Reponse display.

N	Modulation Params	Analysis Params	Data Range	Analysis Time	Traces	Scale	Prefs	
	Trace: Ma	agnitude 🔻	Sa	ave Trace As			Recall Trace	
							Show recalled trace	

Settings	Description					
Trace	Selects the Magnitude or Phase trace for saving or recalling.					
Save Trace As	Select to save a trace.					
Recall Trace	Select to recall a trace.					

Scale Tab - WLAN

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings such as Measurement Frequency. There are four versions of the Scale tab for WLAN displays. One version is used for the Constellation display, one for the Spectral Flatness display, one for the Power vs Time display, and one for the EVM, Magnitude Error, Phase Error, and Channel Response displays.

2	Modulation Par	ams	Analysis F	arams	Data	Range	Analysi	s Time	Scale	Prefs	
	Vertical							Horizo	ntal Ful	Burst	
	Scale:	100.	00 dB					Sc	ale: 1	100.000 u	JS
	Position:	-11.	00 dBm			Reset		Posi	ion: (0.000 s	
			Autoscale							Auto	oscale

Scale tab for the WLAN Power vs Time display

Modulation Pa	arams Analysis Params	Data Range	Analysis Time Trace	Scale Pre	fs
Vertical		Horizontal	Symbol	Horizontal	Subcarrier
Scale:	7.80 °	Start:	0 Symbol	Start:	-58 Subcarrier
Position:	-3.90 °	Stop:	99 Symbol	Stop:	58 Subcarrier
	Reset	💟 Auto	Reset		Reset

Scale tab for WLAN EVM, Magnitude Error, Phase Error, and Channel Response displays

Modulation Params	Analy	sis Params	Data Range	Analysis Time	Trace	Scale	Prefs
Zoor	n						
	Scale:	3		Vertical Po	sition:	0	
				Horizontal Po	osition:	0	

Scale tab for WLAN Constellation display

Vertical					Hor	zontal		
Scale:	100.00	dB			5	icale:	52 Subca	rrier
Position:	5.00 dB]		Pos	sition:	-26 Subca	arrier
	Auto	scale]			[Autos	cale

Scale tab for WLAN Spectral Flatness display

Settings	Description						
Vertical	Controls the vertical position and scale of the trace display.						
Scale	Changes the vertical scale of the graph.						
Position	Adjusts the reference level away from top of the graph.						
Autoscale	Resets the scale of the vertical axis to contain the complete trace.						
Subcarrier	Controls the scale of the subcarrier graph and position of the trace.						
Scale	Specifies how many subcarriers are displayed horizontally.						
Position	Specifies the subcarrier that appears at the left edge of the subcarrier graph.						
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.						
Symbols	Controls the scale of the Symbols graph.						
Scale	Specifies the number of symbols that appear in the symbols graph.						
Position	Specifies the symbol that appears at the left edge of the Symbols graph.						
Autoscale	Resets the scale and position settings to optimize the display.						
Auto	When Auto is checked, the scale and position values for the Symbols graph are automatically adjusted to maintain the optimal display.						
Zoom	Sets the Constellation display size and position.						
Scale	Sets the magnification value for the Constellation display.						
Vertical Position	Sets the vertical location of the Constellation display within the graph. Range is -3.7 to +3.7.						
Horizontal Position	Sets the horizontal location of the Constellation display within the graph. Range is -3.7 to +3.7.						

EVM Tab - WLAN

The EVM Tab enables you to chose between dB and percent for the EVM units and to select to set the maximum bursts to average. The EVM Tab is only available for the WLAN Summary display.

Modul	ation Params	Analy	sis Params	Data Range	Analysis	Time	EVM	Prefs
	EVM U	nits:	dB 🔻	·				
м	ax Bursts to /	Avg:	20					
			Count					

Settings	Description	
EVM units	Specifies whether the displayed EVM units are dB or percent.	
Max Bursts to Avg	Specifies the maximum number of bursts to average when Count is selected.	
Count	Enables the Max Bursts to Avg function.	

Prefs Tab - WLAN

The Prefs tab enables you to change appearance characteristics of the WLAN Analysis displays. Not all settings on the Prefs tab shown below appear for every WLAN display.

Modulation Params	Analysis Params	Data Range	Analysis Time	Traces	Scale	Prefs
Time Units:	Symbols	Show	graphs			
nine onics.	Symbols		🗇 Magnitude		V	Show graticule
Freq Units:	Subcarrier	-	Phase			
Radix:	Hex				1	Show marker readout
Noux.	Hex	•	Both			

Settings	Description
Time units	Specifies whether the displayed time units are seconds or symbols.
Freq units	Specifies whether the displayed frequency units are frequency (Hz) or subcarrier channel.
Radix	Specifies whether symbol values are displayed in binary or hex format (for example, in the Symbol Table or markers readouts).
Show graphs	Specifies which graphs are displayed. Select from Symbols, Subcarriers or Both, Magnitude, Phase, or Both. Disabled (no masks), Shaded Region, or Line Only. These selections are only available for OFDM signals.
Show graticule	Specifies to show the graticule on the display when checked.
Show marker readout	Specifies to show the marker readout when checked.

Overview

The OFDM Analysis option provides measurements for OFDM signals specified by 802.11a/g/j (Wifi) and 802.16 (2004) (commonly known as Fixed WiMAX) standards. User controls allow you to modify signal parameters for analysis of non-standard signals. The analysis results give multiple views of OFDM signal characteristics to allow diagnosing signal imperfections and impairments quickly and easily. Display controls provide the ability to selectively display the analysis results to help locate trouble-spots in the signal.

The displays in OFDM Measurements (Displays > Measurements > OFDM Measurements) are:

- OFDM Channel Response (see page 191)
- OFDM Constellation (see page 194)
- OFDM EVM (see page 195)
- OFDM Spectral Flatness (see page 197)
- OFDM Mag Error (see page 199)
- OFDM Phase Error (see page 201)
- OFDM Power (see page 203)
- OFDM Summary (see page 205)
- OFDM Symbol Table (see page 207)

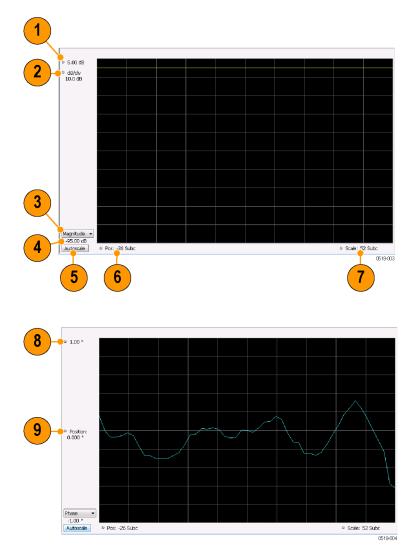
OFDM Channel Response Display

The OFDM Channel Response display plots the channel response (magnitude or phase) versus the subcarrier or frequency. Here, the channel refers to all sources of signal frequency response impairment up to the analyzer input, including the transmitter itself, as well as any transmission medium through which the signal travels between the transmitter and the analyzer.

To show the OFDM Channel Response display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Chan Response** icon or select the icon and click **Add**. The OFDM Chan Response icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to show the OFDM Chan Response display.
- 5. Set the Frequency appropriate for the signal.

- 6. Select **Setup** > **Settings** to display the control panel.
- 7. Select the Modulation Params tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description
1	Top-of-graph (magnitude)	Sets the level that appears at the top of the magnitude graph. This is only a visual control for panning the graph. The Reference Level is adjusted in the Toolbar and the Ampl control panel. By default, Vert Position = Ref Level.
2	dB/div (magnitude)	Sets the vertical scale value. The maximum value is 20.00 dB/division.
3	Display selector Selects the display type. Channel Response Magnitude or Phase can be displayed as a Magnitude or Phase graph.	
4	Bottom-of-graph readout (magnitude)	Indicates the amplitude at the bottom of the graph. This value changes with the dB/div and Vertical Position settings.
5	Autoscale	Adjusts the Vertical and Horizontal scaling to display the optimize the trace display on screen.
6	Pos	Shifts the trace left or right in the graph. The readout indicates the subcarrier or frequency shown at the left edge of the display.
7	Scale	Specifies the number of subcarriers shown in the graph.
8	Top-of-graph (phase)	Sets the phase value indicated at the top of the graph. Since the Position value at the vertical center of this graph remains constant as the Top of Graph value is adjusted, the Vertical Scale increases as the Top of Graph value increases, which also affects the bottom of graph readout.
9	Position (phase)	Specifies the phase shown at the center of the graph display. Changing this value moves the trace up and down in the graph, which affects the Top of Graph and Bottom of Graph values as well.
10	Bottom-of-graph (phase)	Indicates the phase at the bottom of the graph. This value changes with the Position setting.

OFDM Channel Response Settings

The OFDM Channel Response Settings control panel provides access to settings that control parameters of the Channel Response Display.

Settings tab	Description
Modulation Params (see page 209)	Specifies the input signal standard and additional user-settable signal parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range Tab (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the time units (Symbols or Seconds) for OFDM Analysis displays.
Prefs Tab (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

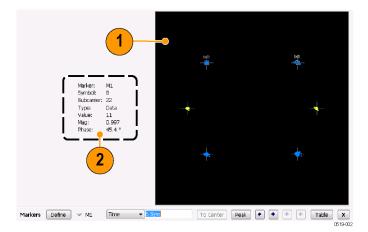
OFDM Constellation Display

Display shows the OFDM signal subcarriers' amplitude and phase in IQ constellation form.

To show the OFDM Constellation display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Constellation in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Constellation** icon or select the icon and click **Add**. The OFDM Constellation icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Constellation display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

Elements of the Display



ltem	Display element	Description
1	Plot	Constellation graph.
2	Marker Readout	If markers are enabled, the marker readout shows the selected Marker, Symbol, Subcarrier, Type, Value, Magnitude, and Phase for the symbol at the marker location. Located to the left of the constellation plot or below it, depending on the size of the window.

OFDM Constellation Settings

Application Toolbar: 虊

The OFDM Constellation Settings control panel provides access to settings that control parameters of the Constellation Display.

Settings tab	Description
Modulation Params (see page 209)	Specifies the input signal standard and additional user-settable signal parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to freeze the display or hide the measurement or average trace.
Scale Tab (see page 213)	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

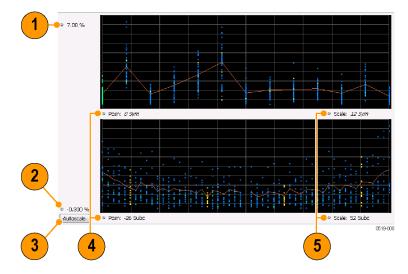
OFDM EVM Display

The OFDM EVM display shows the data symbols' individual subcarrier Error Vector Magnitude values versus symbol interval (time) and subcarrier (frequency).

To show the OFDM EVM display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM EVM in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM EVM** icon or select the icon and click **Add**. The OFDM EVM icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM EVM display.
- 5. Set the Frequency appropriate for the signal.

- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard as appropriate. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description	
1	Top of graph	Sets the EVM value that appears at the top of the graph. This is only a visual control for panning the graph.	
2	Bottom of graph	Sets the EVM value that appears at the bottom of the graph. This is only a visual control for panning the graph.	
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.	
4	Pos	Specifies the horizontal position of the trace on the graph display.	
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.	

OFDM EVM Settings

Application Toolbar: 🕮

The settings for the OFDM EVM display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to freeze the display or hide the measurement or average trace.
Scale (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

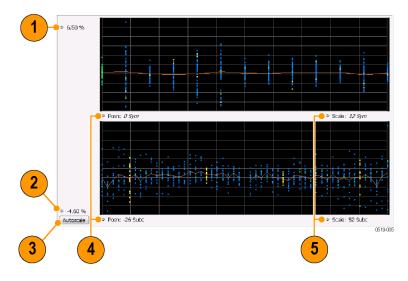
OFDM Spectral Flatness Display

The OFDM Spectral Flatness display shows the average power levels of subcarriers across the signal bandwidth and indicates if they remain within the limits defined for a particular standard.

The averaged subcarrier level is shown as a line on the display, while the individual subcarrier levels are shown as points. The Pass or Fail result indicates whether the average line remains between the upper and lower limit mask boundaries.

To show the OFDM Spectral Flatness display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Flatness** icon or select the icon and click **Add**. The OFDM Flatness icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Flatness display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Subcarrier Spacing and Channel Bandwidth controls as appropriate for the input signal.



ltem	Display element	Description	
1	Top of graph	Sets the Flatness value that appears at the bottom of the graph in dB. This is only a visual control for panning the graph.	
2	Bottom of graph	Shows the Flatness value set at the top of the graph.	
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.	
4	Pos	Specifies the horizontal position of the trace on the graph display.	
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.	

OFDM Spectral Flatness Settings

Application Toolbar: 🕸

The settings for the OFDM Spectral Flatness display are shown in the following table.

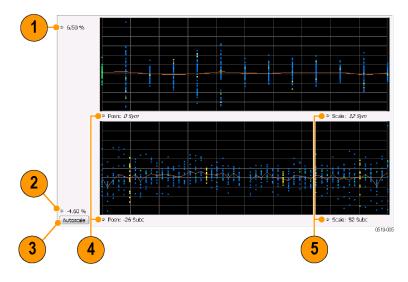
Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for WLAN Analysis displays.
Trace (see page 213)	Enables you to display or hide the measurement or average trace.
Scale Tab (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Magnitude Error Display

The OFDM Mag Error display shows the data symbols' individual subcarrier Magnitude Error values versus symbol interval (time) and subcarrier (frequency).

To show the OFDM Magnitude Error display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Mag Error** icon or select the icon and click **Add**. The OFDM Mag Error icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Mag Error display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



Item	Display element	Description
1	Top of graph	Sets the Magnitude Error value that appears at the top of the graph. This is only a visual control for panning the graph.
2	Bottom of graph	Sets the Magnitude Error value that appears at the bottom of the graph. This is only a visual control for panning the graph.
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
4	Pos	Specifies the horizontal position of the trace on the graph display.
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.

OFDM Magnitude Error Settings

Application Toolbar: 💐

The settings for the OFDM Mag Error display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to display or hide the measurement or average trace.
Scale Tab (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

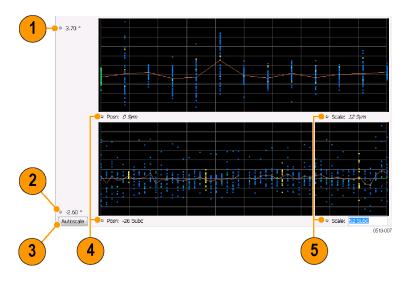
OFDM Phase Error Display

The OFDM Phase Error display shows the data symbols' individual subcarrier Phase Error values versus symbol interval (time) and subcarrier (frequency).

To show the OFDM Phase Error display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Phase Error** icon or select the icon and click **Add**. The OFDM Phase Error icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Phase Error display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

Elements of the Display



Item	Display element	Description				
1	Top of graph	Sets the Phase Error value that appears at the top of the graph. This is only a visual control for panning the graph.				
2	Bottom of graph	Sets the Phase Error value that appears at the bottom of the graph. This is only a visual control for panning the graph.				
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.				
4	Pos	Specifies the horizontal position of the trace on the graph display.				
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.				

OFDM Phase Error Settings

Application Toolbar: 🕸

The settings for the OFDM Phase Error display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to display or hide the measurement or average trace.
Scale Tab (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

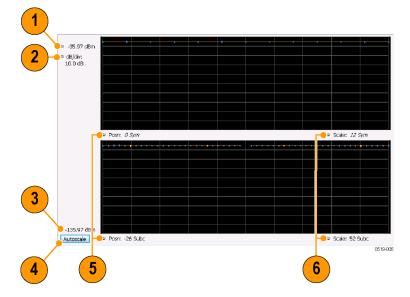
OFDM Power Display

The OFDM Power display shows the data symbols' individual subcarrier Power values versus symbol interval (time) and subcarrier (frequency).

To show the OFDM Power display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Power** icon or select the icon and click **Add**. The OFDM Power icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Power display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
- 8. If you are analyzing a stored data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	Display element	Description
1	Vertical Position	Sets the top of graph value. This is only a visual control for panning the graph. The Reference Level is adjusted in the Toolbar and the Ampl control panel. By default, Vert Position = Ref Level.
2	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.
2	Bottom of graph readout	Indicates the amplitude at the bottom of the graph. This value changes with the dB/div and Vertical Position settings.
3	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
4	Pos	Specifies the horizontal position of the trace on the graph display.
5	Scale	Adjusts the horizontal range of the graph. By decreasing the scale, the graph essentially becomes a window that you can move over the analysis results by adjusting the position.

OFDM Power Settings

Application Toolbar: 🕸

The settings for the OFDM Power display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to display or hide the measurement or average trace.
Scale (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Summary Display

The OFDM Summary display shows several measurements of OFDM signal quality.

To show the OFDM Summary display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Summary** icon or select the icon and click **Add**. The OFDM Summary icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to show the OFDM Summary display.
- 5. Set the Frequency appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

Elements of the Display

802.11a/g/j		Symbols:	13			
Frequency Error:	1.75 Hz	Symbol Clk Error:	-0.502 ppm			
IQ Origin Offset:	-74.31 dB	CPE:	1.509 %			
Average Power:	-24.31 dBm	Peak-to-Average:	9.53 dB			
Subcarriers:	All	Pilots	Data			
RMS EVM:	-35.17 dB	-36.43 dB	-35.08 dB			
	1.744 %	1.509 %	1.763 %			
Peak EVM:	-23.75 dB	-27.80 dB	-23.75 dB			
	6.492 %	4.074 %	6.492 %			
at symbol:	1	5	1			
at subcarrier:	26	21	26			

Measurement	Description
Standard	Display of the standard selected on the Setup > Settings > Modulation Params tab.
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the measurement frequency setting.
IQ Origin Offset	The average magnitude of the DC subcarrier level relative to total signal power. It indicates the level of carrier feedthrough detected at the center (DC) subcarrier.
Average Power	The average power of all symbols in the analysis. Calculated over only the data symbols in the packet.
Symbols	How many symbols were analyzed.
Symbol Clk Error	The symbol clock error in parts per million.
CPE	CPE, Common Pilot Error, is the RMS magnitude error of the pilots over all analyzed symbols.
Peak-to-Average	The ratio of the highest instantaneous signal power level to the average signal power. Calculated over only the data symbols in the packet.
EVM	The RMS and Peak values of the normalized subcarrier Error Vector Magnitude values. The normalized subcarrier EVM values are calculated as the difference between the detected received signal subcarrier constellation points and ideal reference points estimated by the instrument from the received signal. Values are reported in units of percent and dB. Peak values include the symbol and subcarrier location.
	RMS and Peak values are displayed for groupings of all subcarriers, Pilots only and Data only. Results are calculated over the entire signal packet analyzed, covering the number of Symbols indicated in the Summary display.

OFDM Summary Settings

Application Toolbar: 🕸

The settings for the OFDM Summary display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Prefs (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Symbol Table Display

The OFDM Symbol Table display shows decoded data bits for each subcarrier in each symbol in the analyzed signal packet. Results are presented with subcarrier (frequency) indices in the horizontal dimension and symbol (time) intervals in the vertical dimension.

To show the OFDM Symbol Table display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select OFDM Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **OFDM Symb Table** icon or select the icon and click **Add**. The OFDM Symbol icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the OFDM Symbol Table display.
- 5. Set the **Frequency** appropriate for the signal.
- 6. Select Setup > Settings to display the control panel.
- 7. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.

	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16
	10	0	0	0	0	1	1	1	0	1	1
1	001010	111110	111101	101001	100000	1	111111	100001	010011	001011	110100
2	001010	110111	000011	000010	101111	1	111111	101110	000000	110001	111110
3	110011	110110	110001	010101	111110	1	011000	011111	011011	011011	010001
4	110100	001011	001011	110000	110101	0	101100	001110	111110	011010	011101
5	101010	100100	001100	011000	111101	0	111001	110010	001010	010010	010011
5	011011	111010	011010	100000	110011	0	010000	010111	010001	110100	011000
7	100111	111111	110001	001011	111100	1	000000	100000	101011	001110	010010
8	110010	001110	010011	100001	001111	0	101001	001001	101110	000101	001000
9	001101	011011	011010	110110	011100	0	111011	100000	100001	101111	100100
10	101001	010100	010101	101010	110101	0	001011	011010	011011	001001	101101
11	101111	100010	000011	000000	000100	0	001110	110111	000000	110010	110100
12	000001	011101	100110	110100	100000	1	000011	010101	000001	011100	110100
2		4				3					

Item	Description
1	Subcarrier identifiers.
2	Symbol identifiers.

(cont.)

Item	Description
3	Subcarrier data values.
4	Marker readout when markers are enabled.

OFDM Symbol Table Settings

Application Toolbar: 🕮

The settings for the OFDM Symbol Table display are shown in the following table.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Prefs (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Analysis Shared Measurement Settings

Application Toolbar: 🕸

The control panel tabs in this section are shared between the displays in the OFDM Analysis folder (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a couple of displays. The settings available on some tabs change depending on the selected display.

Settings tab	Description
Modulation Params (see page 209)	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params (see page 210)	Specifies parameters used by the instrument to analyze the input signal.
Data Range (see page 211)	Specifies which symbols and subcarriers of the signal to display.
Analysis Time (see page 211)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for OFDM Analysis displays.
Trace (see page 213)	Enables you to display or hide the measurement or average trace.
Scale (see page 213)	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs (see page 215)	Specifies the units of the display and whether elements of the graphs are displayed.

Common controls for OFDM analysis displays

Modulation Params Tab - OFDM

The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that control the demodulation of the input signal.

Modulation Params	Advanced Params	Data Range	AnalysisTime	Trace	Scale	Prefs	
Standard:	802.16 (2004) 🔻		Spacing	and Ban ubcarrier		- 6	0.000 kHz
Guard Interval:	FFT Length : 256			hannel B			20.160 MHz
				FFT S	ample R	ate:	23.040 MS/s

Settings	Description
Standard	Specifies the standard used for the input signal. Choices are 802.11a/g/j and 802.16 (2004).
Guard Interval	Specifies the guard interval used in the input signal. Choices are 1/4, 1/8, 1/16/, 1/32, and User. When you select User, you can enter a percentage value to specify the size of the guard interval as a percentage of the useful symbol interval. The Guard Interval range is 0–100%.
Spacing and Bandwidth	Specifies the spacing between subcarriers and the nominal channel bandwidth. Only one of these settings can be set at a time, the other setting is automatically calculated.
Sample Rate	Indicates the FFT sample rate, based on the bandwidth or subcarrier setting.

Advanced Params Tab - OFDM

The Advanced Params tab contains parameters that control the analysis of the input signal.

Modulation Params Ad	Ivanced Params	Data Range	AnalysisTime	Trace	Scale	Prefs		
Constellation determi	nation Auto D	etect	Pilo	nel Estima t tracking Phase		Preamt plitude	ole	•
Symbol analysis (offset: -0.5 %		 9	wap I & Ç	2			

Settings	Description			
Constellation determination	Specifies the method used to detect the constellation. Auto Detect analyzes the signal to determine the appropriate constellation, Manual allows you to specify the constellation type. Manual choices are: BPSK, QPSK, 16QAM, and 64QAM.			
Symbol analysis offset	Specifies the analysis offset in the symbol interval. This value is a percentage of the Guard Interval. The allowable range is -100% to 0%100% positions the FFT to start at the beginning of the Guard Interval, 0% positions it to start at the end of the Guard Interval. Default value is -50% which usually gives the best measurement results.			
Channel Estimation	Specifies the method used to estimate channel frequency response and equalization. This control can be used to diagnose changes in frequency response over the signal packet.			
Preamble	When you select Preamble, the instrument uses only the Preamble to estimate channel frequency response. This response is then used to equalize the entire signal packet.			
Preamble + Data	When you select Preamble + Data, the instrument makes an initial channel frequency response estimate from the Preamble. Then estimates the channel response for each data symbol using the decoded data content to derive equalization for each symbol individually. This allows compensation for time-varying channel response over the packet.			
Pilot tracking	Specifies if pilot subcarriers should be used to correct amplitude, phase, and symbol timing variations over the packet. The choices available are Phase, Amplitude, and Timing. The default setting is Phase.			
Swap I & Q	Select the checkbox to swap the I and Q components of a signal. This compensates the input signal for spectral inversion.			

Data Range Tab - OFDM

The Data Range tab enables you to control how much signal is analyzed, as well as specify the range of results that are displayed in the Constellation, EVM, Magnitude Error, Phase Error, Power and Symbol Table graphs.

1004
1004

Settings	Description
Symbols	Specifies which symbols are displayed in the graphs.
All	Select All to display all symbols.
Range	Select Range to specify a subset of symbols for display.
Start	Specifies the first symbol to include in the display.
Number	Specifies how many symbols to display in the graphs.
Single	Select Single to display a single symbol.
Index	Use Index to specify the symbol you want to display.
Subcarriers	Specifies which subcarriers are displayed.
All	Select All to display all subcarriers in the signal.
Pilots Only	Select Pilot to display only pilot subcarriers.
Data Only	Select Data to display only data subcarriers.
Single	Specifies a specific subcarrier for display.
Index	Specifies the specific subcarrier to be displayed.
Range	Specifies a range to subcarriers to be displayed.
Start	Specifies the start value of the range to be displayed.
Stop	Specifies the ending value of the range to be displayed.
Max symbols to analyze	Specifies how many symbols are analyzed. You can use this setting to speed analysis by limiting the number of symbols being analyzed.

Analysis Time Tab - OFDM

The Analysis Time tab contains parameters that define how the signal is analyzed in the OFDM Analysis displays.

Modulation Params	Advanced Params	Data Range	AnalysisTime	Trace S	ale Prefs
Analysis Offse	t: <i>-0.668 Sym</i>	🔽 Auto	Time Zero	Reference	: Trigger 🗸
Analysis Lengtł	n: <i>66.000 Sym</i>	📝 Auto		Unit	:: Symbols 🔹
Actua	l: 66.000 Sym				

Settings	Description
Analysis Offset	Specifies the location of the first time sample to use in measurements.
Auto	When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.
Analysis Length	Specifies the length of the analysis period to use in measurements. Length is specified in either symbols or seconds, depending on the Units setting.
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.
Actual	This is a displayed value, not a setting. It is the Analysis Length (time or symbols) being used by the analyzer, this value may not match the Analysis Length requested (in manual mode).
Time Zero Reference	Specifies the zero point for the analysis time.
Units	Specifies the units of the Analysis Length to either Symbols or Seconds.

Analysis Offset

Use analysis offset to specify where measurements begin. Be aware that you cannot set the Analysis Offset outside the range of time covered by the current acquisition data. (all time values are relative to the Time Zero Reference).

You can set the Analysis Length so that the requested analysis period falls partly or entirely outside the current range of acquisition data settings. When the next acquisition is taken, its Acquisition Length will be increased to cover the new Analysis Length, as long as the Sampling controls are set to Auto. If the Sampling parameters are set to manual, or if the instrument is analyzing saved data, the actual analysis length will be constrained by the available data length, but in most cases, measurements are able to be made anyway. The instrument will display a notification when measurement results are computed from less data than requested. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed. As you adjust this value, the actual amount of time for Analysis Length, in Symbol or Seconds units, is shown below the control in the "Actual" readout. This setting is not available when Auto is checked. Range: minimum value depends on modulation type. Resolution: 1 symbol.

Time Zero Reference

All time values are measured from this point (such as marker position or horizontal position (in Y vs Time displays). Choices are: Acquisition Start or Trigger.

Parameter	Description
Acquisition Start	Offset is measured from the point at which acquisition begins.
Trigger	Offset is measured from the trigger point.

Trace Tab - OFDM

The Trace tab allows you to set the trace display characteristics of the selected display. This tab is not available for all OFDM displays.

Modulation Params	Advanced Params	Data Range	AnalysisTime	Trace	Scale	Prefs	
Trace: Ma	ig Error 🔻	🗹 Show	E Freeze				

Settings	Description
Trace	Use this drop-down list to select whether or not the Average trace or the measurement trace is displayed. The measurement trace depends on the selected display.
Show	Select or deselect this checkbox to show or hide the trace selected in the Trace drop-down list.
Freeze	Selecting Freeze halts updates to the trace.

Scale Tab - OFDM

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings such as Measurement Frequency. There are two versions of the Scale tab for OFDM displays. One version is used only for the Constellation display and the other version is used for the OFDM EVM, OFDM Magnitude Error, OFDM Phase Error, and OFDM Power displays.

Modulation Params	Advanced Params Data	ta Range	AnalysisTime	Trace Scale	le Prefs
Vertical	Subo	carrier		Symbo	pols
Scale: 41.8 %	> 9	Scale: 20	10 Subc	Sc	cale: 12 Sym
Position: -21.9 %	% Pos	sition: -1	00 Subc	Posit	ition: 0 Sym
Auto	oscale		Autoscale	🔽 Au	uto Autoscale

Scale tab for OFDM EVM, OFDM Mag Error, OFDM Phase Error, and OFDM Power displays

Modulation Params	Advanced Params	Data Range AnalysisTime	Trace Scale I	Prefs
Zoon	n			
s	Scale: 3	Vertical Posit	on: 0	
		Horizontal Posit	on: 0	_

Scale tab for OFDM Constellation display

Settings	Description				
Vertical	Controls the vertical position and scale of the trace display.				
Scale	Changes the vertical scale of the graph.				
Position	Adjusts the reference level away from top of the graph.				
Autoscale	Resets the scale of the vertical axis to contain the complete trace.				
Subcarrier	Controls the scale of the subcarrier graph and position of the trace.				
Scale	Specifies how many subcarriers are displayed horizontally.				
Position	Specifies the subcarrier that appears at the left edge of the subcarrier graph.				
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.				
Symbols	Controls the scale of the Symbols graph.				
Scale	Specifies the number of symbols that appear in the symbols graph.				
Position	Specifies the symbol that appears at the left edge of the Symbols graph. Resets the scale and position settings to optimize the display.				
Autoscale					
Auto	When Auto is checked, the scale and position values for the Symbols graph are automatically adjusted to maintain the optimal display.				
Zoom	Sets the Constellation display size and position.				
Scale	Sets the magnification value for the Constellation display.				
Vertical Position	Sets the vertical location of the Constellation display within the graph. Range is -3.7 to +3.7.				
Horizontal Position	Sets the horizontal location of the Constellation display within the graph. Range is -3.7 to +3.7.				

Prefs Tab - OFDM

The Prefs tab enables you to change appearance characteristics of the OFDM Analysis displays. Not all settings on the Prefs tab shown below appear for every OFDM display.

Specifies whether the displayed time units are seconds or symbols.	
Specifies whether the displayed frequency units are frequency (Hz) or subcarrier channel.	
Specifies whether symbol values are displayed in binary or hex format (for example, in the Symbol Table or markers readouts).	
Specifies which graph types are displayed.	
Displays both the Subcarrier and Symbol graphs.	
Displays only the subcarrier graph.	
Displays only the symbol graph.	
Displays or hides the graticule in the graphs.	
Displays or hides the marker readouts in the graphs.	

Overview

The noise contribution from circuit elements is usually defined by noise figure, noise factor, or noise temperature.

For example, the function of an amplifier in a particular system is to amplify the signal presented at its input and deliver it to the load. The thermal noise that is present at the input is amplified along with the input signal. The amplifier also contributes additional noise. The load receives a composite signal made up of the sum of the amplified input signal, the amplified thermal noise, and the additional noise contributed by the amplifier.

Noise figure, noise factor, and noise temperature are figures of merit used to quantify the noise added by the amplifier. This noise can be measured directly using available test equipment.

For example, devices with high noise figure can be measured directly, as long as gain is known, with accurately known bandwidths. The input to the DUT should be terminated in a source that is near the reference temperature (290K).

The Noise Figure and Gain Measurement options in this instrument measure noise figure using the Y Factor method, perform mask testing to user-defined limits, and include an uncertainty calculator.

NOTE. To read a white paper about Noise measurements and when to use particular types of noise measurements, visit www.tektronix.com/downloads.

Displays

Displays include noise figure, gain, Y-factor, noise temperature, and tabular results. Single-frequency metering and swept-trace results are available, as well as support for industry-standard noise sources. Measurements for amplifiers and other non-frequency converting devices, and fixed local-oscillator up and down converters are also available.

The displays for Noise Figure and Gain (Displays > Measurements > Noise Figure and Gain) are:

- Noise Temperature (see page 223)
- Gain (see page 220)
- Noise Figure (see page 222)
- Noise Table (see page 218)
- Uncertainty Calculator (see page 227)
- Y Factor (see page 225)

These measurements allow you to measure the noise contributions of circuit elements to a signal.

Noise Figure and Gain Measurements

The analyzer takes the following noise measurements: Noise Figure, Noise Temperature, Y Factor, and Gain. See the <u>Available Measurements (see page 39)</u> section for brief definitions of each measurement.

Noise Table Display

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The Noise Table lists selected measurements in a spreadsheet format, showing the numeric value at step frequencies for Gain, Noise Figure, Y Factor, Noise Temperature, PHot, and PCold.

	Gain	Noise Figure	Noise Factor	ΥF
2.245 GHz	26.03 dB	1.33 dB	1.36	13.2
2.384 GHz	26.25 dB	1.25 dB	1.33	13.2
2.524 GHz	26.56 dB	1.44 dB	1.39	13.1
2.663 GHz	26.49 dB	1.56 dB	1.43	12.9
2.803 GHz	24.92 dB	1.59 dB	1.44	12.9
2.942 GHz	22.21 dB	1.69 dB	1.48	12.
3.082 GHz	19.36 dB	1.78 dB	1.51	12.
3.221 GHz	16.14 dB	2.11 dB	1.63	12.
3.361 GHz	13.50 dB	3.07 dB	2.03	10.9
3.500 GHz	11.70 dB	3.89 dB	2.45	10.
-				

Displaying the Noise Table Using a Preset

Using the Noise Figure Application Preset will turn on the Noise Figure, Gain, and Noise Table displays, and set the preamplifer (if present) ON, with the acquisition mode to *minimum noise* and the attenuator to $0 \ dB$ for the best noise floor.

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CAUTION. Make sure that the input of the analyzer is not connected to a device that will overload or damage the preamplifier.

- 1. Select **Presets** >**Application** from the menu bar.
- 2. Select Noise Figure from the Preset drop down menu.
- 3. Click OK.

Displaying the Noise Table

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. Select Noise Figure and Gain in the Measurements box.
- 3. Double-click Noise Table in the Available displays box to add the display to the Selected displays box.
- 4. Click OK.

Setting the Frequency for a Local Oscillator

If you are using a local oscillator and need to set the local oscillator frequency, do the following:

- 1. With the Noise Table selected, press the Settings button.
- 2. Select Up or Down Convertor as the Measurement Type in the Overview tab.

Overview	Freq Setup	Noise Source	Ext Gain/Loss	Corrections	Params	Internal Settings	Traces	Scale	Prefs	
Measure Up Conve	ment Type erter 🔻	of 	Gain/Loss f	DUT of	Gain/Loss f	→ ▷ _		→ 🔤		
		Source ENR: Constant: 15		†	\bigcirc	Frequency: 1.500 GHz				

- 3. Click on the Frequency icon in the Overview tab image (see above). This will open the Params tab.
- 4. Set the frequency under LO Settings.
- 5. Click the X located in the right top corner of the Settings control panel to close the panel.

Noise Table Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The Settings control panel tabs for the Noise Table Display are shown in the following table.

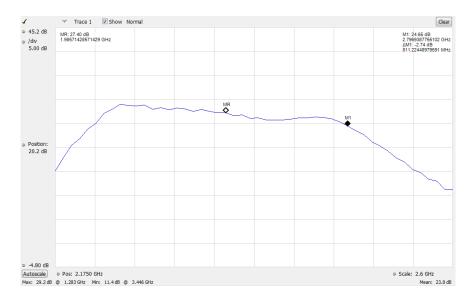
Settings tab	Description
Overview (see page 231)	Specifies the measurement type (non-frequency converting or frequency converting devices) to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup (see page 232)	Specifies several parameters that control frequency of the test and number of points per measurement.
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params (see page 235)	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Prefs (see page 239)	Specifies display preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

Gain Display

The Gain display shows gain versus frequency of the signal. The gain measurement is the ratio of output power to input power in an amplifier or circuit element.

Elements of the Gain Display



ltem	Display element	Description		
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Gain display is the optimized display.		
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.		
2	dB	Sets the vertical scale maximum.		
3	/Div	The distance between graticule lines on the display in dB.		
4	Position	Sets the vertical scale center.		
5	Min	Sets the vertical scale minimum.		
6	Autoscale	Set the axes to values that show all trace points.		
7	Horizontal offset and scale	Located along the bottom edge of the trace display, these controls specify the offset and scale on the horizontal axis.		
8	Max	Shows the maximum level of the trace.		
9	Min	Shows the minimum level of the trace.		
10	Mean	Shows the mean value of the trace.		

Gain Settings

Menu Bar: Setup > Settings

Application Toolbar: 🗳

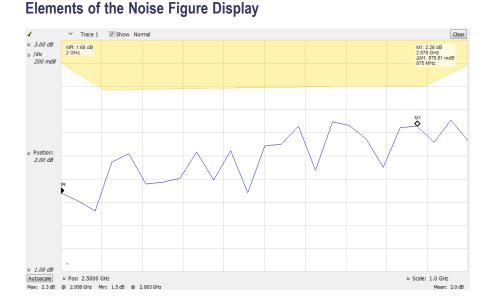
The Setup settings for the Gain display are shown in the following table.

Settings tab	Description
Overview (see page 231)	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup (see page 232)	Specifies several parameters that control frequency displayed.
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params (see page 235)	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces (see page 237)	Specify the display trace parameters and also allows you to save traces.
Scale (see page 238)	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs (see page 239)	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

Noise Figure Display

The Noise Figure display shows the noise factor in dB. This measurement can help you assess the low level sensitivity of the DUT. Lower noise figure is found in better performing DUTs. Noise factor is defined as the ratio of the input signal to noise ratio to the output signal to noise ratio (Input SNR/Output SNR).



ltem	Display element	Description			
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Noise Figure display is the optimized display.			
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.			
2	Max	Sets the vertical scale maximum.			
3	/Div	The distance between graticule lines on the display in dB.			
4	Position	Sets the vertical scale center.			
5	Min Sets the vertical scale minimum.				
6	Autoscale Set the axes to values that show all trace points.				
7	Horizontal offset and scale	Located along the bottom edge of the trace display, these controls specify the offset and scale on the horizontal axis.			

Noise Figure Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕸

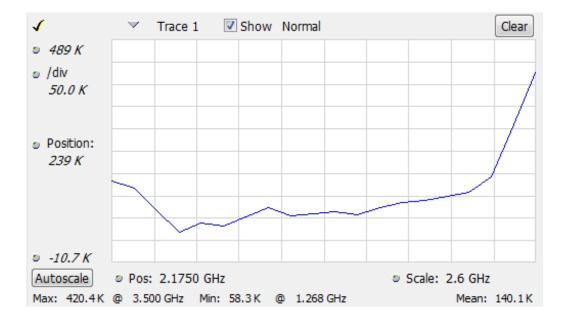
The settings for the Noise Figure Display are shown in the following table.

Settings tab	Description
Overview (see page 231)	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup (see page 232)	Specifies several parameters that control measurement and displayed frequencies.
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params (see page 235)	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces (see page 237)	Specify the display trace parameters and also allows you to save traces.
Scale (see page 238)	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs (see page 239)	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

Noise Temperature Display

The Noise Temperature display shows the temperature of a source impedance that would give the same SNR as the amplifier or system element, if it were noiseless.



Elements of the Noise Temperature Display

ltem	Display element	Description	
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Noise Temperature display is the optimized display.	
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.	
2	Max	Sets the vertical scale maximum.	
3	/Div	The distance between graticule lines on the display in K.	
4	Position	Sets the vertical scale center.	
5	Min	Sets the vertical scale minimum.	
6	Autoscale	Set the axes to values that show all trace points.	
7	Horizontal offset and scale	Located along the bottom edge of the trace display, these controls specify the offset and scale on the horizontal axis.	
8	Vertical scale	Sets the vertical scale value.	

Noise Temperature Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The settings for the Noise Temperature Display are shown in the following table.

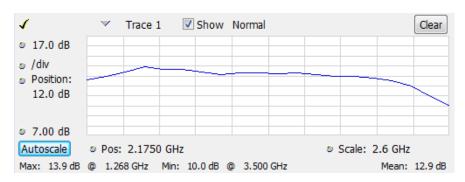
Settings tab	Description				
Overview (see page 231)	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.				
Freq Setup (see page 232)	Specifies several parameters that control measurement and displayed frequencies.				
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).				
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.				
Params (see page 235)	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.				
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.				
Traces (see page 237)	Specify the display trace parameters and also allows you to save traces.				
Scale (see page 238)	Specifies the scale settings that control how the trace appears on the display but does not change control settings.				
Prefs (see page 239)	Specifies preferences such as graticule on/off, number of displayed points and measurement units.				

Calibrate. Calibrates the equipment setup prior to measurement.

Y Factor Display

The Y-Factor measurement method uses a noise source that can be switched off and on with a specified amount of excess noise. It is based on two power measurements, each performed with the same port impedances and the same measurement bandwidth. This is specified as the Excess Noise Ratio (ENR). ENR is the ratio of noise from the source to the system thermal noise or kTB, often expressed in dB.

Y-Factor measurements require an initial calibration where the noise source is measured in the on and off state with the DUT bypassed. This allows removal of the RSA noise figure using the two-stage NF correction, and allows for accurate gain measurement.



Elements of the Y Factor Display

ltem	Display element	Description	
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Y Factor display is the optimized display.	
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.	
2	Max	Sets the vertical scale maximum.	
3	/Div	The distance between graticule lines on the display in dB.	
4	Position	Sets the vertical scale center.	
5	Min	Sets the vertical scale minimum.	
6	Autoscale	Set the axes to values that show all trace points.	
7	Horizontal offset and scale	Located along the bottom edge of the trace display, these controls specify offset and scale on the horizontal axis.	
8	Vertical scale	Sets the vertical scale value.	

Y Factor Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕸

The settings for the Y Factor Display are shown in the following table.

Settings tab	Description
Overview (see page 231)	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup (see page 232)	Specifies several parameters that control measurement and displayed frequencies.
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params (see page 235)	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces (see page 237)	Specify the display trace parameters and also allows you to save traces.
Scale (see page 238)	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs (see page 239)	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

Uncertainty Calculator Display

The noise factor of a DUT is computed from two power measurements (noise source and DUT) and two calibration power measurements (external preamp and RSA). These computations rely on specified characteristics on the noise source ENR, input and output match specifications, and other component specifications used in these measurements. The Uncertainty Calculator accepts the key specifications of each device and their specification limit and converts them to standard uncertainty for the noise figure and gain measurement. The output of the Uncertainty Calculator is the uncertainty tolerance for gain and noise figure based on the confidence level (conversion factor) set by the user.

It is important to understand that the computations rely on the nominal values and tolerance limits of components in the noise figure and gain measurement. The Calculator will accept different forms of component specifications and confidence level in the component specifications. The Calculator converts the component specifications into standard uncertainties for the measurement. All of the component standard uncertainties are combined into a standard measurement uncertainty. The standard measurement uncertainty is multiplied by a coverage factor to yield an *expanded coverage factor* for the measurement. For K=2, approximately 95% confidence is frequently used, as is K=3, approximately 99% confidence (maximum). So, if the noise figure is reported as 2 dB ± 0.25 dB at 95% confidence, this means that the "true" value of noise figure is thought to lie between 1.75 dB to 2.25 dB with 95% confidence.

Elements of the Uncertainty Calculator Display

Noise Figure:	0.378 dB	Gain:	0.782 dB	Measurement Confidence	5% 🔹
Noise Source	1				
Noise ENR:	15 dB		_		
		Coverage	Error Distribution	Noise Figure	Gain
Incertainty ENR:	0.15 dB	99 %	•	0.117 dB	0 dB
Output VSWR:	1.5	99.7 %	U-Shaped		
out DUT - Device	Under Test				
	3.000 dB				
	20.000 dB				
Gain.	20.000 00		Error		
Input VSWR:	1.5	Coverage 99.7 %	Distribution U-Shaped		
-					
Output VSWR:	1.5	99.7 %	U-Shaped		
Ext Preamp					
In Use:	No 🔻				
Noise Figure:	3.500 dB				
Gain:	21.000 dB				
		Coverage	Error Distribution		
Input VSWR:	1.3	99.7 %	U-Shaped		
RSA					
NF:	10.000 dB				
			Error		
Up contain the NE	0.070 dB	Coverage	Distribution	Noise Figure 0.161 dB	Gain 0.102 dB
Uncertainty NF:		95 %	-	0.01 dB	0 dB
Gain:	0.020 dB	95 %		0.01 08	0 UD
Input VOUD.	1.5	00.7.84	II Chanad		
Input VSWR:	1.5	99.7 %	U-Shaped		
Sub DANL Floor:	13.000 dB	00.9%	-	0 dB	0.01 dB
545 Druc 11001.	101000 00	99 %	•		

ltem	Display element	Description
1	Computed Uncertainty	Shows the noise figure and gain standard uncertainties. You can also select the measurement uncertainty (99%, 95%, or 80%).
2	Noise Source	Sets the noise source ENR, uncertainty of the ENR and source match, coverage (measurement confidence), output Voltage Standing Wave Ratio (VSWR). It also shows the error distribution and the Noise Figure and Gain uncertainties, which will vary according to the values entered for the available parameters. These values can be determined from the manufacturer's data sheet for the noise source you are using.
3	DUT- Device Under Test	Sets the input Voltage Standing Wave Ratio (VSWR) and output VSWR for your device under test (DUT). It also shows the coverage (measurement confidence) and error distributions for this element of the uncertainty calculation.
4	Ext Preamp	Sets the external preamp to in use (Yes), and the input Voltage Standing Wave Ratio (VSWR) value. When the external preamp is selected on, you can also set the noise figure and gain of the preamp. It also shows the coverage (measurement confidence) and error distributions for the input Voltage Standing Wave Ratio (VSWR).
5	RSA	Sets the error parameters for the RSA. These include the input noise figure and noise figure uncertainty, gain uncertainty, input VSWR, and the sub-DANL noise floor error terms of the RSA. Input noise figure and VSWR information can be taken from the RSA data sheet or measured by the user for the specific instrument used. Gain uncertainty contains a predetermined value that is the same for all RSAs. Sub-DANL distortion refers to distortion products present in the RSA that exist below the noise floor and cannot be measured by the user. The worst-case value is given for the term by default. You can also select the coverage (measurement confidence) for Noise Figure uncertainty, Gain measurement, and sub DANL floor. The error distribution is also displayed.

Uncertainty Calculator Settings

Menu Bar: Setup > Settings

Application Toolbar: 鄻

The settings for the Uncertainty Calculator display are shown in the following table.

Settings tab	Description
Uncertainty (see page 229)	Shows noise figure and gain uncertainty values (dB).
Intermediate Values (see page 230)	Shows standard uncertainties in system.

Uncertainty Tab

The Uncertainty tab shows the noise figure and gain uncertainty values (dB). These values change based on the noise measurement result and the parameters set in the Uncertainty Calculator display.

Uncertainty	Interm	ediate Values		
Noise Figur	e:	0.338 dB		
Gai	n:	0.632 dB		

Setting	Description
Noise Figure	Shows the standard uncertainty for the noise figure measurement. This value also reflects the uncertainty tolerance for noise figure based on the confidence level (conversion factor) set by the user in the Display.
Gain	Shows the standard uncertainty for the gain measurement. This value also reflects the uncertainty tolerance for gain based on the confidence level (conversion factor) set by the user in the Display.

Intermediate Values Tab

The Intermediate Values tab shows the noise figure and gain uncertainty values (dB). These values change based on the parameters set in the Uncertainty Calculator display and the noise measurement results.

Uncertainty In	termediate Values				
		Uncertaint	ty for Noise Factor	Uncertainty for G	ain
	Mismatch Source-S	A: 0	dB	0.465 dB	
N	lismatch Source-DU	T: 0.	.234 dB	0.465 dB	
	Mismatch DUT-S	A: 0.	.234 dB	0.465 dB	

Setting	Description
Uncertainty for Noise Figure	Shows the uncertainty for three components of the noise figure measurement.
Uncertainty for Gain	Shows the uncertainty for three components of the gain measurement.
Mismatch Source-SA	Shows the error between the noise source and the spectrum analyzer.
Mismatch Source-DUT	Shows the error between the noise source and the device under test (DUT).
Mismatch DUT-SA	Shows the error between the device under test (DUT) and the spectrum analyzer.

Noise Figure and Gain Measurement Settings

The control panel tabs in this section are shared by the displays in the Noise Figure and Gain measurement (Setup > Displays). Changing a setting on one tab changes that setting for all the noise and gain measurement displays.

Settings tab	Description
Overview (see page 231)	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup (see page 232)	Specifies several parameters that control measurement and displayed frequencies.
Noise Source (see page 233)	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections (see page 233)	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params (see page 235)	Specifies LO and RSA settings, reference temperature, RBW, and average counts.
Internal Settings (see page 236)	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces (see page 237)	Specifies the display trace parameters and also allows you to save traces.
Scale (see page 238)	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs (see page 239)	Specifies display view.

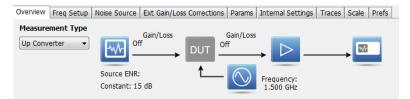
Overview Tab

The Overview tab is used to specify the measurement type that appears in the display. You can also use the images in the tab to quickly navigate to tabs that allow you to adjust parameters at key places in the circuit system. You can select either **Amp/Direct**, **Up Converter**, or **Down Converter** as the measurement type. If you are using an up frequency converter, for example, you would want to select **Up Converter**.

 Overview
 Freq Setup
 Noise Source
 Ext Gain/Loss Corrections
 Params
 Internal Settings
 Traces
 Scale
 Prefs

 Measurement Type
 Image: Constant:
 Off
 Image: Constant:
 Image: Cons

The above image shows the Overview tab with Amp/Direct selected.



The above image shows the Overview tab with Up Convertor selected.

Setting	Description
Measurement Type	Specify whether the measurement should account for a frequency converter (Up Converter or Down Converter) or not (Amp/Direct).

Freq Setup Tab

The Freq Setup tab is used to specify the frequency mode (Sweep, Single, or Frequency Table). If you select the Frequency Table, you can edit and load an existing table or save a table.

Overview Freq S	etup Noise Source	Ext Gain/Loss Table	Settings	Traces	Scale	Prefs	
Frequency Mode:	Center Freq:	1.50000 GHz	Fre	quency (H	(z)	-	Edit Table
Sweep Frequency •	cy 🔹 Span:	40.00 MHz	1.480G 1.484G 1.488G			E	Load Table
	Start Freq:	1.48000 GHz			1		
	Stop Freq:	1.52000 GHz					Save As
	Steps:	11	1.492G				
	oceps.	11	1,496G			-	

Setting	Description
Frequency Mode	Set to Single Frequency, Sweep Frequency, or Frequency Table. To set the band of interest for Sweep Frequency, set the Start and Stop frequencies and then specify the Steps value for the number of measurement points you want to have. To set the band of interest for Single Frequency, set the Center Frequency value. To use the Frequency Table, you can edit the current table, load an existing table, or save the current table.
Center Frequency	Specify the center frequency (GHz).
Span	Specify the range over which to measure the signal. (Only available with Sweep mode.)
Start frequency	Specify the minimum frequency to include in the measurement. (Only available with Sweep mode.)
Stop frequency	Specify the maximum frequency to include in the measurement. (Only available with Sweep mode.)
Steps	Specify the number of steps in the measurement range. This value determines how many steps (rows) are in the frequency table. (Only available with Sweep mode.)
Table	You can edit an existing frequency table, load a previously saved table, or save a table.

Noise Source Tab

The Noise Source tab is used to specify the Noise mode (constant or table) and the ENR constant. If you select Table mode, you can edit and load an existing table or save a table.

Overview Freq Setup	Noise Source	Ext Gain/Loss Correc	tions Pa	rams Internal Se	etting	s Prefs
Mode: Constant •	ENR Constan 15.00 dB Noise Source 346B 10MHz	t: • Model: z - 18 GHz	Freque 2.90 GHz 2.90 GHz 2.90 GHz	ency ENR 2 15.00 dB 2 15.00 dB		Edit Table Load Table Save As
	Noise source	Serial Number: 3	2.90 GHz		-	

Setting	Description
Mode	Set mode to Constant or Table. For Constant, set the ENR value. For Table, enter the noise source model and serial number.
	To use the Table, you can edit the current table, load an existing table, or save the current table.
	You can also load a predefined noise source. These values are useful starting points because they contain the frequency points for common noise sources, along with representative excess noise ratios. However, you must enter your own ENR values.
ENR Constant	Specify the excess noise ratio (ENR) value. The ENR is the difference between the two power levels calculated in a Y-Factor measurement.
Noise Source Model	Specify the model of the noise source. (Only available with Table mode.)
Noise Source Serial Number	Specify serial number of the noise source. (Only available with Table mode.)
Table	You can edit an existing Noise Source table, load a previously saved table, or save a table.

Ext Gain/Loss Corrections Tab

The Ext Gain/Loss Corrections tab is used to specify external gain and loss values. You can set loss values for three common loss scenarios: loss at the DUT input, loss at the DUT output, and loss at calibration. You can also edit directly in an external loss table.

Overview Freq Setup	Noise Source	Ext Gain/Loss Corrections	Params Internal Settings	Traces	Scale Prefs
	Constant Values	External Loss Tables (L	oss > 0, Gain < 0)	Temperat	ture
Loss @ DUT Input:	🔲 0.0 dB	Ext Loss Table 1	Edit	290 K	🔽 Use Ref
Loss @ DUT Output:	0.0 dB	Ext Loss Table 2	Edit	290 K	👿 Use Ref
Loss @ Calibration:	0.0 dB	Ext Loss Table 3	Edit	290 K	🔽 Use Ref
(Loss < 0, Gain > 0)					

Setting	Description
Constant values	Specify up to three external gain values (dB). Use these settings to apply a flat gain/loss correction to the signal. Positive values represent a gain and negative values represent a loss. The range is –50 to +30 dB. Resolution is 0.1 dB.
Loss @ DUT Input	This specifies the loss at the DUT input. For example, this can be the result of an adapter connected between a waveguide adapter and the DUT input.
Loss @ DUT Output	This specifies the loss at the DUT output. For example, this can be the result of an adapter connected between the DUT output and the analyzer.
Loss @ Calibration	This specifies the total loss in the calibrated system. For example, if an adapter must be used during calibration that is not present during measurements, the frequency response of the adapter can be removed with this correction table.
External Loss Tables	Each loss component (at DUT input, DUT output, and at calibration) can use an External Loss Table for correction of loss versus frequency. When an External Loss Table is selected, the analyzer adjusts the signal according to the values in the table. An external loss table allows you to compensate the signal level for variations in cable loss, antenna frequency response or preamp frequency response. You can read more about using Loss Tables here (see page 483).
Temperature	Specify the temperature (K) of the loss elements. The temperatures are used in adjusting the measured results based on the temperature difference of the loss elements compared to the reference temperature. You can also use the reference temperature for these values by selecting the click-box. The reference temperature is entered in the Params tab.

The following image shows the External Loss Table setup window.

Add Point	Undo	X: Frequency 2.000000 GH:	Y: Loss (Atten) 0.000000 dB
Frequency Interpolation			
 Linear Log (affects only Trace Correction) 			
Trace Correction)		-	

Params Tab

The Params tab is used to specify the local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average count.

 Overview
 Freq Setup
 Noise Source
 Ext Gain/Loss Corrections
 Params
 Internal Settings
 Traces
 Scale
 Prefs

 RSA Settings
 Settle Time (On):
 27 ms
 Ref Temperature:
 290 K
 Frequency:
 1.500 GHz

 Settle Time (Off):
 1.001 s
 RBW:
 1.00 MHz
 Frequency:
 1.500 GHz

Setting	Description
RSA Settings	The Settle Time sets the time the RSA will pause before measuring after turning the noise source On or Off to assure measurement stability. The required settling time for your measurement setup will vary with the noise source used. The default values have been set for Noisecom 346B series noise sources. Settling time for your noise source may be different and can be determined by judging the stability of your measurement as the settle time is varied.
Ref Temperature	Sets the reference temperature (K).
RBW	Sets the resolution bandwidth (MHz).
Average Count	Sets the number of measurements to average.
LO Settings	Sets the frequency of the local oscillator, which is an oscillator that produces the internal signal that is mixed with an incoming signal to produce the IF signal. Set the Side Band to Upper, Lower, or Double.

Internal Settings Tab

The Internal Settings tab is used to specify the reference level (dB) for the signal analyzer's RF front end, the settings for the internal attenuator, enable/disable the optional internal preamp, and specify the RF & IF Optimization. If you use the application preset for Noise Figure and Gain, these settings will be automatically optimized for the best measurements. The application preset will turn the preamplifier on, set the attenuator to 0 dB, and set RF/IF optimization to minimize noise using 25 MHz bandwidth acquisitions. In instruments that have wider acquisition bandwidths, measurement speed can be improved by setting the RF & IF Optimization to *Best for multiple displays*. This allows use of wider acquisition bandwidths, but causes a slight reduction in ultimate instrument noise floor.

Overview Freq Setup Noise	Source Ext G	ain/Loss Table Params	Internal Settings	Traces	Scale	Prefs
Ref Level: 0.00 dBm			Internal Prear	mp		
Internal Attenuator:	25 dB	🖉 Auto	1.0 MHz - 6.2	2 GHz		
RF & IF Optimization:	Best for multi	ple displays 🔻				

Setting	Description				
Ref Level	Specify the reference level (dB) for the signal analyzer's RF front end.				
Internal Attenuator	Set to Auto or manual. When Auto mode is enabled, the attenuation setting is displayed but is not adjustable. When Auto is disabled, the attenuator operates in manual mode, allowing you to set the internal attenuation. The internal attenuation setting range is 0 - 75 dB.				
RF & IF Optimization Specifies how the gain and bandwidth should be optimized (in the RF a the front end). Read about these settings <u>here</u> .					
Internal Preamp	Switch the preamp on or off. To ensure the best accuracy, turn on the Internal Preamp and allow it to run for 20 minutes to thermally stabilize before taking critical measurements.				

Traces Tab

The Traces tab is used to specify the display trace parameters and also allows you to save traces. This tab is available for trace displays only.

	Prefs	Scale	Traces	Settings	oss Table	Ext Gain/Lo	oise Source	q Setup N	verview Fre
han	race As	Save Tr		Freeze		Show	•	Trace 1	Trace:
trace	ecalled tra	how re	🗆 s				5) 🔹	Avg (VRM	Detection:
							•	Normal	Function:

This is the Traces tab when Function is set to Normal.

Overview	Freq Setup	Noise Source	Ext Gain/Los	s Table	Settings	Traces	Scale	Prefs	
Trac	ce: Trace 1	•	Show		Freeze		Save Tr	ace As	
Detectio	on: Avg (VF	RMS) 🔻	Count			□ s	ihow re	called trac	e
Functio	on: Max Hol	ld 🔻	10						

This is the Traces tab when Function is set to .

Setting	Description
Trace	Specify up to three traces and whether or not to show the traces of freeze them.
Detection	Detection is set to Average (VRMS).
Function	Specify the trace function as Normal, Average (VRMS), Max Hold, or Min Hold.
Count	Specify the trace count.
(Only available for Noise Temperature display)	

Scale Tab

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings such as Frequency. In effect, these controls operate like pan and zoom controls. This tab is only available for trace displays.

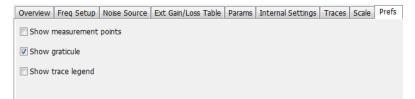
Overview I	Freq Setup	Noise Source	Ext Gain/Loss Table	Params	Internal Settin	gs Traces	Scale	Prefs
Vertical					Horizontal			
Scale:	50.0 dB				Scale:	3.0 GHz		
Position:	49.5 dB		Reset		Position:	1.5050 GH	z	
🔽 Auto	Aut	oscale				Au	toscale	

Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale of the graph.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Auto	When Auto is checked, the scale and position values for the are automatically adjusted to maintain the optimal display.
Reset	Resets horizontal and vertical values to default values.
Horizontal	Controls the horizontal position and scale of the trace display.
Scale	Changes the horizontal scale of the graph.
Position Adjusts the horizontal reference level of the graph.	
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.

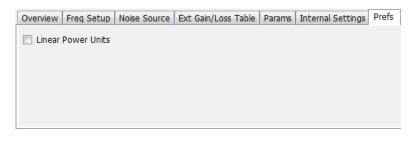
Prefs Tab

The Prefs tab is used to set display preferences. You can set preferences to show measurement points, graticule, trace legend, scale, units, or to view a linear display of results instead of dBm depending on the selected display.

The following image shows the Prefs tab for all of the trace displays.



The following image shows the Prefs tab for the Noise Table display.



The following image shows the Prefs tab for the Noise Figure display.



Overview

The displays in Pulsed RF (Displays > Measurements > Pulsed RF) are:

- Pulse Statistics
- Pulse Table
- Pulse Trace

The Pulse measurements provide deep insight into pulse train behavior.

Pulse Measurements

The analyzer takes the following pulse measurements: Average ON Power, Peak Power, Average Transmitted Power, Pulse Width, Rise Time, Fall Time, Repetition Interval (Sec), Repetition Rate (Hz), Duty Factor (%), Duty Factor (Ratio), Ripple, Droop, Pulse-Pulse Phase Difference, Pulse-Pulse Frequency Difference, RMS Frequency Error, Maximum Frequency Error, RMS Phase Error, Maximum Phase Error, Frequency Deviation, Delta Frequency, Phase Deviation, and Time. See <u>Available Measurements (see page 33)</u> for definitions.

Pulse Table Display

The Pulse Table lists selected measurements in a spreadsheet format, showing the pulse numbers and all the results for each measurement on all the detected pulses. Pulses are numbered from one.

	Avg ON	Peak	Avg Tx	Width	Rise	Fall	Rep Int	Rep Rate	Ri 1
1	-2.3542 dBm	-2.2729 dBm	-18.732 dBm	5.1147485 us	70.286255 ns	69.794922 ns	220.95078 us	4.525895 kHz	0.1
2	-2.3518 dBm	-2.2345 dBm	-18.187 dBm	7.2183543 us	70.688479 ns	70.083004 ns	275.67105 us	3.627512 kHz	0.1
з	-2.3510 dBm	-2.2595 dBm	-18.619 dBm	5.2991536 us	71.052249 ns	69.774167 ns	223.23629 us	4.479559 kHz	0.1
4	-2.3551 dBm	-2.2816 dBm	-18.731 dBm	5.1165252 us	70.684202 ns	70.438233 ns	220.96363 us	4.525632 kHz	0.1
5	-2.3513 dBm	-2.2713 dBm	-18.192 dBm	7.2066669 us	71.347657 ns	70.579837 ns	275.49471 us	3.629834 kHz	0.1
6	-2.3531 dBm	-2.2518 dBm	-18.587 dBm	5.4644311 us	70.315551 ns	70.734863 ns	228.46991 us	4.376944 kHz	0.1
7	-2.3537 dBm	-2.2510 dBm	-18.727 dBm	5.1185839 us	71.486205 ns	70.560304 ns	220.90306 us		
8	-2.3530 dBm	-2.3067 dBm	-18.157 dBm	7.2754278 us	70.033572 ns	69.621585 ns	275.90856 us	3.624389 kHz	0.1
9	-2.3547 dBm	-2.2646 dBm	-18.667 dBm	5.1216639 us	70.291136 ns	69.699709 ns	218.00389 us	4.587074 kHz	0.1
10	-2.3505 dBm	-2.2762 dBm	-18.735 dBm	5.1066654 us	69.887697 ns	70.510254 ns	220.97585 us	4.525381 kHz	0.1
11	-2.3541 dBm	-2.2895 dBm	-18.198 dBm	7.1933723 us	70.523072 ns	70.412597 ns	275.21345 us	3.633543 kHz	0.1
12	-2.3528 dBm	-2.2509 dBm	-18.556 dBm	5.7297557 us	70.941773 ns	69.781493 ns	237.95580 us	4.202461 kHz	0.1
13	-2.3561 dBm	-2.2638 dBm	-18.444 dBm	6.0395946 us	71.277462 ns	70.528564 ns	244.25826 us	4.094027 kHz	0.1
14	-2.3530 dBm	-2.3083 dBm	-18.730 dBm	5.1135430 us	70.236204 ns	69.981688 ns	220.97836 us	4.525330 kHz	0.1
15	-2.3500 dBm	-2.3191 dBm	-18.193 dBm	7.2002217 us	71.079711 ns	71.169431 ns	275.33952 us	3.631880 kHz	0.1
16	-2.3559 dBm	-2.2768 dBm	-18.572 dBm	5.6117051 us	69.582519 ns	70.191653 ns	233.68913 us	4.279189 kHz	0.1
17	-2.3563 dBm	-2.3134 dBm	-18.668 dBm	5.1218622 us	70.316162 ns	69.885253 ns	218.00520 us	4.587046 kHz	0.1
18	-2.3558 dBm	-2.2804 dBm	-18.740 dBm	5.1066395 us	70.247189 ns	69.825440 ns	220.96526 us	4.525598 kHz	0.1
19	-2.3564 dBm	-2.2648 dBm	-18.195 dBm	7.2042967 us	71.071774 ns	70.909422 ns	275.35643 us	3.631656 kHz	0.1
20	-2.3509 dBm	-2.2886 dBm	-18.573 dBm	5.6055314 us	70.825806 ns	70.736085 ns	233.68525 us	4.279260 kHz	0.1
21	-2.3566 dBm	-2.2565 dBm	-18.669 dBm	5.1220964 us	71.097411 ns	70.708005 ns	218.00013 us	4.587153 kHz	0.1
22	-2.3541 dBm	-2.2646 dBm	-18.735 dBm	5.1116199 us	71.083370 ns	69.742434 ns	220.97304 us	4.525439 kHz	0.1

Displaying the Pulse Table

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. Select Pulsed RF in the Measurements box.
- 3. Double-click Pulse Table in the Available displays box to add the display to the Selected displays box.
- 4. Click OK.

Selecting the Measurements to Show

- 1. With the Pulse Table selected, press the Settings button.
- 2. In the Pulse Table Settings control panel, select the Measurements tab.

Measurements Params Define	Levels Freq Estimation		
Show in Pulse	Average ON Power Peak Power Average Transmitted Power Pulse Width	•	Select all
	Rise Time	Ŧ	

- **3.** Select the measurements you wish to take from the list of measurements or click **Select all** to choose all measurements.
- 4. Click the close box () to remove the Settings control panel.

Changing the Pulse Table Display Settings (see page 242)

Pulse Table Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The Settings control panel tabs for the Pulse Table Display are shown in the following table.

Settings tab	Description
Measurements (see page 243)	Selects the measurements to be show in the Pulse Table.
Params (see page 248)	Specifies several parameters that control how pulses are counted and defined.
Define (see page 250)	Specifies parameters that control where measurements are taken on a pulse.
Levels (see page 255)	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation (see page 255)	Specifies the reference used for computing frequency errors.

Restore defaults. Sets the Pulse Table parameters to their default values.

Measurements Tab

The Measurements tab is used to specify the measurements that appear in the Pulse Table.

Measurements Params Define	Levels Freq Estimation	
Show in Pulse	Average ON Power Peak Power Average Transmitted Power Pulse Width Rise Time	Select all Clear all

Show in Pulse

Checked measurements appear in the Pulse Table.

Select all

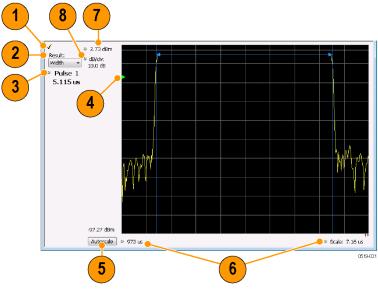
Click Select all to choose all measurements for display in the Pulse Table.

Clear all

Click Clear all to remove all measurements from the Pulse Table display.

Pulse Trace Display

The Pulse Trace display shows one measurement result and a trace graph illustrating that measurement for a selected pulse number. You can also choose to display arrows and lines in the graph that illustrate where on the pulse the measurement is being taken.



ltem	Display element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Pulse Trace display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Result	Use this list to select the measurement to show. The measurement chosen here selects the same result to be displayed in the Statistics view and highlighted in the Table view. Selecting a result in any of these views causes the same result to be selected in all of them.
3	Pulse	Selects which pulse result is shown. Like the Result, this selection is shared with the Statistics and Table views. The maximum number of pulses that can be measured is limited to 10000.
4	Pulse threshold indicator	This green triangle indicates the power threshold used to detect pulses. See Settings > Params > Power threshold to detect pulses.
5	Autoscale	Set the axes to values that show all trace points.
6	Horizontal offset and scale	Located along the bottom edge of the trace display, these controls specify the offset and scale on the horizontal axis.
7	Top of graph adjustment	Sets the power level shown at the top of the graph. If the number is greater than the Ref Level, a white line will appear in the graph to indicate the Ref Level.
8	Vertical scale	Sets the vertical scale value.

Elements of the Pulse Trace Display

Changing the Pulse Trace Display Settings (see page 245)

Pulse Trace Settings

Menu Bar: Setup > Settings

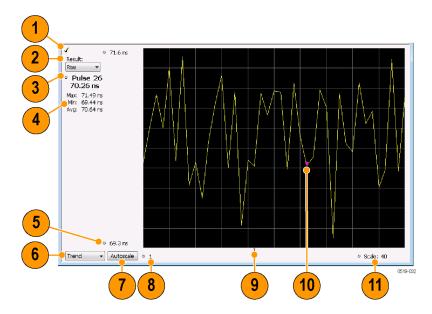
Application Toolbar: 🕸

The Setup settings for the Pulse Trace display are shown in the following table.

Settings tab	Description
Params (see page 248)	Specifies several parameters that control how pulses are counted and defined.
Define (see page 250)	Specifies parameters that control where measurements are taken on a pulse.
Levels (see page 255)	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation (see page 255)	Specifies the reference used for computing frequency error.
Scale (see page 257)	Specifies the vertical and horizontal scale settings.
Prefs (see page 258)	Specifies whether on not certain display elements are shown.

Pulse Statistics Display

The Pulse Statistics view displays a plot of a pulse measurement's values for every pulse in the analysis period. For example, the Pulse Statistics display will show the rise time measurement for each of 30 pulses, with rise time on the Y axis and pulse number on the X axis. Alternatively, the Statistics Display can show an FFT trace for the values of a measurement over all the pulses analyzed. Numeric readouts of Max, Min, and Average in this display summarize results for the selected pulse measurement.



Elements of the Pulse Statistics Display

tem	Display element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Pulse Statistics display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Result	Use this list to select which measurement statistics to display. The measurement chosen here selects the same result to be displayed in the Pulse Trace display and the Pulse Table display. Selecting a result in any of these views causes the same result to be selected in all of them.
3	Pulse	Selects which pulse's result is shown. Like the Result, this selection is shared with the Statistics and Table views.
1	Statistics summary	Display of measurement statistics for the selected Result.
5	Vertical range	Located at the top of the left graph edge and at the bottom of the left graph edge, use these controls to adjust the values at the top of the graph and the bottom of the graph.
6	Plot	Selects from Trend, Time Trend, FFT, and Histogram for the graph.
7	Autoscale	Set the axes to values that show all trace points.
3	Horizontal offset	Adjusting this value moves the graph right or left.
)	Trigger indicator	Indicates the trigger point on the pulse train if the trigger occurred during the time frame of the pulse measurements.
10	Pulse indicator	For Trend and Time Trend plot types, this indicates the pulse selected by the Pulse setting. For the FFT plot type, this indicator marks the trace point at the selected frequency. For Histogram plot types, this indicator marks the selected results bin.
11	Scale	Adjusts the horizontal scale.

Changing the Pulse Statistics Display Settings (see page 247)

Pulse Statistics Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The settings for the Pulse Statistics Display are shown in the following table.

Settings tab	Description
Params (see page 248)	Specifies several parameters that control how pulses are counted and defined.
Define (see page 250)	Specifies parameters that control where measurements are taken on a pulse.
Levels (see page 255)	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation (see page 255)	Specifies the reference used for computing frequency errors.
Scale (see page 257)	Specifies the vertical and horizontal scale settings.
Prefs (see page 258)	Specifies whether or not certain elements of the display are shown.

Pulsed RF Shared Measurement Settings

The control panel tabs in this section are shared by the displays in the Pulsed RF folder (Setup > Displays). Changing a setting on one tab changes that setting for all the Pulsed RF displays.

Settings tab	Description
Params (see page 248)	Specifies several parameters that control how pulses are counted and defined.
Define (see page 250)	Specifies parameters that control where measurements are taken on a pulse.
Levels (see page 255)	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation (see page 255)	Specifies the reference used for computing frequency errors.
Scale (see page 257)	Specifies the vertical and horizontal scale settings.
Prefs (see page 258)	Specifies whether or not certain elements of the display are shown.

Common controls for pulsed RF displays

Params Tab

The Params tab enables you to adjust several measurement parameters for Pulsed RF displays.

Params Define Level	Freq Estimation	Scale	Prefs	
Measurement Filter:	Gaussian	•	Power threshold to detect pulses:	-12 dBc
Bandwidth:	10 MHz		Minimum OFF time between pulses:	0.000 s
			Max number of pulses:	100

Setting	Description				
Measurement Filter	Specify whether a filter is used to limit the bandwidth of the input signal.				
Bandwidth	Sets the bandwidth of the measurement filter.				
Power threshold to detect pulses	Specifies the level used for locating pulses in the data.				
Minimum OFF time between pulses	Specifies the time the signal must fall below the power threshold for two pulses to be considered separate pulses.				
Max number of pulses	Specifies the number of pulses to measure within the analysis time.				

Measurement Filter

Three choices are available for the measurement filter:

- No Filter Max BW: The widest acquisition bandwidth available is used. The Bandwidth setting is disabled, but shows the value in use.
- **No Filter**: This is the default. The Bandwidth control is enabled for you to specify an acquisition bandwidth.
- **Gaussian** The Bandwidth control is enabled for you to specify a value. The instrument uses an acquisition bandwidth two times wider than the entered value.

Power Threshold to Detect Pulses

Specifies the minimum power level the trace must exceed to be detected as a pulse. The range for this setting is: -3 to -70 dBc. The setting resolution is 1 dB. The default value is -10 dB.

Max Number of Pulses

If the Analysis Time contains fewer pulses than specified, the analyzer will measure all the pulse within the analysis time. If there are more pulses in the Analysis Time, than the specified number, the analyzer measures the specified number of pulses and ignores the rest. The range for this setting is: 1 - 10000. The setting resolution is: 1. If this setting is not checked, the analyzer will measure all pulses within the Analysis Time, up to a maximum of 10000 pulses.

To determine the maximum number of pulses that can be analyzed, use the following equation:

Max number of pulses that can analyzed = Pulse Rate \times capacity

where:

- Pulse rate is the number of pulses per second (frequency).
- Capacity is a length of time which is displayed on the Acquire > Sampling Parameters tab.

Note that the maximum number of pulses is affected by several parameters. For example, measurement bandwidth affects the sample rate. The measurement algorithm also can reduce the maximum number of pulses that can be analyzed (by increasing the sample rate) based on the characteristics of the signal.

Additionally, when FastFrame is enabled, determining the maximum number of pulses is even more challenging. In FastFrame mode, the signal analyzer samples the signal around events of interest and

ignores the signal between events of interest. Thus, if the instrument is only looking at pulses and ignoring the signal between pulses, the number of pulses that can be analyzed depends strongly on the characteristics of the pulse itself (for example, fewer wide pulses can be analyzed than narrow pulses, all other things being equal).

Define Tab

The Define tab enables you to specify parameters that control where measurements are made on a pulse. The settings available depend on the measurement selected.

Params Define Levels Freq Estimation	Scale Prefs	
Measurement(s):		
Impulse Response 👻	Time method: Absolute 👻	Ref (R): 100 %
Apply ampl corrections		
Keep-out time (+/-); 0.000 s	×%-	Start (S): 0.000 s
	ŔŚĽ	
- Matu		Length (L): 1.00 us

The following paragraphs describe the settings that appear on the Define tab according to the Measurement(s) selection.

Freq-Domain Linearity

Params	Define	Levels	Freq Estimation	Scale	Prefs		
Measu	rement(s	;):					
Freq-c	lomain Lir	nearity	•	Time r	method: Absolute	 Ref (R): 	100 %
				×	∞∦₊₊₊	Start (S):	0.000 s
					N 3 L	Length (L):	1.00 us

Setting	Description
lime method	Specifies how the measurement's duration is determined. The choices are Absolute and Relative.
Absolute time method	
Ref (R)	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 90% 100%; Default: 100%
Start (S)	Start specifies the time the instrument waits after the rising-edge reference before starting to measure the pulse. The Start time is measured from the point along the pulse rising edge specified by the Ref setting. Start Range: ±100 ms; Resolution: 3 digits; inc/dec small: 1 ns, large: 1,2,5,10; Default: 0
Length (L)	Length specifies the period of time that is used for pulse measurements The measurement time begins at the Start point and continues for the amount of time specified by Length.
Relative time method	
Length	In the Relative time method, Length specifies the percentage of the top of the pulse that is used for measurements. The instrument automatically determines the pulse top. The measurement length is centered within the pulse ON time.

Impulse Response

Params	Define	Levels	Freq Estimation	Scale	Prefs				
Measu	rement(s	;):							
Impuls	e Respor	nse	•	Time r	method:	Absolute	•	Ref (R):	100 %
🔽 Api	oly amplic	orrectio	ns						
	out time	_		X	<u>%</u>	• • ~		Start (S):	0.000 s
10000					RS	S L		Length (L):	1.00 us
		4						congar (c).	1.00 00

Setting	Description
Apply ampl corrections	Enable/disable corrections that remove errors due to the window function and to the time offset of the side lobe.
Keep-out time (+/-)	The Keep-out time specifies a region that is ignored when the trace is analyzed for side lobes. The setting defines a region to the left and to the right of the center of the main lobe. Lobes that fall within this time region are not eligible to be the "highest side lobe".
Time method	Specifies how measurement parameters are determined. The choices are Absolute and Relative.
Absolute time method	
Ref (R)	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 90% 100%; Default: 100%
Start (S)	Start specifies the time the instrument waits after the rising-edge reference before starting to measure the pulse. The Start time is measured from the point along the pulse rising edge specified by the Ref setting. Start Range: ±100 ms; Resolution: 3 digits; inc/dec small: 1 ns, large: 1,2,5,10; Default: 0
Length (L)	Amount of time that should be included in the measurement. The measurement time begins at the Start point and continues for the amount of time specified by Length.
Relative time method	In the Absolute time method, Length specifies the period of time that is used for pulse measurements.
Length	In the Relative time method, Length specifies the percentage of the top of the pulse that is used for measurements. The instrument automatically determines the pulse top. The measurement length is centered within the pulse ON time.

Freq Diff, Phase Diff

Params Define Levels Freq Estimation Scale	e Prefs	
Measurement(s): Freq Diff, Phase Diff		Measurement point: 1.000 us

Setting	Description
Measure point	Specifies the period in time after the 50% rising edge at which frequency and phase difference measurements are made.

Ripple

Params	Define	Levels	Freq Estimation	Scale	Prefs				
Measu	rement(s	;):							
Ripple			-	Time r	method:	Relative	-	Ref (R): 100 %	
									_
				_		1%		Start (S): 0.000 s	
					T	100% -+ Ť			_
								Length (L): 50.0 %	

Setting	Description
Length	Length specifies the percentage of the top of the pulse that is used for measurements. The instrument automatically determines the pulse top. The measurement length is centered within the pulse ON time. Only the Relative Time method is available for Ripple.

Overshoot

Params	Define	Levels	Freq Estimation	Scale	Prefs				
Measur	ement(s	;):							
Oversh	noot		-	Time r	method	l: Relative	•	Ref (R):	100 %
				X	<u>*</u>			Start (S):	0.000 s
					N S I	_/0		Length (L):	25.0 %

Setting	Description
Time method	Specifies how measurement parameters are determined. The choices are Absolute and Relative.
Absolute time method	
Ref (R)	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 90% 100%; Default: 100%
Start (S)	Start specifies the time the instrument waits after the rising-edge reference before starting to measure the pulse. The Start time is measured from the point along the pulse rising edge specified by the Ref setting. Start Range: ± 100 ms; Resolution: 3 digits; inc/dec small: 1 ns, large: 1,2,5,10; Default: 0
Length (L)	Amount of time that should be included in the measurement. The measurement time begins at the Start point and continues for the amount of time specified by Length.
Relative time method	
Ref	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 90% 100%; Default: 100%
Start	Start specifies the time the instrument waits after the rising-edge reference before starting to measure the pulse. The Start time is measured from the point along the pulse rising edge specified by the Ref setting. Start Range: ± 100 ms; Resolution: 3 digits; inc/dec small: 1 ns, large: 1,2,5,10; Default: 0
Length	In the Relative time method, Length specifies the percentage of the top of the pulse that is used for measurements. The instrument automatically determines the pulse top. The measurement length is centered within the pulse ON time.

Levels Tab

Use the Levels tab to set parameters that control the method and levels used to calculate some pulse values.

Params Define Levels Freq	Estimation Scale Prefs	;	
100% Level		50% Level	Rise/Fall Levels
 Pulse Average Amplitude 	J Both	Voltage	10 - 90%
 Independent (adjust for droop) 	100% Rise	Power	0 20 - 80%

Setting	Description	
100% Level	Specifies the method used to determine the 100% level(s).	
50% Level	Specifies the method used to determine the 50% level on the pulse.	
Rise/Fall Levels	Select whether to use the 10% to 90% or 20% to 80% points (based on voltage level) to define the rise and fall times.	

100% Level

Use the 100% Level settings to select the method used to determine the 100% level(s) used for calculating pulse parameters, for example, Rise, Fall, and Width.

The Pulse Average Amplitude defines the pulse top as the average of the values of all the points along the pulse top. This average is used as the 100% level, from which the 10, 20, 50, 80 and 90% levels are calculated. Pulse measurements are referenced against these various levels. For example, Rise is the time between the 10 and 90% (or 20 and 80%) levels on the rising edge of the pulse. When the Pulse Average Amplitude method is selected, the same 100% level is used for both rising and falling edges.

Because some RF pulse types have droop (a height difference between the beginning and ending points of the pulse top), the 100% percent level on the rising edge may not be equal to the 100% level on the falling edge. The Independent method of pulse point location is designed for pulses with different 100% levels at their rising and falling edges. The Independent method calculates the 100% level for the rising edge separately from the 100% level of the falling edge. As a result, the 10, 20, 50, 80 and 90% levels are also different for the rising and falling edges, allowing for more accurate measurements on pulses with droop.

50% Level

Select Voltage to use -6 dB as the 50% point. Select Power to use -3 dB as the 50% level.

Freq Estimation Tab

Use the Freq Estimation tab to specify parameters used for determining frequency offset.

Params Define Levels Freq Estimation	Scale Prefs
	Pulse Frequency Reference
Modulation type: Linear Chirp 🔹	Freq Offset: 169.1 Hz 🕢 Auto
	Chirp Slope: 0.0000 Hz/us 🛛 Auto

Setting	Description
Modulation type	Specifies which algorithm to use for estimating frequency error.
Pulse Frequency Reference	Specifies the method used to determine the pulse frequency error and if applicable, the chirp slope.
Auto	Selecting Auto causes the instrument to calculate the frequency offset and if applicable, the chirp slope.
Freq Offset	If Auto is not enabled, specify the value for frequency offset here. If Auto is enabled, the offset is set to zero and this readout displays the calculated frequency error.
Chirp BW	If Auto is not enabled, specify the value for Chirp Slope here. If Auto is enabled, this readout displays the calculated Chirp slope. This setting is used only when the modulation type is set to Linear Chirp.

Modulation Type

Frequency estimation is performed by the instrument using selectable methods, depending on signal type. The selections for modulation type are CW (constant phase), CW (changing phase), Linear Chirp and Other. Select the method of frequency method based upon a best match to your signal based on the following descriptions:

- CW (constant phase): The signal is not designed to change in either frequency or phase during the measured pulse train.
- CW (changing phase): The signal does not change the carrier phase within each pulse, although it could change the phase from one pulse to another pulse. The signal is not designed to make frequency changes.
- Linear Chirp: The signal changes frequency in a linear manner during each pulse. The signal has the same carrier phase at the same time offset from the rising edge of the pulse.
- Other: The signal is not one of the listed types. You must manually enter the Frequency Offset value.

The following table maps the appropriate signal type selection with the signal characteristics.

Signature	Phase offset from one pulse to another				
	Zero	Any (unknown)			
CW	CW Constant Phase	CW Changing Phase			
LFM	Linear Chirp	N/A			

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.

Params	Define	e Levels Freq Estin	nation Scale Pre	fs		
Vertic	al			-Horizontal -		
So	cale:	100.00 dB		Scale:	348 ns	Full scale:
Posit	tion:	2.73 dBm	Reset Scale	Position:	6.99 ms	Selected
		Autoscale			Autoscale	🔘 Max pulse

Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale. The units for this setting depend on the statistic selected from the Result drop-down list in the Pulse Statistics display.
Position	Adjusts the Reference Level away from the top of the trace display. The units for this setting depend on the statistic selected from the Result drop-down list in the Pulse Statistics display.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the span of the trace display and position of the trace.
Scale	Allows you to change the span.
Position	Allows you to pan a zoomed trace.
Full Scale (Pulse Trace display only)	Specifies the Horizontal scale default.
Selected	Sets the horizontal scale default to be based on the result value for the currently-select pulse.
Max Pulse	Sets the horizontal scale default to be based on the largest value for the selected pulse measurement.
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.
Plot (Pulse Statistics display only)	Specifies the FFT, Trend, Time Trend, or Histogram plot.
Reset Scale	Restores all settings to their default values.

Prefs Tab

The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display.

Params Defi	ne Levels	Freq Estimation Scale Prefs	
🔽 Shov	/ graticule	Show Marker readout in graph (selected marker)	
		(Time Trend only)	
		Histogram readout: Count 👻 Bins: 10 🛛 📝 Auto	

Settings on the Pulsed RF Displays Prefs Tab

The following table describes the settings that appear on the Prefs tab of the Pulsed RF displays: Pulse Statistics and Pulse Trace. There is no Prefs tab for the Pulse Table display.

Setting	Description
Show graticule	Displays or hides the graticule in the trace display.
Show Marker readout in graph	When a marker is enabled, this setting displays or hides the maker readout, but not the maker itself, on Time Trend plots.
Histogram readout (present only when Histogram is the selected plot type)	Controls the parameters Histogram readout and Bins. Histogram readout can be set to either Count or %. Count indicates the number of hits that fell into each bin. % indicates percentage of the total count (for the acquisition) that fell into each bin.
Bins	Specifies how many "bins" or histogram bars the results are distributed into.

APCO P25 Analysis

Overview

The Association of Public Safety Communication Officials (APCO) P25 Compliance Testing and Analysis option allows you to evaluate radio signals to ensure they meet the standards set for the public safety communications community for interoperable LMR equipment. This complete set of push-button Telecommunication Industry Association TIA-102 standard-based transmitter measurements includes modulation measurements, power measurements, and timing measurements. These measurements are also compared with the limits that best fit the signal for which the standard applies to provide pass/fail results.

The P25 measurements available with this option can be made on signals defined by the Phase 1 (C4FM) and Phase 2 (HCPM, HDQPSK) P25 standards. With this test suite, test engineers can simplify the execution of a number of transmitter tests while still allowing for controls to modify signal parameters for signal analysis. The analysis results give multiple views of P25 signal characteristics to allow the diagnosis of signal imperfections and impairments quickly and easily. Display controls allow you to selectively display the analysis results to help locate trouble-spots in the signal.

P25 Topics

The following information about the P25 Analysis option is available:

- Reference Table of Supported P25 Measurements (see page 259)
- P25 Standards Presets (see page 260)
- P25 Displays (see page 261)
- P25 Settings (see page 323)
- P25 Measurements (see page 262)
- P25 Test Patterns (see page 270)

Reference Table of Supported P25 Measurements

TIA-102 transmitter measurement	Tektronix measurement display(s) (value name if different from TIA-102 measurement name)	Phase 1	Phase 2
RF output power	P25 Summary	Yes	Yes
	P25 Power vs Time		
Operating frequency accuracy	P25 Summary (Operating Freq Accuracy)	Yes	Yes
Modulation emission spectrum	SEM (The SEM display can be found in Select Displays > RF Measurements)	Yes	Yes
Unwanted emissions: Non spurious adjacent channel power ratio	MCPR (The MCPR display can be found in Select Displays > P25 Analysis)	Yes	Yes

TIA-102 transmitter measurement	Tektronix measurement display(s) (value name if different from TIA-102 measurement name)	Phase 1	Phase 2
Frequency deviation	P25 Summary (Freq Dev)	Yes	HCPM
Modulation fidelity	P25 Summary P25 Constellation	Yes	Yes
Symbol rate accuracy	P25 Summary	Yes	Yes
Transmitter power and encoder attack time	P25 Summary (Phase1 Tx Attack Time) P25 Power vs Time (Power Attack Time and Encoder Attack Time)	Yes	N/A
Transmitter power and encoder attack time with busy/idle operations	P25 Summary (Phase1 Tx Attack Time (Busy/Idle)) P25 Power vs Time (Power Attack Time Busy Idle and Encoder Attack Time Busy Idle)	Yes	N/A
Transmitter throughput delay	P25 Summary (Phase1 Tx Throughput Delay)	Yes	N/A
Transient frequency behavior	P25 Freq Dev vs.Time	Yes	N/A
HCPM transmitter logical channel peak adjacent channel power ratio	P25 Summary (HCPM Tx Logic Ch Pk ACPR)	N/A	НСРМ
HCPM Transmitter logical channel off slot power	P25 Power vs Time (Off Slot Power) P25 Summary (HCPM Tx Logic Ch Off Slot)	N/A	HCPM
HCPM Transmitter logical channel power envelope	P25 Power vs Time (Power Info) P25 Summary (HCPM Tx Logic Ch Pwr Env Limits)	N/A	HCPM
HCPM Transmitter logical channel time alignment	P25 Summary (HCPM Tx Logic Ch Time Alignt)	N/A	HCPM

P25 Standards Presets

The P25 standards preset allows you to access displays preconfigured for the P25 standards you select. You can read more about how Presets work here (see page 20).

The following table shows the bandwidth, modulation type, and displays that are automatically loaded for each of the listed standards. MCPR masks are also loaded and are explained here (see page 261).

Table 2: P25 standards, modulation type, bandwidth, and displays

Standard	Modulation type	Bandwidth (kHz)	Displays loaded with preset
Phase 1	C4FM	12.5	MCPR, Time Overview, P25 Constellation, P25 Summary
Phase 2	HCPM (inbound)	12.5	MCPR, Time Overview, P25 Constellation, P25
	HDQPSK (outbound)	12.5	Summary

Retain Current Center Frequency

This setting becomes available when P25 is the selected preset in the Standards Preset window. You can access this window by selecting **Presets** > **Standards** and then selecting **P25** from the **Preset** drop down menu. To activate the **Retain current Center Frequency Setting**, check the box. This setting allows you to retain the previously used center frequency. By default, the box is unchecked and therefore the four P25 preset displays will load with a center frequency of 850 MHz.

Preset: P25	•
Preset displays:	
	view P25 Summary P25
	Constellation
Standard:	Phase1
Bandwidth:	12.5 KHz
Modulation Type:	C4FM 👻
🛛 Retain current Center F	Frequency setting
To go directly to a preset in the	e future, use Tools->Options->Presets->Preset action
	OK Cancel

The default adjacent channels table for MCPR is different for RF frequencies in the range of 769 to 806 MHz (called 700 MHz band) and for frequency ranges outside it. The option of retaining center frequency in Standards Preset is therefore useful if you want to load the default table for center frequencies in the 700 MHz band.

MCPR channel and limit parameters. The MCPR (ACPR) standard channel and limit parameters that are applied to the P25 signal depend on the standard you select when you configure the preset. Once you select a standard and center frequency, the application will automatically load the parameters and default limits recommended for best performance comparison by the Standard document. All channel and limit parameters are derived from the TIA-102 standard and loaded for you. This provides you the assurance that you are evaluating the signal with the most appropriate parameters.

NOTE. Changing analysis and display parameters recalculates the measurement results, but does not affect acquisitions.

P25 Displays

The displays in P25 Analysis (Setup > Displays > Measurements: P25 Analysis) are:

- <u>MCPR</u>
- P25 Constellation (see page 273)

- P25 Power vs Time (see page 278)
- P25 Eye Diagram (see page 275)
- P25 Frequency Dev Vs Time (see page 286)
- P25 Symbol Table (see page 283)
- P25 Summary (see page 280)
- <u>Time Overview (see page 43)</u>

P25 Measurements

The following topics contain important information you should know about specific P25 measurements.

RF Output Power (Phase 1 and Phase 2)

This is a measure of RF output power when the transmitter is connected to the standard load during defined duty cycle. This measurement is presented as a scalar result in the P25 Summary display. Power variation is shown in the P25 Power vs Time display.

Information of note about this measurement:

- For bursty HCPM (Phase 2 Inbound) signals, the RF Output Power is measured only during the on slot regions centered at the middle of the on slot.
- The result shown in the P25 Summary Display is the average RF Output Power of all the bursts selected in the analysis window.
- If only one on slot region is chosen in the analysis window, then the RF Output Power of only the chosen on slot is reported.
- For non-bursty data, the entire duration of analysis window is considered to obtain RF Output Power.
- Enter external attenuation introduced by the user by entering the attenuation in the Amplitude control panel (Setup > Amplitude > External Gain/Loss Correction tab. > External Gain Value (dB). Select All acquired data (filter method).
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when Trigger Measurements are selected.

NOTE. Read about important information related to HCPM bursty data measurements here (see page 272).

Operating Frequency Accuracy (Phase 1 and Phase 2)

The Operating Frequency Accuracy is the ability of the transmitter to operate on its assigned frequency. This measurement is presented as a scalar result in the P25 Summary display.

- For bursty HCPM (Phase 2 Inbound) signals, the operating frequency accuracy is measured only during the on slot regions centered at the middle of the on slot.
- The result shown in the P25 Summary display is the average of all the bursts selected in the analysis window.
- If only one on slot region is chosen in the analysis window, then the operating frequency accuracy of only the chosen on slot is reported.
- For non-bursty data, the entire duration of the analysis window is considered to obtain the operating frequency accuracy.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when Trigger Measurements are selected.

Unwanted Emissions (ACPR) (Phase 1 and Phase 2)

This measurement is the ratio of the total power of a transmitter under prescribed conditions and modulation to that of the output power that falls within a prescribed bandwidth centered on the nominal frequency of adjacent channels. This measurement is shown in the MCPR display.

- For HCPM signals, Adjacent Channel Power Ratio analysis is only done on the first on slot region. When the Modulation Type is set to HCPM from any P25 display or from Standards Presets, there will be a search for bursts before ACPR analysis is done. If a burst is found, then analysis is done only on first burst. If a burst is not found, it will show the results of the entire analysis length. The Main Preset will remove the HCPM modulation Type setting, allowing MCPR to work in its regular mode.
- The MCPR display will only have one Main channel for P25 signals in addition to relevant adjacent channels.
- The default adjacent channels table for Unwanted Emissions (ACPR) as suggested by the standard can be loaded by using the P25 Standards Preset option (for which MCPR is one of the four displays).
- The default adjacent channels table for MCPR is different for RF frequencies in the range of 769 to 806 MHz (called 700 MHz band) and for frequency ranges outside it.
- To load the default adjacent channels table of a 700 MHz band, first set the center frequency. Next, select Presets > Standards to view the Standards Preset window. Lastly, check the Retain current Center Frequency Setting box.
- By default, the Retain Center Frequency box is unchecked and therefore the four P25 preset displays will load with a center frequency of 850 MHz and load the adjacent channels table for non-700 MHz band.
- By default, only six adjacent channels (on either side) will be shown when 700 MHz band is analyzed in P25 (for visual clarity). However, analysis is done for all the ten channels and results will be available in the table just under the display. You can zoom out to see the remaining bands.

Frequency Deviation (Phase 1 (C4FM) and Phase 2 (HCPM))

This measurement shows the amount of frequency deviation that results for a Low Deviation and High Deviation test pattern. This measurement is shown in the P25 Summary display.

- This measurement only applies to HCPM and C4FM signals and High Deviation or Low Deviation test patterns. If this measurement is run for any other test patterns or for HDQPSK signals, comparisons for limits (set in the Limits tab of the control panel) will result in N/A being shown, as the measurement will not be valid.
- This measurement is done using a FM demodulator without any filter. As a result, it will not be exactly the same as the result given in the P25 Frequency Deviation vs Time display. That display shows the frequency deviation after complete demodulation and might use relevant shaping filters.
- Measurement results are only available when High Deviation, Low Deviation, or Symbol Rate test pattern is selected.
- The scalar result in the P25 Summary display will be shown as f1 (Positive Peak) and f2 (Negative Peak) when analyzing the High Deviation test pattern (or the Symbol Rate test pattern for C4FM signals).
- The scalar result in the P25 Summary display will be shown as f3 (Positive Peak) and f4 (Negative Peak) when analyzing the Low Deviation test pattern.
- The scalar results in the P25 Summary display do not have a corresponding graphical view. A closely representative display would be the FM display (Setup > Displays > Analog Modulation).
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.

Modulation Fidelity (Phase 1 and Phase 2)

This measures the degree of closeness to which the modulation follows the ideal theoretical modulation determined by the rms difference between the actual deviation and the expected deviation for the transmitted symbols. This measurement is shown in the P25 Summary and P25 Constellation displays.

- This measurement is done on the first on slot region in the analysis window for bursty HCPM data. The analysis is done on 160 symbols centered at the burst.
- This measurement is done on all of the data chosen in the analysis window for non-bursty modulation types. A warning message is issued if the data is less than 164 symbols (the standard recommends at least 164 symbols be present for the measurement of non-bursty signals).
- This measurement is done by performing the frequency demodulation after taking the signal through relevant shaping filters and comparing it with expected frequency deviation points.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when Trigger measurements are selected.

NOTE. Read about important information related to HCPM bursty data measurements here (see page 272).

Symbol Rate Accuracy (Phase 1 and Phase 2)

Symbol Rate Accuracy measures the ability of the transmitter to operate at the assigned symbol rate (4.8 kHz for Phase 1, 6 kHz for Phase 2). It is a scalar result shown in the P25 Summary display.

- This measurement result appears in the P25 Summary display and only applies to High Deviation or Low Deviation test patterns. Test patterns are selected in the Test Patterns tab in the Settings control panel.
- To check if the results are consistent with the symbol rate used, the measurement is done based on the number of zero crossings when a High Deviation or Low Deviation test pattern is used.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement only applies to High Deviation or Low Deviation test patterns. If this measurement is run for any other test patterns, comparisons for limits will result in N/A being shown, as the measurement will not be valid.

Common Trigger Related Measurements

The measurements covered in this subsection have some common information. These measurements are:

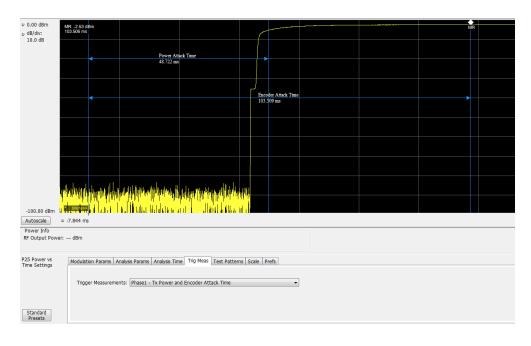
- Transmitter Power and Encoder Attack Time (Phase 1): This measurement is the time required for a transmitter to prepare and transmit information on the radio channel after changing state from standby to transmit (applies to conventional mode). This measurement result can be seen in the P25 Summary display. A graphical representation of these results can be seen in the P25 Power vs Time display.
- Transmitter Power and Encoder Attack Time with Busy/Idle Operations (Phase 1): This measures the time required for a transmitter to prepare and transmit information on the radio channel after the receiving channel changes state from busy to idle. Transmission is inhibited until a status symbol indicates an idle channel. This measurement result can be seen in the P25 Summary display. A graphical representation of these results can be seen in the P25 Power vs Time display.
- Transmitter Throughput Delay (Phase 1): This measures the time it requires for audio changes in the microphone to be encoded and transmitted over the air. A calibrated receiver with a known receiver throughput delay is used to monitor the transmitted signal. The aggregate delay of the transmitter under test and calibrated receiver is measured and the desired transmitter throughput delay is then the aggregate delay less the delay of the calibrated receiver. A calibrated Receiver throughput delay from the UI is needed. This measurement result can be seen in the P25 Summary display.
- Transient Frequency Behavior (Phase 1): This is a measure of difference of the actual transmitter frequency and assigned transmitter frequency as a function of time when the RF output power is switched on or off. This measurement appears in the P25 Freq Dev vs Time display.
- HCPM Tx Logical Channel Time Alignment (Phase 2 HCPM): This measures the ratio of total transmitter power under prescribed conditions and modulation to the peak power that falls in a prescribed bandwidth centred on the nominal frequency of the adjacent channel during the transmitter power ramping interval. This applies only to inbound signals. This measurement result appears in the P25 Summary display.

Common information. The following information applies to all of the measurements in the previous list.

- Select the relevant Trigger measurement from the Trig Meas tab of the control panel.
- When this measurement is chosen from the Trig Meas tab of the control panel, only this result will be populated in the P25 Summary display and everything else will have no result.
- The Time Zero Reference under the Analysis Time tab in the control panel is forced to Trigger.
- Align the Trigger to the RSA/MDO4000B as described in the measurement methods standard document.
- When a trigger measurement is chosen from the Trig Meas tab of the control panel, the following status message will appear: *P25: Set instrument in Triggered Mode*.
- You must set the trigger mode from Free Run to Triggered in the Trigger control panel.
- This measurement can only be performed when the Source is Trig In (front) or Trig 2 In (rear).
- Use the Acquisition control panel to select enough acquisition length to ensure that sufficient data is available when the acquisition is triggered.
- This measurement operates in Single Acquisition mode as the acquisition is triggered.
- You can select to do the same experiment multiple times and this measurement will produce an average result of the last 10 single acquisitions. Clicking the Clear button on the P25 Summary display will clear the results and start a new measurement.

Transmitter Power and Encoder Attack Time and Transmitter Power and Encoder Attack Time with Busy/Idle Operations (Phase 1). The following information is specific to these two measurements.

- The Transmitter Power Attack Time analysis is done by measuring the time taken from the trigger point to the point where the transmitter output power will reach 50% of its maximum value.
- For Encoder Attack Time, the initial frame synchronization word is searched in the demodulated output and the time taken from trigger to the start of the synchronization word is reported as the result.
- When a clear power ramp up is not available, the analysis will report the following error, indicating that no power ramp was received as expected: *Input data too short*. When the synchronization word is not found, the analysis will report the following error: *IQ Processing error*.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- The P25 Power vs Time display shows marking from trigger point to 50% ramp point and also up to the Synchronization word for Transmitter Power and Encoder Attack Time. Frequency Dev vs Time can also be used to check for the synchronization word. The following image shows this measurement.



Transmitter Throughput Delay (Phase 1). The following information is specific to this measurement.

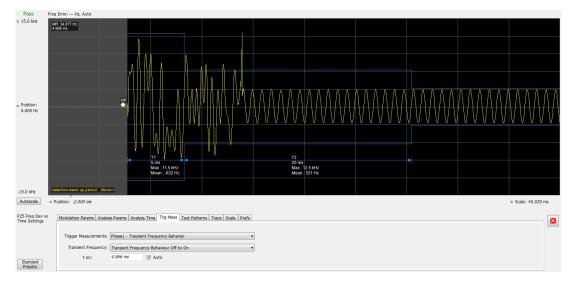
- Select Tx Throughput Delay from the Trig Meas tab of the Settings control panel to get this measurement.
- The original noise source is connected as input to this trigger and the acquisition is triggered when the input from the noise source exceeds the trigger level set by the user.
- The actual input to the RSA comes after the noise signal from the source has passed through the DUT and calibrated receiver as shown in the setup for this measurement in the measurement methods standard document.
- The level in the Trigger control panel set by the user is used for analysis to determine that Input to the RSA (after it has gone through the DUT and calibrated receiver) has hit the desired power levels.
- The time difference between the trigger point and the point when the input to the RSA has exceeded the level set by the user for triggering is calculated.
- The calibrated receiver throughput delay entered by the user in the Trig Meas tab in the Settings control panel (this option appears when Throughput Delay is selected) is subtracted from the calculated time difference and reported as Throughput Delay.
- A limit comparison can be performed by selecting the appropriate limits from the Limits tab in the Settings control panel.

Transient Frequency Behavior (Phase 1). The following information is specific to this measurement.

- Select Transmitter Frequency Behavior from the Trig Meas tab of the Settings control panel to get this measurement.
- This measurement can be done for On to Off and Off to On behaviors. Select which behavior to measure by selecting the desired behavior from the Transient Frequency drop down list that appears

when the Transient Frequency Behavior measurement is selected in the Trig Meas tab of the Settings control panel.

- Select enough acquisition length (from the Acquisition control panel) to ensure that sufficient data is available when the acquisition is triggered. For a transient frequency behavior, there is a need for t_1+t_2 amount of time after t_{on} as defined in the measurement methods standard document. Approximately 100 ms of data after trigger should ensure that all cases are taken care of as suggested by the standard. t_1 , t_2 , and t_3 durations are fetched based on the RF frequency range.
- The identification of t_{on} is done by looking for a significant frequency deviation after a certain power level has been achieved. A manual override for the t_{on} is also provided in the Trigger Meas tab of the Settings control panel when a Transient Frequency Behavior measurement is chosen. This allows you to manually override the t_{on} that is calculated (by releasing the Auto Option) and place it appropriately based on the P25 Freq Dev vs Time display. The same is true for t_{off} when the measurement is being done for the On to Off behavior.
- t_1 and t_2 regions are identified after t_{on} and t_3 before t_{off} (for the On to Off behavior).
- The mean and max frequency deviation is reported in the regions identified.
- A Pass or Fail is also reported by comparing the Mean frequency deviation with the recommended values given in the standard. A red band is shown if a particular region's result is less than the performance recommendation. The following image shows this measurement.



HCPM Tx Logical Channel Time Alignment (Phase 2 HCPM). The following information is specific to this measurement. This result can be viewed in P25 Summary and P25 Power vs Time displays.

This measurement is done in two steps: First by calculating tOB_sync using HDQPSK data (the ISCH pattern is looked for) and then by using the result to calculate tIB_sync using HCPM data (the SACCH pattern is looked for).

The first step is done by choosing Time Alignment (tOB_sync measurement) in the Trig Meas tab in the Settings control panel.

When the second step, Time Alignment (t_error_0 calculation) or (t_error_1 calculation) is selected in the Trig Meas tab of the control panel, there is an option to override the tOB_sync value calculated in the first step.

- When this measurement is chosen, only this result is provided in the P25 Summary display.
- You must provide the ultraframe boundary to the trigger of the analyzer.
- An autocorrelation of the input RF signal with the reference patterns is performed to get the peak that will determine tOB_sync (measured) and t_error_0 or t_error_1 from the trigger point.

HCPM Tx Logical Channel Peak ACPR (Phase 2 HCPM)

This measures the ratio of total transmitter power under prescribed conditions and modulation to the peak power that falls in a prescribed bandwidth centred on the nominal frequency of the adjacent channel during the transmitter power ramping interval. This applies only to inbound signals. This measurement result appears in the P25 Summary display.

- This measurement is done by calculating power in the adjacent channels for the entire duration of data chosen by the user, including the power ramp up and ramp down portions. The standard recommends 360 ms of data for this measurement, unlike the other ACPR measurements for which the analysis is done only for the on slot region.
- The higher and lower adjacent channel power is reported in the P25 Summary display under Power Measurements.
- The two results are then subtracted from the calculated RF output power and the minimum of the two results is presented as the Min Pk ACPR in the P25 Summary display.
- This measurement is only done for bursty HCPM data and not for High Deviation or Low Deviation test patterns.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when trigger measurements are chosen.

NOTE. Read about important information related to HCPM bursty data measurements here (see page 272).

HCPM Transmitter Logical Channel Off Slot power (Phase 2 HCPM)

This measures the power of a TDMA transmitter during the off portion of the TDMA pulse. This measurement only applies to inbound signals. This result can be viewed in P25 Summary and P25 Power vs Time displays.

- The measurement is done as suggested by the standard to calculate P_{ONREL} and P_{OFFREL}
- P_{TX} is an input expected from the user and this can be given from the Analysis Params tab in the Settings control panel.
- The absolute level of the off slot power is then calculated as $P_{OFF} = P_{TX} (P_{ONREL} P_{OFFREL}) dBm$

- This measurement is only done for bursty HCPM data and not for High Deviation or Low Deviation test patterns.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when trigger measurements are chosen.

NOTE. Read about important information related to HCPM bursty data measurements here (see page 272).

HCPM Transmitter Logical Channel Power Envelope (Phase 2 HCPM)

This is a measure of how well a portable radio controls the transmitter power as it inserts an inbound HCPM TDMA burst into a frame on a voice channel. This measurement applies to inbound signals only.

- All scalar results relevant to this measurement are shown both in P25 Power vs Time display and the P25 Summary display.
- The measurement results and the duration in which the measurements are made are shown graphically in P25 Power vs Time display. The results are grouped under Power Info and Time Info in the table at the bottom of the display.
- This measurement is only done for bursty HCPM data and not for High Deviation or Low Deviation test patterns.
- The Limits tab in the P25 Summary Settings control panel allows you to compare the results against limits set for Pass/Fail.
- This measurement result is not shown in the P25 Summary display when trigger measurements are chosen.

NOTE. Read about important information related to HCPM bursty data measurements here (see page 272).

P25 Test Patterns

A variety of test patterns are specified in the TIA-102 documents for use in performance testing of transmitters. These test patterns allow the software to compare the measurement result to the standards limit. Test engineers can select from the test patterns described in the following tables.

NOTE. Although this table gives the test patterns for measurements as recommended by the Standard, other measurement results are also be provided as additional information for a given test pattern. For example, Modulation Fidelity results can also be provided for High Deviation and Low Deviation test patterns.

TIA-102 Phase 1 C4FM test pattern	Phase 1 (C4FM) measurement
Standard transmitter	RF Output Power
	Operating Frequency Accuracy
	Modulation Emission Spectrum
	Unwanted Emissions (Adjacent Channel Power Ratio)
	Modulation Fidelity
	Transmitter Power and Encoder Attack Time
Standard Busy	Transmitter Power and Encoder Attack Time (With Busy/Idle Operations)
Low Deviation	Operating Frequency Accuracy
	Transient Frequency Behavior
	Frequency Deviation
Standard Idle	Transmitter Power and Encoder Attack Time (With Busy/Idle Operations)
Standard Transmitter Symbol Rate	Symbol Rate Accuracy
(Same as High Deviation test pattern	Frequency Deviation
C4FM Modulation Fidelity	Modulation Fidelity
Standard Tone	Can be used for measurements such as RF Output Power, Operating Frequency Accuracy, Modulation Fidelity, and ACPR
Other (User created test pattern)	Can be used for measurements such as RF Output Power, Operating Frequency Accuracy, Modulation Fidelity, and ACPR

Table 3: P25 test patterns, Phase 1 C4FM

Table 4: P25 test patterns, Phase 2 Inbound and Outbound

TIA-102 Phase 2 test pattern	Phase 2 measurement
Standard Transmitter (Inbound and Outbound)	RF Output Power
	Operating Frequency Accuracy
	Modulation Emission Spectrum
	Unwanted Emissions (Adjacent Channel Power Ratio)
	Modulation Fidelity
Inbound Standard Tone Ch0	Can be used for measurements such as RF Output Power, Operating Frequency Accuracy, Modulation Fidelity, and ACPR
Inbound Standard Tone Ch1	Can be used for measurements such as RF Output Power, Operating Frequency Accuracy, Modulation Fidelity, and ACPR
Outbound Standard Tone	Operational Frequency Accuracy

TIA-102 Phase 2 test pattern	Phase 2 measurement	
Inbound Symmetrical Time Slot	RF Output Power	
	Modulation Emission Spectrum	
	Modulation Fidelity	
	HCPM (Peak ACPR)	
	HCPM (Off slot power)	
	HCPM (Power envelope)	
	Unwanted Emissions (Adjacent Channel Power Ratio)	
Low Deviation (Inbound)	Frequency deviation for HCPM	
	Symbol Rate Accuracy	
Low Deviation (Outbound)	Symbol Rate Accuracy	
High Deviation (Inbound and Outbound)	Symbol Rate Accuracy	
Other	Can be used for measurements such as RF Output Power, Operating Frequenc	
(User created test pattern)	Accuracy, Modulation Fidelity, and ACPR	

Table 4: P25 test patterns, Phase 2 Inbound and Outbound (cont.)

Analysis of HCPM Bursty Data

It important to take into account the following information when analyzing HCPM bursty data.

- It is mandatory that at least one complete on slot and off slot region (including the ramp up and ramp down portion) have to be included in the analysis window for HCPM measurement results to be analyzed.
- If HCPM is the chosen standard in Standards Presets, then a minimum length of 94 ms is set for the analysis window. This is to ensure that a full on slot and off slot region is available irrespective of the selected analysis offset.
- Do not use the High Deviation or Low Deviation test patterns for bursty signals. Test patterns are selected in the P25 Settings control panel on the Test Patterns tab. If selected, analysis would look for a bursty pattern. High Deviation and Low Deviation test patterns are not bursty and therefore do not have the above analysis length restriction.

If you try to set the analysis length to less than 94 ms, the following status message will display: $P25:HCPM:Minimum Analysis Length should be \ge 94 ms.$

Most measurements that are required to be done on on slot regions are done centered at the on slot region of HCPM bursty data.

When HCPM bursty data is analyzed, the following status message will appear on all relevant displays: *P25:HCPM modulation analysis is done only on on slot regions*.

P25 Constellation Display

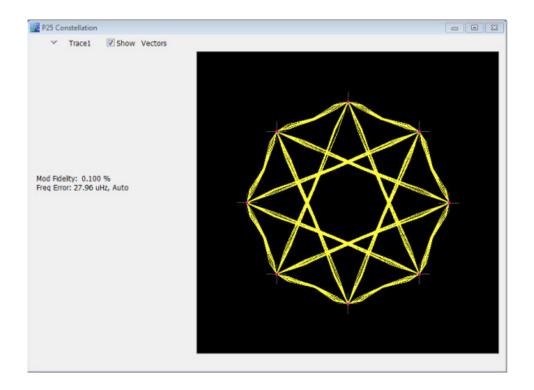
The P25 Constellation Display shows the P25 signal modulation amplitude. For the HCPM and HDQPSK standards, you can view this display as frequency deviation or as I and Q. For the C4FM standard, only the frequency deviation applies.

To show the P25 Constellation display you can select **Presets** > **Standards** > **P25** or do the following:

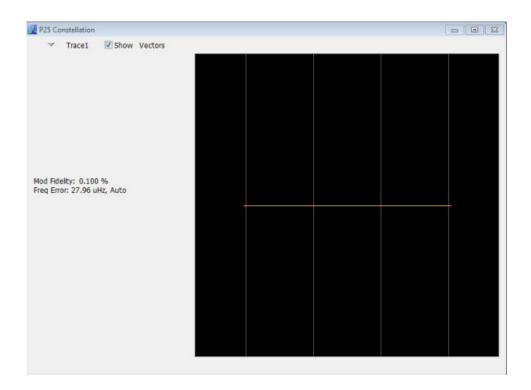
- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select P25 Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **P25 Constellation** icon or select the icon and click **Add**. The P25 Constellation icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the P25 Constellation display.
- 5. Select Setup > Settings to display the control panel.
- **6.** Select the **Modulation Params** tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 7. For Phase 2 signals, select the Trace tab and set the Trace Type to Freq Dev or IQ.
- 8. Select the Test Patterns tab and select the desired test pattern as appropriate for the input signal.

Elements of the Display

The following image shows the P25 Constellation display set to IQ for a HDQPSK signal.



The following image shows the same signal as the previous image, but with the display set to Frequency Deviation.



ltem	Display element	Description
1	Marker Readout	Located to the left of the constellation plot or below it, depending on the size of the window. If markers are enabled, the marker readout will show frequency deviation results or IQ results (time, mag, phase, symbol marker and symbol value) of the point with the selected marker.
2	Measurement results readout	These readouts are located to the left or below of the Constellation plot, depending on the window size. The readout shows Modulation Fidelity (%) and Frequency Error (Hz).
		The second readout can either be Freq Error where the result is followed by Auto or it could be Freq Offset where the result is followed by Manual. This choice between Freq Error and Freq Offset is made from the Analysis Params tab in the Settings control panel.
3	Plot	Shown as either I vs Q or as Frequency Deviation. The trace type is controlled from the Settings > Trace tab.

P25 Constellation Settings

Application Toolbar: 🕮

The P25 Constellation Settings control panel provides access to settings that control parameters of the Constellation Display.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for P25 Analysis displays.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Trace (see page 296)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.
Prefs (see page 299)	Specifies the radix of the marker readout and whether elements of the graphs are displayed.
Trig Meas (see page 298)	Enables you to select from several different trigger measurements.

P25 Eye Diagram Display

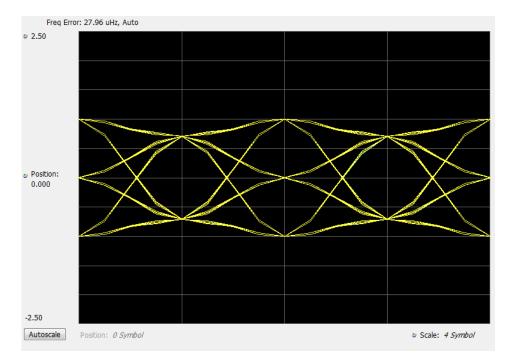
The P25 Eye Diagram display shows a digitally modulated signal overlapped on itself to reveal variations in the signal.

To show the P25 Eye Diagram display:

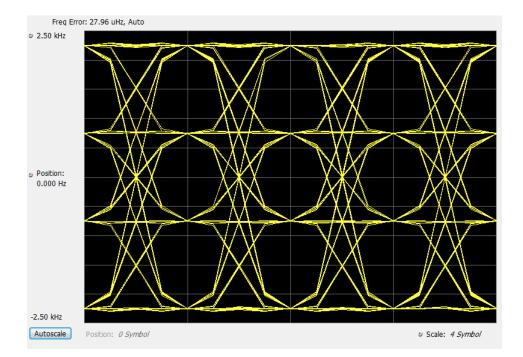
- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. From the Measurements box, select P25 Analysis.
- **3.** Double-click the **P25** Eye Diagram icon in the Available Displays box. This adds the P25 Eye Diagram icon to the Selected displays box.
- 4. Click OK button. This displays the P25 Eye Diagram view.
- 5. Select Setup > Settings to display the control panel.
- **6.** Select the **Modulation Params** tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 7. For Phase 2 signals, select the Trace tab and set the Trace Type to Freq Dev or IQ.
- 8. Select the Test Patterns tab and choose a test pattern appropriate for the input signal.

Elements of the Display

The following image shows the P25 Eye display with Trace Type set to IQ.



The following image shows the P25 Eye display with Trace Type set to Freq Dev.



ltem	Display element	Description	
1	Top of graph	The vertical scale is normalized with no units (for IQ) and with Hz (for Freq dev).	
2	Position	Specifies the value shown at the center of the graph display.	
3	Bottom Readout	Displays the value indicated by the bottom of graph.	
4	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.	
5	Position	Displays the horizontal position of the trace on the graph display.	
6	Scale	Adjusts the span of the graph in symbols.	
7	Freq Error	Displays the difference between the maximum and minimum measured values of the signal frequency during the Measurement Time. The readout can either be Freq Error where the result is followed by Auto or it could be Freq Offset where the result is followed by Manual. This choice between Freq Error and Freq Offset is made from the Analysis Params tab in the Settings control panel.	

P25 Eye Diagram Settings

Application Toolbar: 虊

The settings for the P25 Eye Diagram display are shown in the following table.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trig Meas (see page 298)	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Trace (see page 296)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.
Scale (see page 296)	Defines the vertical and horizontal axes.
Prefs (see page 299)	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

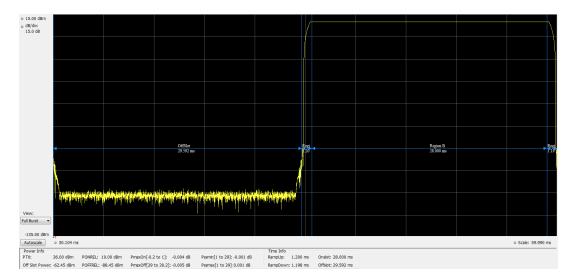
P25 Power vs Time Display

The P25 Power vs Time display shows the signal power amplitude versus time.

To show the P25 Power vs Time display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select P25 Analysis in the Measurements box.
- 3. In the Available displays box, double-click the P25 Power vs Time icon or select the icon and click Add. The P25 Power vs Time icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click **OK** to show the P25 Power vs Time display.
- 5. Select Setup > Settings to display the control panel.
- **6.** Select the **Modulation Params** tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 7. Select the Test Patterns tab and choose a test pattern appropriate for the input signal.

Elements of the Display



ltem	Display element	Description
1	Top of graph, first settting	Sets the Power level that appears at the top of the graph, in dBm. This is only a visual control for panning the graph.
2	Top of graph, second setting	Sets the vertical Scale of the graphs, in dB/div. This is only a visual control for panning the graph.
3	View	Selects the specific view of the packet burst within the display:
	(Only available for bursty HCPM data.)	Full Burst displays the entire packet, with vertical lines indicating Power ramp up, On Slot, Power ramp down, and Off slot regions.
		Ramp Up zooms the display into the interval around the packet rising edge.
		Ramp Down zooms the display into the interval around the packet falling edge.
4	Bottom of graph readout	Shows the Power level at the bottom of the graph in dBm.
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
6	Bottom of graph, left side	Sets the starting time of the graph in seconds
7	Bottom of graph, right side	Sets the scale (width) of the graph in seconds
8	Table below graph	This table shows the following results.
		For non-bursty signals: RF output power
		For bursty signals: Power Info (Offslot Power and Power Envelope results) and Time Info.

P25 Power vs Time Settings

Application Toolbar: 🕸

The settings for the P25 Power vs Time display are shown in the following table.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trig Meas (see page 298)	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Scale (see page 296)	Defines the vertical and horizontal axes.
Prefs (see page 299)	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

P25 Summary Display

The P25 Summary display shows a summary of all the scalar measurements done on the acquired test pattern. The summary display and contents will vary according to the selected standard.

Pass/Fail information is also provided in this display for all enabled scalar measurements. You can set limits and choose which measurement to compare for Pass/Fail from the Limits tab in the P25 Summary Settings control panel. The default limits come from the performance recommendation limits given by the Standard document. The default limits can be reloaded by selecting the P25 Standards Preset option or by loading the default limits table.

To show the P25 Summary display you can select **Presets** > **Standards** > **P25** or do the following:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select P25 Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **P25 Summary** icon or select the icon and click **Add**. The P25 Summary icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to show the P25 Summary display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the Modulation Params tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 7. Select the **Test Patterns** tab and select a test pattern. The available test patterns in the drop down list depend of the standard and modulation type you have selected.

P25 Summary Display

The Modulation Measurements, Power Measurements, and Trigger Measurements components of this display vary depending on which modulation type is selected.

The following image shows an example of the display for a Phase 1 C4FM signal.

Standard: Phase1	Bandwidth: 12	.5 KHz Modu	ulation Type: C4FM	Clear
Modulatio	n Measurements		Trigger Mea	asurements
Modulation Fidelity:	0.465 %	PASS	Phase1 Tx /	Attack Time
Operating Freq Accuracy	y: 0 ppm	PASS	Avg Tx Pwr Attack	N/A
Symbol Rate Accuracy:	ppm	N/A	Avg Tx Encoder Attack	N/A
Frequence	Frequency Deviation			of 10
Positive Peak:	Hz	N/A	Phase1 Tx Attack	Time (Busy/Idle)
Negative Peak:	Hz	N/A	Avg Tx Pwr Attack	
			Avg Tx Encoder Attack	
Power	Power Measurements			of 10
RF Output Power:	10.00 dBm	PASS	Phase1 Tx Throughput De	elay: of 10

The following image shows an example of the display for a Phase 1 C4FM High Deviation signal.

Standard: Phase1	Bandwidth: 12	2.5 KHz Modu	ulation Type: C4FM	Clear
Modulati	on Measurements	;	Trigger Me	asurements
Modulation Fidelity:	0.030 %	PASS	Phase1 Tx	Attack Time
Operating Freq Accurac	cy: 0 ppm	PASS	Avg Tx Pwr Attack	
Symbol Rate Accuracy:	0.00 ppm	PASS	Avg Tx Encoder Attack	
Frequency Deviation	Frequency Deviation (Symbol Rate Pattern)			of 10
f1 Positive Peak:	2768.93 Hz	PASS	Phase1 Tx Attac	k Time (Busy/Idle)
f2 Negative Peak:	-2865.77 Hz	PASS	Avg Tx Pwr Attack	
			Avg Tx Encoder Attack	
Power	Measurements			of 10
RF Output Power:	10.00 dBm	PASS	Phase1 Tx Throughput D	e lay: of 10

The following image shows an example of the display for a Phase 2 HCPM (Inbound) signal.

Modulation	Measurements		Trig	gger Measurements
ulation Fidelity:	0.477 %	PASS	НСРМ	Tx Logic Ch Time Align
erating Freq Accuracy:	0 ppm	PASS	tOB_sync (measured	
nbol Rate Accuracy:	ppm	N/A	COD_Sync (measured	of 5
Frequency	Deviation		Avg t_error_0	
sitive Peak:	Hz	N/A		of 5
egative Peak:	Hz	N/A	Avg t_error_1	of 5
D M	easurements			
Power Me Dutput Power:	10.00 dBm	PASS		
PM Tx Logic Ch Off Slo		PASS		
HCPM Tx Logic Cl	n Pwr Env Limits			
Time (ms)	Power			
ax-on -0.2 to 1.0	-0.004 dB	PASS		
s-max 1.0 to 29.0	0.001 dB	PASS		
min 1.0 to 29.0	-0.001 dB	PASS		
ax-off 29.0 to 30.2	-0.005 dB	PASS		
HCPM Tx Logi	c Ch Pk ACPR			
CP_HI	-37.96 dBm			
CP_LOW	-40.13 dBm			
Pk ACPR	47.964 dB	PASS		

The following image shows an example of the display for a Phase 2 HDQPSK (Outbound) signal.

Standard: Phase2	Bandwidth: 12.	5 KHz Mod	dulation Type: HDQPSK (Outbound)	Clear
Modulatio	on Measurements]	
Modulation Fidelity:	0.100 %	PASS		
Operating Freq Accurac	c y: 0 ppm	PASS		
Symbol Rate Accuracy:	ppm	N/A		
Power	Measurements]	
RF Output Power:	7.94 dBm	PASS	-	
Kr output Power.	7.94 UDIII	PASS		

For more information about specific measurement results, see the P25 Measurements section here (see page 307).

Elements of the Display

Element	Description
Standard	Display of the standard selected on the Setup > Settings > Modulation Params tab.
Bandwidth	Display of the channel bandwidth which is set based on the standard and modulation type.
Modulation Type	Display of the modulation type selected on Setup > Settings > Modulation Parameters tab.
Clear	Click button to reset measurement. Clears all values.
Modulation Measurements	Shows the modulation measurements associated with the signal.
Power Measurements	Shows the power measurements associated with the signal.
Trigger Measurements	Shows the trigger measurements associated with the signal.

P25 Summary Settings

Application Toolbar: 鄻

The settings for the P25 Summary display are shown in the following table.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trig Meas (see page 298)	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Limits (see page 300)	Load and define P25 measurement limits for Pass/Fail comparison. You can save defined limits as a .csv file and also load previously saved .csv files.

P25 Symbol Table Display

The P25 Symbol Table display shows decoded data values for each data symbol in the analyzed signal packet.

To show the P25 Symbol Table display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select P25 Analysis in the Measurements box.

- **3.** In the Available displays box, double-click the **P25 Symbol Table** icon or select the icon and click **Add**. The P25 Symbol icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the P25 Symbol Table display.
- 5. Select Setup > Settings to display the control panel.
- **6.** Select the **Modulation Params** tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 7. Select the **Test Patterns** tab and select a test pattern. The available test patterns in the drop down list depend on the standard and modulation type you have selected.

P25 Symbol Table

The following image shows the P25 Symbol Table for HCPM (bursty) signals. For this signal type, the symbols are arranged as Bursts vs Symbols. The analysis is done only on the on slot regions of the bursty HCPM data and 160 symbols (centered at the middle of the burst) are reported on the symbol table for every on slot region. You can read more about specific measurements here (see page 307).

B1		B2
	1	3
1	3	1
2	2	1
3	1	0
4	2	3
5	3	3
6	0	0
	3	1
8	2	3
9	1	2
10	0	3
11		2
12	3	0
13	1	3
14		2
15		2
16		1
	0	3
18	0	2
19		3
20		3
21		0
22		0
23	1	0

The following image shows the P25 Symbol Table for C4FM (non-bursty) signals. For this signal type and for HDQPSK, there is no grouping into bursts and all symbols that are analyzed are shown.

0	3	2	0	0	0	2	1	1	3	2	2	3	0	2	2	1	
16	1	3	3	1	1	3	0	2	2	0	0	3	0	0	0	3	
32	3	2	0	2	0	0	0	3	1	2	0	3	1	0	3	2	
48	3	2	3	3	3	1	3	1	3	1	0	0	1	1	2	3	
64	2	1	2	3	3	3	3	0	2	1	0	2	3	3	3	1	
80	0	1	3	3	0	1	3	1	0	1	2	3	1	1	2	2	
96	0	2	0	0	3	0	1	3	2	3	0	0	2	2	0	3	
112	3	2	3	3	1	0	3	3	2	0	3	0	2	0	0	2	
128	1	2	2	1	2	2	2	0	3	1	1	2	2	2	1	2	
144	3	1	3	1	3	2	2	0	2	1	1	1	2	0	0	3	
160	3	2	2	0	2	3	1	1	3	0	2	2	0	2	3	0	
176	2	1	1	0	0	0	3	2	1	1	3	1	3	3	3	2	
192	3	1	0	3	1	2	2	2	1	3	3	0	3	0	3	0	
208	2	3	3	2	1	3	0	3	1	2	2	2	0	0	0	1	
224	0	2	1	0	1	0	1	3	2	3	2	2	3	1	2	0	
240	3	2	2	0	2	3	2	1	0	1	3	3	2	1	2	0	
256	1	2	3	2	0	0	2	0	0	0	1	0	1	1	0	3	
272	3	2	0	2	1	3	3	0	0	3	2	0	3	0	3	3	
288	3	2	3	0	2	1	1	1	2	0	1	1	1	2	1	3	
304	1	2	3	0	1	0	1	3	1	2	2	1	1	3	3	2	
320	1	1	3	2	3	2	0	0	1	0	0	0	3	3	2	1	

Elements of the Display

Element	Description
Marker	Displays the selected marker label.
Time	Displays the time in ms or in Symbols based on the Units chosen in the Analysis Time tab of the Settings Control panel.
Symbol	The value shown here reflects the symbol you have selected (highlighted) in the display.
Value	Displays the value of the selected symbol.

P25 Symbol Table Settings

Application Toolbar: 鄻

The settings for the P25 Symbol Table display are shown in the following table.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
<u>Trig Meas (see page 298)</u>	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Prefs (see page 299)	Specifies the radix of the marker readout.

P25 Frequency Dev vs Time Display

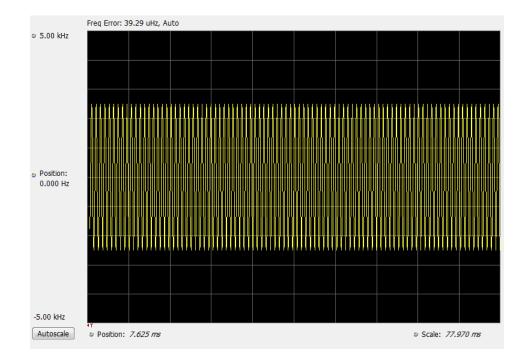
The P25 Frequency Deviation vs. Time Display shows how the signal frequency varies with time.

To display the P25 Frequency Dev vs. Time Display:

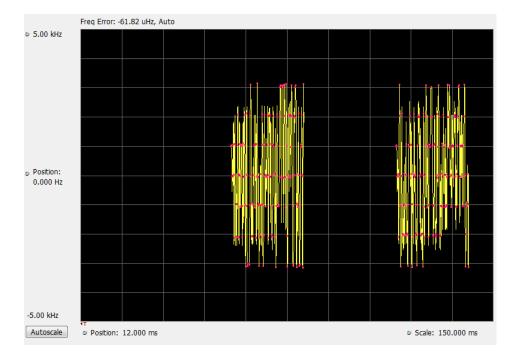
- 1. Select the **Displays** button or **Setup** > **Displays**.
- 2. In the Select Displays dialog, select P25 Analysis in the Measurements box.
- **3.** In the **Available displays** box, double-click the **P25 Frequency Dev vs. Time** icon or select the icon and click **Add**. The P25 Frequency Dev vs. Time icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK to display the Freq Dev vs. Time display.
- **5.** Select the **Modulation Params** tab. Set the Standard, Modulation Type, and Measurement and Reference filters as appropriate for the input signal.
- 6. Select the **Test Patterns** tab and select a test pattern. The available test patterns in the drop down list depend of the standard and modulation type you have selected.

Elements of the Display

The following image shows the P25 Freq Dev vs Time display for Phase 1 C4FM (non-bursty) High Deviation signals.



The following image shows the P25 Freq Dev vs Time display for Phase 2 HCPM (bursty) signals.



NOTE. For bursty HCPM signals, frequency deviation analysis is done only on 160 symbols centered at every on slot region in the chosen analysis window and not on off slot regions. That is why there is no information shown during off slot regions. You can read more specific information about P25 measurements here (see page 262).

Elements of the Display

Display element	Description				
Top of graph adjustment	Adjust the frequency range displayed on the vertical axis.				
Position (center)	Adjust the frequency shown at the center of the display.				
Autoscale button	Adjusts the offset and range for both vertical and horizontal to provide the best display.				
Position	Displays the horizontal position of the trace on the graph display.				
Scale	Adjust the horizontal scale (time).				
	Top of graph adjustment Position (center) Autoscale button Position				

Changing Frequency vs Time Display Settings (see page 288)

P25 Frequency Dev Vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 鄻

The Setup settings for P25 Frequency Dev vs. Time are shown in the following table.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the instrument to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trig Meas (see page 298)	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns (see page 295)	Specifies the type of test pattern being used. Some analysis differs based on the selected test pattern. Available test patterns vary depending on the selected standard and modulation type.
Trace (see page 296)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.
Scale (see page 296)	Defines the vertical and horizontal axes.
Prefs (see page 299)	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

P25 Analysis Shared Measurement Settings

Application Toolbar: 🕸

The control panel tabs in this section are shared between the displays in P25 Analysis (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a subset of displays. The settings available on some tabs change depending on the selected display.

Settings tab	Description
Modulation Params (see page 290)	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params (see page 293)	Specifies parameters used by the application to analyze the input signal.
Analysis Time (see page 293)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trace (see page 296)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.
Scale (see page 296)	Defines the vertical and horizontal axes.
Test Patterns (see page 295)	Enables you to select from eight different test patterns.
Trig Meas (see page 298)	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Prefs (see page 299)	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

Common controls for P25 analysis displays

Modulation Params Tab - P25

The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that define the signal format.

Modulation Params A	Analysis Params Analysis T	ime Trig Meas Tes	t Patterns Prefs	
Standard:	Phase2 -	Measurement Filter:	None 🔹	Symbol Rate: 6 kHz
Channel Bandwidth:	12.5 KHz	Reference Filter:	None 🔹	
Modulation Type:	HCPM (Inbound)			

Settings	Description					
Standard	Specifies the standard used for the input signal: Phase 1, Phase 2.					
Channel Bandwidth	This readout shows the nominal channel bandwidth based on the standard.					
Modulation Type	Specifies the modulation type of the input signal. Choices vary depending on the selected standard. Modulation types for Phase 2 are HCPM (Inbound) and HDQPSK (Outbound). Phase 1 has only C4FM as the modulation type selection.					
Measurement Filter	Specifies the filter used as a measurement.					
Reference Filter	Specifies the filter used as a reference.					
Filter Parameter	Enter a value used for defining the Reference Filter. (Not present for some filter types)					
Symbol Rate	This is a readout that shows the symbol rate for demodulating digitally modulated signals based on the standard. This rate is always 4.8 kHz for Phase 1 signals and 6 kHz for Phase 2 signals.					

Symbol Rate

Specifies the symbol rate for demodulating digitally modulated signals based on the standard. The symbol rate and the bit rate are related as follows:

(Symbol rate) = (Bit rate)/(Number of bits per symbol)

The bit rate used for Phase 1 (C4FM) is 9600 bps. For Phase 2 (HCPM and HDQPSK) it is 12000 bps. There are two bits per symbol for all above mentioned modulation types. Therefore, the symbol rate is 4800 Hz for Phase 1 and 6000 Hz for Phase 2.

Measurement and Reference Filters

The available measurement and reference filters depend on the selected modulation type. The following table shows the recommended filters for the specified modulation types.



CAUTION. Although there are other filter types listed in the drop down menu, if you select any filter other than that which is recommended, the measurement results may not be accurate.

Modulation type	Measurement filters	Reference filters
HDQPSK	HDQPSK-P25	None
HPCM	None	None
C4FM	C4FM-P25	RaisedCosine (Filter parameter 0.2)

The measurement filter is applied before the demodulation bit is detected and the ideal reference is calculated.

The reference filter is applied to the internally generated ideal reference signal before the modulation fidelity is calculated.

How to Select Filters

In a signal transmitter/receiver system, the baseband signal might be filtered for bandwidth limiting or for another kind of necessary shaping that needs to be applied. Normally, a filter in the transmitter (Ft) and a filter in the receiver (Fr) are applied.

The Measurement Filter setting in the analyzer corresponds to the baseband filter in the receiver (Fr): This setting tells the analyzer what filter your receiver uses. When the analyzer is set to the same filter used by the receiver, the analyzer sees the signal as your receiver would. The Measurement Filter setting should be the same as the filter used in the receiver under normal operation (as opposed to testing).

The Reference Filter setting in the analyzer corresponds to the baseband filter in the transmitter-receiver combination (Fr * Ft). The baseband filter for the transmitter-receiver combination is often referred to as the *System Filter*. This filter is called the reference filter because it is used to recreate a reference signal that is compared to the received signal. This recreated reference signal is the *ideal signal* with Fr * Ft applied; differences between this *ideal signal* and the received signal enables the determination of signal quality, such as modulation fidelity measurements.

Filter Parameter (C4FM only)

The filter parameter specifies the alpha for the Raised Cosine filter when selected as the Reference filter. Some filter types have a fixed parameter value that is specified by industry standard, while other filter types by definition have no filter parameter. For filter types with no filter parameter, there is no filter parameter control present in the control panel. The recommended Reference filter for C4FM is Raised Cosine and the corresponding filter parameter for C4FM is 0.2.

Analysis Params Tab - P25

The Analysis Params tab contains parameters that control the analysis of the input signal.

Modulation Params	Analy	sis Params	Analysis	Time	Test Patt	erns Pr	refs Trig	Meas			
Frequency Er	ror:	-223.0 uH	z	🔽 Ai	uto		PTX:	30.00	dBm]	
Measurement	BW:	153.6 kHz	•	Auto)	•					

Settings	Description
Frequency Error	When the Auto box is checked, the analysis determines the Frequency Error and the measured Frequency Error is displayed. When the Auto box is unchecked, the entered value is used by the analysis as a fixed frequency offset. This is useful when the exact frequency offset of the signal is known.
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made. Select Manual, Auto, or Link to Span.
РТХ	Specifies the RF Output Power as recommended for transmitters. This is only used in the computation of off slot power in HCPM modulated signals.

Analysis Time Tab - P25

The Analysis Time tab contains parameters that define how the signal is analyzed in the P25 Analysis displays.

Modulation Params	Analysis Params	Analysis Time	Test Patterns P	Prefs Trig	Meas
Analysis Offset:	-204.800 us	🔽 Auto	Time Zero R	Reference:	Trigger 💌
Analysis Length:	94.000 ms	🗖 Auto		Units:	Seconds 🔹
Available:	31.816 ms				

Settings	Description
Analysis Offset	Specifies the location of the first time sample to use in measurements.
Auto	When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.
Analysis Length	Specifies the length of the analysis period to use in measurements. Length is specified in either symbols or seconds, depending on the Units setting.
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.
Actual	This is a displayed value, not a setting. It is the Analysis Length (time or symbols) being used by the analyzer, this value may not match the Analysis Length requested (in manual mode).
Time Zero Reference	Specifies the zero point for the analysis time.
Units	Specifies the units of the Analysis Length to either Symbols or Seconds.

Analysis Offset

Use analysis offset to specify where measurements begin. Be aware that you cannot set the Analysis Offset outside the range of time covered by the current acquisition data. (all time values are relative to the Time Zero Reference).

You can set the Analysis Length so that the requested analysis period falls partly or entirely outside the current range of acquisition data settings. When the next acquisition is taken, its Acquisition Length will be increased to cover the new Analysis Length, as long as the Sampling controls are set to Auto. If the Sampling parameters are set to manual, or if the instrument is analyzing saved data, the actual analysis length will be constrained by the available data length, but in most cases, measurements are able to be made anyway. The instrument will display a notification when measurement results are computed from less data than requested. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed. As you adjust this value, the actual amount of time for Analysis Length, in Symbol or Seconds units, is shown below the control in the "Actual" readout. This setting is not available when Auto is checked. Range: minimum value depends on modulation type. Resolution: 1 symbol.

Time Zero Reference

All time values are measured from this point (such as marker position or horizontal position (in Y vs Time displays). Choices are: Acquisition Start or Trigger. When a trigger measurement is chosen from the Trig Meas tab of the Settings control panel, Time Zero Reference is forced to Trigger.

Parameter	Description
Acquisition Start	Time zero starts from the point at which acquisition begins.
Trigger	Time zero starts from the trigger point.

Test Patterns Tab - P25

Test patterns allow the software to compare the measurement result to the standards limit. The list of available test patterns varies depending on which standard and modulation type is selected.

Modulation Params	Analysis Params A	nalysis Time	Test Patterns	Trace	Scale	Prefs
Test Patterns:	Low Deviation Te	est Pattern		•	1	
	Standard Transm Outbound Stand				Ì	
	Low Deviation Te					
	High Deviation Te Other	est Pattern				

Settings	Description
Test Patterns	Use this drop-down list to select an appropriate test pattern. The list varies depending on which standard and modulation type is selected.

You can read more about test patterns here (see page 270).

Trace Tab - P25

The Trace tab allows you to set the trace display characteristics of the P25 trace display. The selections vary depending on the selected display.

The following image shows the tab for the Constellation and Eye Diagram displays. For the other trace displays, the Trace Type setting is not available.

Modulation Params	Analysis Params	Analysis	Time	Test Pa	tterns	Trace	Prefs	Trig Meas	
Trace:	Trace1	•	<mark>▼ S</mark>	how	Fre	eze			
Points/Symbol:	4	•	Trace	e Type:	Freq I	Dev	•		
Content:	Vectors	•							

Setting	Description					
Trace	Select the trace to display.					
(P25 Constellation and P25 Eye Diagram displays only)	P25 Constellation display only: Select the trace that is hidden or displayed based on whether or not Show is selected.					
Show	Specifies whether the trace selected by Trace is displayed or hidden.					
(P25 Constellation and P25 Eye Diagram displays only)						
Freeze	Halts updates to the trace selected by the Trace setting. Present for the Constellation					
(P25 Constellation display only)	display only.					
Points/Symbol	Select how many points to use between symbols when connecting the dots. Values: 1, 2, 4, 8.					
Content	Select whether to display the trace as vectors (points connected by lines), points					
(P25 Constellation and P25 Freq Dev & Time displays only)	(symbols only without lines), or lines (lines drawn between symbols, but no symbols a displayed). The choices available depend on the display.					
Trace Type	Select to specify whether the plots in the Constellation and Eye Diagram displays are					
(P25 Constellation and P25 Eye Digram displays only)	shown as I vs Q or as Frequency Deviation.					

Scale Tab - P25

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings such as Measurement Frequency. There are three versions of the Scale tab for P25 displays.

 Modulation Params
 Analysis Params
 Analysis Time
 Test Patterns
 Trace
 Scale
 Prefs
 Trig Meas

 Vertical
 Horizontal
 Scale:
 20.0 Hz
 Scale:
 4 Symbol

 Position:
 0.000 Hz
 Position:
 0 Symbol
 Autoscale

Scale tab for the P25 Eye Diagram display

Modulation P	arams	Analysis Params	Analysis Time	Test Patterns	Scale	Prefs	Trig Meas
Vertical				- Horizontal I	Full Burst	t	
Scale:	100.0	0 dB		Scale:	94.000	ms	
Position:	0.00	dBm	Reset	Position:	-40.96	0 us	
		Autoscale			A	utoscale	

Scale tab for the P25 Power vs Time display

Modulation P	arams	Analysis Params	Analysis Time	Test Patterns	Trace	Scale	Prefs Trig Meas
Vertical					H	orizontal	
Scale:	20.0	Hz				Scale:	94.000 ms
Position:	0.000	Hz			F	Position:	-51.200 us
	-	Autoscale				🖊 Auto	Autoscale

Scale tab for the P25 Freq Dev vs Time display

Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale of the graph.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the span of the trace display and position of the trace.
Horizontal Full Burst	
Scale	Allows you to, in effect, change the span.
Position	Allows you to pan a zoomed trace without changing the Measurement Frequency.
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.
Auto	When Auto is checked, the scale and position values for the Symbols graph are automatically adjusted to maintain the optimal display.
Reset	Resets the vertical and horizontal settings.

NOTE. The Units used for the horizontal scale can be either Seconds or Symbols. To set the units for the horizontal scale, display the Analysis Time tab. On the tab, select the appropriate units from the Units drop-down list.

Trig MeasTab - P25

The Trig Meas tab enables you to chose a trigger measurement. The available measurements in the drop-down menu depend on the standard and modulation type selected in the Modulation Params tab. The Trig Meas tab is not available for Phase 2 HDQPSK (Outbound) signals. You can read more about P25 trigger related measurements here (see page 265).

The following image shows the tab for Phase 1 (C4FM) signals.

Modulation Params	Analysis Params	Analysis Time	Test Patterns	Trace	Scale	Prefs	Trig Meas	
							4	
Trigger Measuren	ments: None							-
	None							÷.
	Phase1 -	Tx Power and I	Encoder Attack	Time				11
			Encoder Attack	Time wi	th Busy	/Idle Op	perations	
		Tx Throughtpu						
	Phase1 -	Transient Frequ	ency Behavior					11

The following image shows the tab for Phase 1 (HCPM Inbound) signals.

ent))))

Settings	Description
Trigger Measurements	Select the trigger measurement test.

Prefs Tab - P25

The Prefs tab enables you to change appearance characteristics of the P25 Analysis displays. Not all settings on the Prefs tab shown below appear for every P25 display. The Summary display does not have a Prefs tab.

Modulation Params	Analysis Params	Analysis Time	Test Patterns	Trace	Scale	Prefs	Trig Meas	
		Rad	ix: Binary	•]			
					,			
Show grati	icule	V 9	Show Marker rea	dout in	graph (selected	d marker)	

Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Radix	Specifies how symbols are displayed in the Symbol Table display and in the Marker readout in the display. There are three choices for Radix: Binary (00,01,10,11), Quaternary (0,1,2,3), and Modulation Symbols (+1,+3,-1,-3).

Limits Tab - P25

The Limits tab is only available for the P25 Summary display. It enables you to load an existing limits table, save a limits table, or edit limits values.

25 Summary	Iodulation F	Params Analysis Params Analysis T	ime Trig Meas	Test Patt	erns Limits
	On	Measurement Name	Limit	*	
		ModulationFidelity	4.000	=	
		FrequencyAccuracy	1.500	-	Load
		SymbolRateAccuracy	10.00		
		RFOutputPower	3.0000		
		FrequencyDeviationPosPeakUp	3111.0000		Save
Standard Presets		FrequencyDeviationPosPeakLow	2544.0000	-	

Setting	Description	
Load	Click to load a saved Limits table from a .csv file.	
Save	Click to save the current Limits table to a .csv file.	

Edit Limits

To directly edit measurement limits in the table, click on the value in the Limit column that you want to change.

The following table describes the parameters that are set in the Limits Table.

Limits Table Settings

Setting	Description	
On	Click on the cell in the On column next to the measurement to specify whether ofrnot measurements are selected for limit comparison to indicate Pass or Fail A check mark means the measurement will be taken. An empty box means it will not be taken.	
Measurement Name Specifies the name of the measurement related to the limit. (Not editable.		
Limit	Specifies the value of the limit to the related measurement. When the cell is selected, the value is shown along with the units.	

LTE Analysis

Overview

The Long Term Evolution (LTE) Downlink RF Measurements Analysis option allows you to evaluate RF signals to ensure that they meet 3GPP measurements. These are described in the TS 36.104 Base Station (BS) radio transmission and reception and test specifications TS36.141 Base Station (BS) conformance testing documents version 12.5. This analysis option supports both LTE TDD and LTE FDD frame structures. This analysis option supports the following measurements.

- Channel Power
- Occupied Bandwidth
- Adjacent Channel Leakage Ratio (ACLR)
- Spectral Emission Mask (Operating Band Unwanted Emission)
- Cell ID
- For TDD LTE Transmitter Off Power

These measurements are also compared with the limits provided by the standard to give pass/fail results (except for Channel Power and OBW).

More detailed information about these measurements is available in the <u>LTE measurements</u> section and the supported measurements <u>table</u>.

You can also select these measurements from four LTE preset test setups. The test setups load pre-configured displays and control setting as suggested by the standard to accelerate the test setup of the analyzer. The following four test setups are available for this analysis option.

- Cell ID
- ACLR
- Channel Power and TDD Toff Power
- SEM

More detailed information about these test setups is available here.

With the LTE downlink RF Measurement Analysis test suite, test engineers can simplify the execution of a number of transmitter tests while still enabled to modify signal parameters for in-depth signal analysis. The analysis results give multiple views of LTE signal characteristics to allow the diagnosis of signal imperfections and impairments quickly and easily. Display controls allow you to selectively display the analysis results to help locate trouble spots in the signal.

LTE topics in this Help

The following information about the LTE Analysis option is available:

- Reference table of supported LTE measurements
- LTE measurements
- LTE Standards preset test setups
- LTE displays
- LTE measurement control settings

Supported LTE measurements

The following table gives a brief description of the available LTE measurements. More detailed information can be found here. <u>LTE measurements</u>

LTE measurement	LTE standard(s)	Description
Cell ID detection	TDD	The Cell ID is detected from the input LTE
	FDD	signal.
Adjacent Channel Leakage Ratio (ACLR)	TDD FDD	The Adjacent Channel integrated power is calculated and shown. The relative power compared to the reference signal is also computed. The computed power is compared against limits suggested by the selected standard and pass/fail is reported. The appropriate settings for this measurement are loaded with the ACLR test setup (Presets>Standards>LTE).
Channel Power	TDD FDD	The channel power is calculated in the channel bandwidth.
Occupied Bandwidth	TDD FDD	The Occupied bandwidth is calculated as bandwidth containing 99% of the total integrated power in the selected span around the selected center frequency.
Operating Band Unwanted Emission	TDD FDD	The power in the offset regions is calculated and presented and compared against limits set in the offset and limits table and pass/fail is reported. The appropriate settings for this measurement are loaded with the SEM test setup (Presets>Standards>LTE).
T _{off}	TDD	The power in off-slot region is computed and compared against selected limits.

LTE Standards preset test setups

Presets > **Standards**

The LTE Standards preset allows you to access displays preconfigured for the test setup you select. The test setups load the displays and control setting options suggested by the LTE standard to perform the measurements. You can read more about how Presets work <u>here</u>.

There are four test setups for LTE:

Cell	ID

Kandards Presets	×
Preset: LTE	▼
Preset displays:	
<u>, </u>	
Spectrum Time Overv	riew LTE Constellation
Test Setup:	Cell ID 🔹
Frame Structure:	Downlink FDD 🔻
Channel Bandwidth:	1.4 MHz •
Retain current Center Fre	equency setting
Retain current Ref Level	setting
To go directly to a preset in the	e future, use Presets->Preset Options->Presets->Preset action
	OK Cancel

ACLR

Standards Presets	X
Preset: LTE	-
Preset displays:	
Test Setup:	ACLR
Frame Structure:	Downlink TDD 👻
Channel Bandwidth:	5 MHz 👻
Base Station Category:	Wide Area Cat A 🗸
Adjacent Channel Type:	UTRA 🔹
UTRA Chiprate:	3.84 Mcps 👻
📃 Retain current Center Fre	quency setting
Retain current Ref Level s	etting
To go directly to a preset in the	e future, use Presets->Preset Options->Presets->Preset action
	OK Cancel

Channel Power an	d TDD Toff Power
Kandards Presets	
Preset: LTE Preset displays:	▼
Time Overview LTE Cha Spectr	
Test Setup:	Channel Power & TDD Toff Power 🔻
Frame Structure:	Downlink TDD
Channel Bandwidth:	5 MHz 👻
Retain current Center	Frequency setting
Retain current Ref Leve	el setting
To go directly to a preset in	the future, use Presets->Preset Options->Presets->Preset action
	OK Cancel

SEM

M Standards Presets	
Preset:	
Preset displays:	
sem	
Test Setup:	SEM 🔹
Frame Structure:	Downlink FDD 🔹
Channel Bandwidth:	5 MHz 🔹
Base Station Category:	Wide Area Cat A Wide Area Cat B - Option 1 Home Area (2dBm <= P <= 20dBm) Local Area
Retain current Center Fre	(Medium Area (P <= 31dBm)
Retain current Ref Level	setting
To go directly to a preset in the	future, use Presets->Preset Options->Presets->Preset action
	OK Cancel

The following table shows what automatically loads with each test setup.

Table 5: LTE preset test setups

Test setup		Displays loaded with preset
Cell ID	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.) Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz	Spectrum, Time Overview, LTE Constellation
	(Default is 1.4 MHz.)	
ACLR	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.) Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz	LTE ACLR
	(Default is 1.4 MHz.)	
	Base station category: - Wide Area Cat A - Wide Area Cat B — Option 1 - Home Area (P-rated ≤ 20 dBm) - Local Area (P-rated ≤ 24 dBm)) - Medium Area (P-rated ≤ 38 dBm))	
	(Default is Wide Area Cat A.)	
	Adjacent channel type: - UTRA - E-UTRA	
	(Default is UTRA.)	
	UTRA chip rate. 1.28 Mcps 3.84 Mcps 7.68 Mcps	
	Chip rate is only displayed under the following conditions: TDD is frame structure Adjacent channel type selected is UTRA Channel bandwidth is >3 MHz	
	(Default chip rate is 3.84 Mpcs.)	
Channel Power and TDD Toff Power	Frame structure: - Downlink FDD - Downlink TDD	Time Overview (TDD only), LTE Channel Spectrum, LTE Power vs Time (TDD only)
	(Default is Downlink FDD.)	
	Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz (Default is 1.4 MHz.)	

Test setup		Displays loaded with preset
SEM	Frame structure: - Downlink FDD - Downlink TDD	SEM
	(Default is Downlink FDD.)	
	Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz	
	(Default is 1.4 MHz.)	
	Base station category: - Wide Area Cat A - Wide Area Cat B — Option 1 - Home Area (2 dBm ≤ P ≤ 20 dBm) - Local Area - Medium Area (P ≤ 31 dBm)	
	(Default is Wide Area Cat A.)	

Table 5: LTE preset test setups (cont.)

Retain current center frequency and reference level settings

The **Retain current Center Frequency setting** appears when the LTE Standards Preset is chosen. This setting allows you to retain the previously used center frequency. By default, the Center Frequency setting box is unchecked and the LTE preset displays will load with 1.96 GHz for FDD and 1.9 GHz for TDD.

The **Retain current Ref Level setting** appears when the LTE Standards Preset is chosen. This setting allows you to retain the previously used reference level. By default, the Ref Level setting box is checked.

To activate these settings, check the box next to the desired setting. The following image shows the **Retain current Ref Level setting** box checked.

M Standards Presets				
Preset:				
Preset displays:	¥			
<u>Λ</u> ιωι				
Spectrum Time Overvi	ew LTE Constellation			
Test Setup:	Cell ID 👻			
Frame Structure:	Downlink FDD 🔹			
Channel Bandwidth:	1.4 MHz •			
Retain current Center Frequency setting				
Retain current Ref Level setting				
To go directly to a preset in the future, use Presets->Preset Options->Presets->Preset action				
	OK Cancel			

LTE displays

The displays in LTE Analysis (Setup > Displays > Measurements: LTE Analysis) are:

- LTE Channel Spectrum
- LTE ACLR
- LTE Constellation
- LTE Power vs Time
- SEM (This display is not an LTE specific display, but is available when RF Measurements is selected from the Select Displays dialog (Setup > Displays) (see the following image).)

Select Displays Choose any combination bel	bw, or use an Application Preset. Application Presets
Measurements:	Available displays:
General Signal Viewing Analog Modulation RF Measurements LTE Analysis Selected displays:	CCDF Chan Pwr and ACPR MCPR Decupied Bandwidth
	Add
	Remove
	OK Cancel

LTE measurements

LTE Analysis enables RF measurements and detection of Cell ID in the transmitted signal for both TDD and FDD frame structure LTE signals. For TDD signals, the analysis will also do the T_{OFF} measurement. The following topics contain important information you should know about specific LTE measurements. You can view a table with all of the available measurements here.

Channel Power and Occupied Bandwidth (TDD and FDD)

The Channel Power measurement is done by calculating the power in the LTE signal based on the selected channel bandwidth option. The Occupied Bandwidth measurement calculates the frequency range over which 99% of the power is contained in the acquired signal. This measurement is done for the selected channel bandwidth option.

More information about this measurement:

- Select the Channel Power and TDD Toff Power test setup from Presets > Standards > LTE to perform the measurement. This will load the displays found in the LTE preset test setups table.
- This test setup allows you to choose the frame structure and the channel bandwidth.
- The Channel Spectrum display will contain the results of Channel Power and Occupied Bandwidth. The result gives the power in the LTE signal (calculated over the channel bandwidth).
- Results are presented as scalar and are located below the display.
- For TDD signals, the channel power and the occupied bandwidth measurement are done on the on-slot region. If the valid on-slot region is not found, the measurement is done in the selected analysis length.

ACLR (FDD and TDD)

The Adjacent Channel specification and limits for comparison are set based on selected frame structure, adjacent channel and base station types from Standards Presets. It calculates the integrated power in the different adjacent regions and also indicates pass/fail based on comparison with absolute and relative limits in LTE ACLR display.

More information about this measurement:

- Select the ACLR test setup from Presets > Standards > LTE to perform the measurement. This will load the displays found in the LTE preset test setups table.
- This test setup allows you to select the frame structure, channel bandwidth, base station type, and adjacent channel type with the following restrictions:
 - Frame Structure can be TDD or FDD
 - Channel Bandwidth can be 1.4, 3, 5, 10, 15, or 20 MHz
 - Base station type can be Wide Area Cat A, Wide Area Cat B- Option 1, Home Area (P-rated ≤ 20 dBm), Local Area (P-rated ≤ 24 dBm), Medium Area (P-rated ≤ 38 dBm)
 - Adjacent Channel type can E-UTRA or UTRA
 - UTRA chip rate can be 1.28, 3.84, or 7.68 Mcps

Default rate is 3.84 Mcps for all UTRA adjacent channels of FDD and when channel bandwidth is 1.4 or 3 MHz.

However, you can choose other rates when the frame structure is TDD and when the bandwidth is more than 3 MHz. Otherwise, the standard recommends use of 3.84 Mcps.

- Based on the settings you select from Standards Preset, the offset and bandwidth of the adjacent channels are set in the Offset and Limits tab of the control panel. The settings are different for paired and unpaired spectrum.
- The settings also include the absolute power limit for comparison based on the base station type. The standard recommends the settings in dBm/MHz for each base station type. The power limits are appropriately scaled with the integration bandwidth and presented in dBm in the Offset and Limits table of the display. The integrated power in each adjacent band is compared with the absolute and relative limits as recommended by the standard. The absolute limits are dependent on this choice of

base station type because they apply to different power levels (as the P-rated levels in the drop down menu indicate). The relative limit is also set.

- The results are presented in both tabular and display format. In the tabular display, the reference channel power and the offset, bandwidth, integrated power, and relative power of the adjacent channels are presented. An expanded view format is also available.
- The integrated power in the display is shaded blue in each adjacent channel region.
- Each adjacent channel is clearly shown. Interadjacent channel gaps are shown in gray.
- The limit lines are shown in different colors. Based on the Mask option chosen in the Offset & Limits table, failures in the different bands are shown in red on violation. By default for LTE Standards Presets, the Mask option is Abs & Rel, so the failure is shown only when the calculated power violates both relative and absolute power limits.
- The respective rows that violate both absolute and relative limits are also shown in red. Pass/fail information appears in the top left corner of the display.
- This measurement can be performed in Real Time or Non-Real Time mode. In Real Time mode, a single acquisition required for the entire span needed for this measurement is taken and the measurement is done. In the Non-Real Time mode, a separate acquisition for each adjacent channel region is taken and analyzed.

Non-real time mode is also useful when the bandwidth offered by the instrument does not support the span requirement for this measurement. The span requirement comes from the choice of adjacent channel type and channel bandwidth. In such cases, Non-Real Time mode can be used.

- For UTRA adjacent channels, filtering of the adjacent channels with an RRC filter of the same bandwidth is employed, as suggested by the standard. The chip rate is set to 3.84 Mcps for FDD and when the channel bandwidth is 1.4 or 3 MHz. For TDD, when the channel bandwidth is more than 3 MHz, you can choose the UTRA chip rate from the ACLR test setup (Presets > Standards > LTE). The options are 1.28, 3.84, and 7.68 Mcps.
- The standard recommends this measurement be done on the transmitter ON period when the signal being analyzed is TDD. An on slot detection module in the analysis helps you to do the measurement in the transmitter ON period.
 - If you are doing the measurement in Real Time, you can also load the Time Overview display, which will indicate to you the region in which the measurement is done (a purple line at the bottom). You can see the measurement is done only on the valid transmitter ON period. However, when a bursty data is not available, the measurement is done on the available analysis length.

NOTE. Real-Time mode can be set from the <u>Parameters tab</u> of the Settings control panel of the LTE ACLR display. Disabling Real-Time mode is the non-Real-Time setting.

When the measurement is done in non-Real Time mode, separate acquisitions are obtained for each adjacent channel band. In such cases, it cannot be ensured that all the adjacent channel acquisitions are done on the transmitter ON period. It is recommended that you use either Real time mode or an external trigger from the source (when used with non-Real-Time mode) to do the measurement. An external trigger from the source can ensure that all the acquisitions are done just after the rising edge of the burst. A status message in the display indicates when to use Real-Time mode or external trigger for TDD signals. The status message that is displayed in the LTE ACLR display is "Signal must be triggered or measurement in Real-Time". This message is displayed when TDD is chosen from Standard Presets, when Real-Time is not enabled from the Parameters tab of the control panel, and when the instrument is in Free Run mode.

Operating Band Unwanted Emission (FDD and TDD)

This measurement finds the power in the offset regions recommended by the standard. The offset channel specification and limits for comparison are set based on the selected channel bandwidth, frame structure, and base station types in Standards Preset. It calculates the integrated power in the different offset regions and also indicates pass/fail information based on comparison with absolute and relative limits in the SEM display.

More information about this measurement:

- Select the SEM test setup from Presets > Standards > LTE to perform the measurement. This will load the displays found in the LTE preset test setups table.
- This test setup allows you to select the frame structure, channel bandwidth, and base station type with the following restrictions:
 - Frame Structure can be TDD or FDD
 - Channel Bandwidth can be 1.4, 3, 5, 10, 15, or 20 MHz
 - Base station type can be Wide Area Cat A, Wide Area Cat B Option 1, Home Area ($2 \text{ dBm} \le P \le 20 \text{ dBm}$), Local Area, Medium Area ($P \le 31 \text{ dBm}$)
- Based on the settings chosen by the user from Standards Presets the offset and bandwidth of the offset channels are set in the Offset and Limits tab of the control panel of SEM display.
- The settings also include the absolute power limit for comparison based on the base station type. The standard recommends the settings in dBm/MHz for each base station type. The power limits are appropriately scaled with the integration bandwidth and presented in dBm in the Offset and Limits table of the display. The integrated power in each adjacent band is compared with the absolute and relative limits as suggested by the standard. The absolute limits are dependent on this choice of base station type as they apply to different power levels (as the P-rated levels in the drop down menu indicate). The relative limit is also set.
- The results are presented both in tabular and display form.
- The Pass/ Fail information is also shown in the top left corner of the display.
- For TDD signals, a detection module in the analysis helps you to do the measurement in the transmitter ON period.
 - If you are doing the measurement in Real Time, you can also load the Time Overview display, which will indicate to you the region in which the measurement is done (a purple line at the bottom). You can see the measurement is done only on the valid transmitter ON period. However, when a bursty data is not available, the measurement is done on the available analysis length.

NOTE. Real-Time mode can be set from the <u>Parameters tab</u> of the Settings control panel of the SEM display. Disabling Real-Time mode is the non-Real-Time setting.

When the measurement is done in non-Real Time mode, separate acquisitions are obtained for each adjacent channel band. In such cases, it cannot be ensured that all the adjacent channel acquisitions are done on the transmitter ON period. It is recommended that you use either Real-Time mode or an external trigger from the source (when used with non-Real Time mode) to do the measurement. An external trigger from the source can ensure that all the acquisitions are done just after the rising edge of the burst. A status message in the display indicates when to use Real Time mode or external trigger for TDD signals. The status message that is displayed in the LTE SEM display is "Signal must be triggered or measurement in Real-Time". This message is displayed when TDD is chosen from Standard Presets, when Real-Time is not enabled from the Parameters tab of the control panel, and when the instrument is in Free Run mode.

- Settings for all tables provided in the base station conformance testing document (3GPP TS 36.141 v12.5 for Release 12) has been incorporated from Standards Presets.
 - Wide Area and Local area settings from standard presets are provided as per the standard document.
 - Home Area base station settings loaded from standard presets correspond to Reference power levels between 2 to 20 dBm.
 - Medium Area base station settings loaded from standard presets correspond to reference power levels less than 31 dBm.
- The following settings are provided in a *.csv file that you can load. These files will be available in the installed directory (Example Files/LTE).
 - Wide Area category B Option 2 (for specific bands specified by the standard). There are three csv files based on operating band and channel bandwidth for Wide Area.
 - LTE_SEM_1.4MHz_CatB_optn2_bands_3_8.csv
 - LTE_SEM_3MHz_CatB_optn2_bands_3_8.csv
 - LTE_SEM_5to20Hz_CatB_optn2_bands_1_3_8_32_33_34.csv
 - Home Area base station for power level less than 2 dBm. There are six csv files based on operating band and channel bandwidth for Home Area.
 - LTE_SEM_1_4MHz_above3GHz_Home2P.csv
 - = LTE_SEM_1_4MHz_below3GHz_Home2P.csv
 - LTE SEM 3MHz above3GHz Home2P.csv
 - LTE_SEM_3MHz_below3GHz_Home2P.csv
 - LTE SEM 5to20MHz above3GHz Home2P.csv
 - LTE SEM 5to20MHz below3GHz Home2P.csv
 - Medium Area base station for reference power level between 31 to 38 dBm. There are six csv files based on operating band and channel bandwidth for Medium Area.
 - LTE SEM 1 4MHz above3GHz Medium31P38P.csv
 - LTE_SEM_1_4MHz_below3GHz_Medium31P38.csv
 - LTE SEM 3MHz above3GHz Medium31P38.csv
 - LTE SEM 3MHz below3GHz Medium31P38.csv
 - LTE SEM 5to20MHz above3GHz Medium31P38.csv
 - LTE_SEM_5to20MHz_below3GHz_Medium31P38.csv
 - Additional requirements given in Section 6.6.3.5.3 in 3GPP TS 36.141 v12.5 standard document. There are 14 csv files based on the requirements in the standard document. The files are named based on the table numbers of Section 6.6.3.5.3 of the standard document (3GPP TS 36.141 V12.5.0 (2014-09).

Cell ID (TDD and FDD)

The dominant Cell ID in the transmitted LTE signal is detected and presented in the Constellation display. Along with the Cell ID scalar results, the group and sector ID are also presented. The constellation of the Primary and Second Synchronization signals are presented too.

More information about this measurement:

- Select the Cell ID test setup from Presets > Standards > LTE to perform the measurement. This will load the displays found in the <u>LTE preset test setups table</u>.
- This test setup allows you to select the frame structure and channel bandwidth with the following restrictions:
 - Frame Structure can be TDD or FDD
 - Channel Bandwidth can be 1.4, 3, 5, 10, 15, or 20 MHz
- Analysis of the LTE signals is done based on the settings you choose in the Standards Presets.
- The constellation for PSS and SSS (Primary and Secondary Synchronization Signals) are shown. You can optionally select to view only the PSS or SSS constellation (selection is made in the Trace tab).
- Equalization based on PSS (Primary Synchronization Signal) data can be enabled using the "Enable Equalization" option (available in the Analysis Params tab of the Settings Control panel.) This Equalization is based on PSS data and applied on other parts of the OFDM symbol.

TOFF (TDD)

The T_{OFF} measurement is done only for the TDD signal. It is a measure of the off slot power in a LTE TDD signal.

More information about this measurement:

- Select the Channel Power and TDD TOFF Power test setup from Presets > Standards > LTE to perform the measurement. This will load the displays found in the <u>LTE preset test setups table</u>.
- This test setup allows you to select the frame structure and channel bandwidth with the following restrictions:
 - Frame Structure can be TDD or FDD
 - Channel Bandwidth can be 1.4, 3, 5, 10, 15, or 20 MHz
- Analysis of the LTE signals is done based on the settings you choose in the Standards Presets.
- By default, the T_{OFF} measurement is the average of several non-overlapping and adjoining 70 μs windows in the off slot region. This measurement is done only on the 70 μs window in the center of the off slot region, when the Average over entire offslot region option is disabled.
- The scalar result is presented in dBm/MHz.
- The result is compared against limits that can be defined using the Limits tab of the control panel. By default, these limits are set based on the Base Station conformance testing document (3GPP TS 36.141 v12.5 for Release 12). Pass/fail is shown in the top left corner of the LTE Power vs Time display.

LTE Status Messages

The following status messages may appear. Each message indicates the related condition (Description) shown in the following table.

Status message	Description		
LTE Analysis: Signal must be triggered or measured in Real Time	Shown in the display and status bar when the user attempts to make the ACLR measurement and SEM measurement for TDD signals in non-Real-Time mode and when the instrument is in free run.		
	Since the standard recommends the ACLR measurement to be done in transmitter ON periods only, either the measurement has to be done in Real-Time mode (in which a detection module ensures the measurement is done on the transmitter ON period) or has to be externally triggered if in non-Real-Time mode.		
LTE Analysis: Recovery done on PSS/SSS on the center 62 carriers	Shown in the status bar to indicate that the constellation of PSS and SSS shown in the LTE constellation is done based on analysis of PSS and SSS signals in the center 62 carriers of the corresponding OFDM symbols.		
	Therefore, you may see the correct constellation and Cell ID even when a different channel bandwidth is chosen from the control panel because the analysis for PSS and SSS is done only on the center carriers.		
LTE Analysis: Analysis Failure - Synchronization Sequence not found	Shown in the status bar to indicate that a valid Cell ID (from PSS and SSS) is not detected.		

LTE ACLR display

The LTE Adjacent Channel Leakage Ratio (ACLR) display shows the ratio of the mean power centered on the assigned channel frequency to the mean power centered on an adjacent channel frequency. In the 3GPP specification, both the main channel and adjacent channels are required to be filtered with RRC (Root Raised Cosine) filters.

To show the LTE ACLR display you can select **Presets** > **Standards** > **LTE**.

NOTE. Loading the LTE ACLR display from the **Presets** > **Standards** > **LTE** menu is recommended. This loads the control settings based on the selected options.

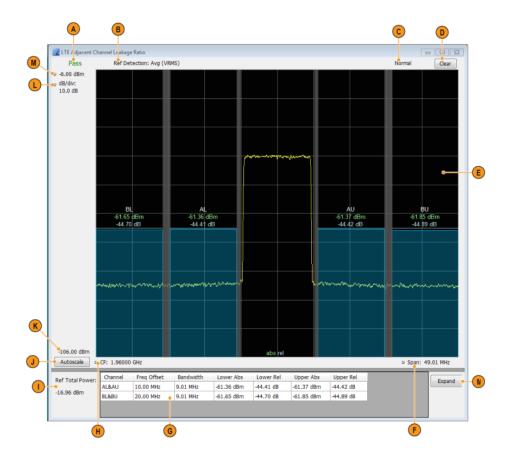
You can also load the LTE ACLR display as follows:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays window, select LTE Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the LTE ACLR icon or select the icon and click Add. The LTE ACLR icon will appear in the Selected displays box and will no longer appear under Available displays.

- 4. Click the **OK** button to show the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the LTE ACLR display.



Item	m Display element Description				
A	Pass/Fail	Indicates Pass or Fail based on Absolute and Relative limits set by the user. The failure condition is set by Mask in the Offset and Limits Table tab of the Settings control panel. By default, the mask is set to Abs & Rel, meaning failure is reported only when both absolute and relative results fail against the respective limits.			
В	Ref Detection	Set to Avg (VRMS) or +Peak based on the choice made in Processing tab of the Settings control panel.			
С	Normal	Indicates how the result is presented over multiple sweeps. This selection is made in the Processing tab of the control panel. Displays Average Count if Avg (VRMS) is checked in the Processing tab in the Settings control panel.			
D	Clear	Resets measurement. Clears all values.			
E	Plot	Shows the reference channel and adjacent channels and the regions in between them. The Absolute and Relative limit lines are also shown. The integrated power is shown as a band. Scalar results are also shown.			
F	Span	Adjust the span of the graph in symbols.			
G	Results Table	Tabulates the results in each adjacent band. Table shows the offset, bandwidth, Integrated Absolute and Relative power in the upper and lower adjacent channel regions.			
Н	CF	Center Frequency at which the measurement is performed.			
I	Ref Total Power	Gives the power in the Reference channel.			
J	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.			
K	Bottom readout	Displays the value indicated by the bottom of graph.			
L	dB / div	Shows the dB per each division in the Y axis of the plot.			
М	Top of graph	The vertical scale is normalized with appropriate power units.			
N	Expand button	Shows the results table in its own window with larger font size.			

Clicking on the **Expand** button allows you to view the results table in a separate window, as shown in the following image.

Channel	Freq Offset	Bandwidth	Lower Abs	Lower Rel	Upper Abs	Upper Rel
AL&AU	7.50 MHz	3.84 MHz	-61.53 dBm	-46.95 dB	-61.11 dBm	-46.53 dB
BL&BU	12.50 MHz	3.84 MHz	-61.53 dBm	-46.95 dB	-61.32 dBm	-46.73 dB

LTE ACLR Settings

Application Toolbar: 🕸

The LTE ACLR Settings control panel provides access to settings that control parameters of the LTE ACLR display.

Settings tab	Description			
Channels (see page 324)	Allows you to control how the measurement is performed. When in Real Time, the RBW and VBW settings apply for all channels (including offset regions) and the other parameters apply only for the reference channel. When Non-Real Time mode is selected, all information in this tab, including RBW and VBW, only applies to the reference channel.			
Parameters (see page 326)	Specifies several characteristics that control how the measurement is made. These parameters are used by the instrument to analyze the input signal.			
Processing (see page 328)	Specifies settings for detection on the reference channel and the offsets. Specifies the function setting on how calculations are done across multiple sweeps.			
Offsets & Limits Table (see page 329)	Allows you to select the characteristics of offsets and mask limits.			
Scale (see page 330)	Specifies the vertical and horizontal scale settings.			
Prefs (see page 332)	Allows you to select to show or hide the graticule, power level, limits, and marker readouts.			

LTE Channel Spectrum display

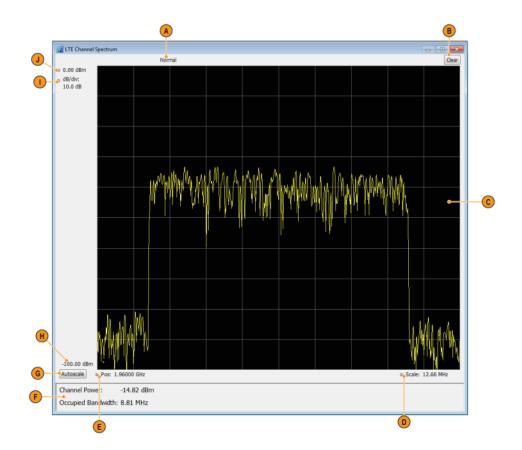
The LTE Channel Spectrum display shows the spectrum of the input signal across one channel. Channel power measures the average power within the selected bandwidth and is expressed in dBm. Other units can be selected from the Units tab of the Analysis control panel. The measured occupied bandwidth is calculated as the bandwidth containing 99% of the total integrated power within the selected span around the selected center frequency.

To show the LTE Channel Spectrum display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. From the Measurements box, select LTE Analysis.
- **3.** Double-click the LTE Channel Spectrum icon in the Available Displays box. This moves the LTE Channel Spectrum icon to the Selected displays box.
- 4. Click **OK** button to view the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the LTE Channel Spectrum display.



ltem	Display element	Description			
A	Normal	Displays Average Count if Average is turned on (set to Time Domain or Frequency Domain) from the Measurement Params tab in the Settings control panel.			
В	Clear	Resets measurement. Clears all values.			
С	Plot	Specifies the value shown at the center of the graph display.			
D	Scale	Adjust the span of the graph.			
E	Position	Displays the horizontal position of the trace on the graph display.			
F	Scalar results	Shows the Channel Power and Occupied Bandwidth measurement results.			
G	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.			
Н	Bottom readout	Displays the value indicated by the bottom of graph.			
I	dB / div	Shows the dB per each division in the Y axis of the plot.			
J	Top of graph	The vertical scale is normalized with appropriate power units.			

LTE Channel Spectrum Settings

Application Toolbar: 鄻

The settings for the LTE Channel Spectrum display are shown in the following table.

Settings tab	Description				
Freq & RBW (see page 335)	Allows you to specify the frequency and resolution bandwidth used for the measurement.				
Measurement Params (see page 336)	Allows you to set averaging (Time Domain, Off, or Frequency Domain) and to set the number value associated with the Average setting.				
Channels (see page 324)	Allows you to set the Channel BW for the Channel Power measurement.				
Scale (see page 330)	Allows you to specify the horizontal and vertical scale settings.				
Prefs (see page 332)	Allows you to select to show or hide certain display elements.				

LTE Constellation display

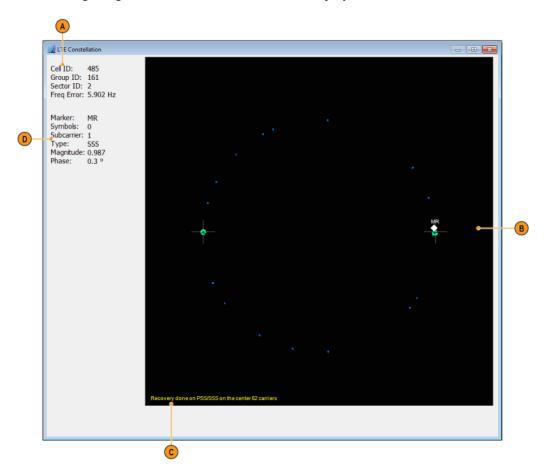
The LTE Constellation display shows the constellation of Primary (PSS) and Secondary (SSS) Synchronization Signals. Scalar results include Cell ID, Group ID, Sector ID, and frequency error.

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select LTE Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **LTE Constellation** icon or select the icon and click **Add**. The LTE Constellation icon will be added to the **Selected displays** box and will no longer appear under Available displays.

- 4. Click **OK** to show the display.
- 5. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the LTE Constellation display.



ltem	Display element	Description			
A	Scalar results Gives results of Cell ID, Group and Sector ID information Frequency error.				
В	Plot	Displays PSS and SSS (Primary and Second Synchronization Signal) constellation.			
С	Status message	Shows relevant status messages.			
		(You can read about status messages here.)			
D	Marker readout	Shows marker type, magnitude, phase and subcarrier number.			

LTE Constellation Settings

Application Toolbar: 🕮

The settings for the LTE Constellation display are shown in the following table.

Settings tab	Description				
Modulation Params (see page 337)	Specifies the frame structure and channel bandwidth.				
Analysis Params (see page 337)	Allows you to enable Equalization based on PSS (Primary Synchronization Signal).				
Analysis Time (see page 338)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for LTE Analysis displays.				
Trace (see page 339)	Allows you to set the display characteristics of the traces.				
Scale (see page 330)	Specifies the vertical and horizontal scale settings.				

LTE Power vs Time display

The LTE Power vs Time display shows the filtered power of the data and marks where the T_{OFF} measurement is done. The T_{OFF} scalar results are also shown.

You can select **Presets** > **Standards** > **LTE** to view the display.

NOTE. Loading the LTE Power vs Time display from the **Presets** > **Standards** > **LTE** menu is recommended. This loads the control settings based on the selected options.

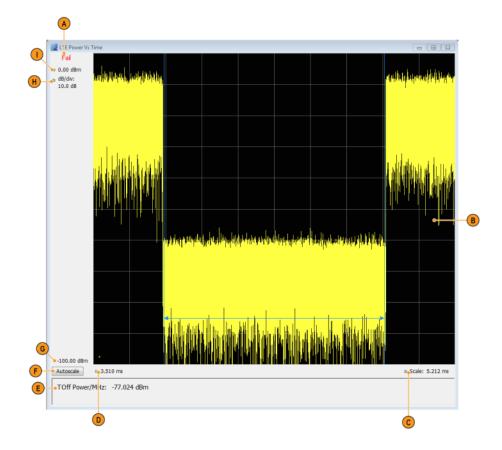
You can also load the LTE Power vs Time display as follows:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select LTE Analysis in the Measurements box.

- **3.** In the Available displays box, double-click the **LTE Power vs Time** icon or select the icon and click **Add**. The LTE Power vs Time icon will be added to the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the LTE Power vs Time display.



Item	Display element	Description			
A	Pass / Fail	Shows Pass or Fail based on whether the T_{OFF} measurement (off slot power) is below the recommended limit set in the Limit tab of the Settings control panel or not. The Pass/Fail information is displayed only when the chosen frame structure if TDD and if a valid off slot is found.			
В	Plot	Displays the filtered signal in case of TDD and the region in which the off slot power is measured is graphically shown. When the frame structure is chosen as FDD, the power in the input signal is displayed.			
С	Scale	Adjust the span of the graph in symbols.			
D	Analysis Start	Gives the start of analysis region.			
E	Toff	The T_{OFF} (off slot power) is measured and displayed here when a valid off slot is found for a TDD signal.			
F	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.			
G	Bottom readout	Displays the value indicated by the bottom of graph.			
Н	dB / div	Shows the dB per each division in the Y axis of the plot.			
I	Top of graph	The vertical scale is normalized with appropriate power units.			

LTE Power vs Time Settings

Application Toolbar: 🕸

The settings for the LTE Power vs Time display are shown in the following table.

Settings tab	Description Specifies the frame structure and channel bandwidth.				
Modulation Params (see page 337)					
Analysis Time (see page 338)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for LTE Analysis displays.				
Prefs (see page 332)	Allows you to select to show or hide the graticule and marker readouts.				
Scale (see page 330)	Specifies the vertical and horizontal scale settings.				
Limit (see page 340)	Specifies the mask limits.				

LTE Analysis Measurement Settings

Application Toolbar: 虊

The control panel tabs in this section are shared between the displays in LTE Analysis (Setup > Displays). Some tabs are shared by all the displays and some tabs are shared by only a subset of displays. The settings available on some tabs change depending on the selected display.

Settings tab	Description			
Modulation Params (see	Allows you to set the frame structure and channel bandwidth.			
page 337)	Available for these displays: LTE Power vs Time, LTE Constellation.			
Analysis Params (see page 337)	Allows you to enable Equalization based on PSS (Primary Synchronization Signal).			
Analysis Time (see page 338)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for LTE Analysis displays.			
	Available for these displays: LTE Power vs Time, LTE Constellation.			
Trace (see page 339)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.			
	Available for the LTE Constellation display only.			
Prefs (see page 332)	Allows preferences with Radix display and marker readouts.			
	Available for these displays: LTE Power vs Time, LTE ACLR, LTE Channel Spectrum, SEM.			
Scale (see page 330)	Defines the vertical and horizontal axes.			
	Available for all LTE displays.			
Offsets & Limits Table (see page 329)	NOTE. Available for the LTE ACLR display only.			
Freq & RBW (see page 335)	Specifies the frequency and resolution bandwidth used for the measurement.			
	NOTE. Available for the LTE Channel Spectrum display only.			
Parameters (see page 326)	Specifies several characteristics that control how the measurement is made.			
Processing (see page 328)	Specifies settings for detection on the reference channel and the offsets. Specifies the function setting on how calculations are done across multiple sweeps.			
Limit (see page 340)	Allows you to define limits for pass/fail comparison with calculated values. The default values are as recommended in the test specification.			
Channels (see page 324)	Specifies the Channel BW for the Channel Power measurement. Allows you to set RBW, VBW, power reference, as well.			
	Available for these displays: LTE ACLR, LTE Channel Spectrum.			
Measurement Params (see page 336)	Allows you to set averaging (Time Domain, Off, or Frequency Domain) and to set the number value associated with the Average setting.			

Controls for LTE Analysis displays

Channels tab - LTE

The Channels tab allows you to control how the measurement is performed.

The following image shows the Channels tab for the LTE ACLR display. When in Real Time, the RBW and VBW settings apply for all channels (including offset regions) and the other parameters such as Power Reference, Channel Width, and Integrated bandwidth apply only to the reference channel. When Non-Real Time mode is selected, all information in this tab, including RBW and VBW, only applies to the reference channel.

LTE ACLR	Channels	Parameters	Processing	Offsets & Limits Table	Scale	Prefs	
settings	Reference						
	Power	Reference:	0.00 dBm	Auto	V Auto		
	Cha	innel width:	1.400 MHz	RB	V: 51	.000 kHz	
Standard Presets	Inte	gration BW:	1.095 MHz	VB)	N:		

Settings	Description
Reference	
Power Reference	The value used to calculate relative measurements. When Auto is selected, the calculated reference channel power is displayed. When Auto is unchecked, you can enter a value for the reference power, and the measured reference power is not used or displayed.
Channel Width	Specifies the width of the reference channel.
Integration BW	Specifies the integration bandwidth used to compute the total power in the reference channel.
All Channels (displayed for Re	al-Time mode)
Reference Channel (displayed	for Non-Real Time mode)
RBW	Sets the RBW
VBW	Enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers. When the check box next to VBW is not checked, the VBW filter is not applied.
	The maximum VBW value is the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.

The following image shows the Channels tab for the LTE Channel Spectrum display. This tab allows you to set the channel bandwidth, which in turn sets the span for LTE Channel Spectrum.

LTE Channel Spectrum Settings	Freq & RBW	Measurement	Params	Channels	Scale	Prefs
	Chanr	nel Bandwidth:	5 MHz		•	
Standard Presets						

Settings	Description
Channel Bandwidth	Specifies the Channel Bandwidth, which in turn sets the span of the LTE Channel Spectrum.

Parameters tab - LTE

The Parameters tab enables you to specify several parameters that control the LTE ACLR measurements are made.

LTE ACLR settings	Channels Parameters Pro	ocessing Offsets & Limits Table	Scale Prefs		
	Meas Freq: 1.00000	GHz	Filter shape:	Gaussian	•
	Step: 2.0000 M	MHz 🔽 Auto			
	Real-Time				
Standard Presets	Measure Noise Floor	Apply noise correction			

Setting	Description
Meas Freq	Specify the frequency of the signal to be measured.
Step	Sets the increment size when changing the Frequency using the knob or mouse wheel. Auto: When Auto is enabled, the step size is adjusted automatically based on the span setting.
Real-Time	When Real-Time mode is enabled, the entire LTE ACLR span is measured using a real-time/contiguous acquisition. Not all described parameters are available in Real-Time mode.
	When Real-Time is disabled (non-Real-Time mode), a separate acquisition for each region is taken and analyzed. Non-Real-Time mode is also useful when the bandwidth offered by the instrument does not support the span requirement for this measurement. The span requirement is guided by the choice of adjacent channel type and channel bandwidth selected in LTE Standards Presets.
Measure Noise Floor	Takes preliminary acquisitions to measures the instrument noise floor. This initiates a noise correction. A noise correction signal is created by switching off the RF input and performing acquisitions of the instrument's internal noise. Fifty acquisitions are averaged to create the noise reference signal. The noise reference signal is measured for the Reference channel and each Offset is defined by the measurement settings.
Apply noise correction	This item is enabled and the check box automatically checked after the noise reference signal is taken when the Measure Noise floor button is clicked. This initiates noise reference subtraction from the incoming signal power for each region to create the corrected result. All calculations are performed in Watts and then converted to the desired units. The amount of noise correction is limited to 20 dB to avoid the possibility of a negative
	power measurement. This is a rare condition that could occur if the subtraction of the reference power from the channel power results in a negative value (or "infinite" dBm). The noise reference for a region is subtracted from each trace point in the channel, rather than offsetting the entire region by a single amount. This produces a smooth trace with no discontinuities at the region edges.
	NOTE. If any relevant settings (such as reference level, frequency, span, RBW) are changed once the noise reference is measured, the following warning message will be displayed to notify you that Noise Correction was not applied: Noise correction not applied - select Measure Noise Floor for new noise correction.
Filter shape	Specifies the shape of the filter determined by the window that is applied to the data record, in the spectrum analysis, to reduce spectral leakage. 3GPP specifies a Gaussian window shape be applied to the reference channel measurements.
	Gaussian : This filter shape provides optimal localization in the frequency domain. Rectangular : This filter shape provides the best frequency, worst magnitude resolution. This is essentially the same as no window.

Processing tab - LTE

The Processing tab controls the detection settings for the Reference Channel and Offsets, as well as selecting the function for the LTE ACLR display.

LTE ACLR settings	Channels Parameters Processing Offsets & Lim	its Table Scale Prefs
occargo	Detection (in each sweep) Ref Channel: Avg (VRMS)	Function (across multiple sweeps)
		Normal
	Offsets: Avg (VRMS)	
Standard Presets	Processing settings affect	all LTE ACLR numeric and trace results.

Setting	Description
Detection (in each sweep)	
Reference Channel	Specifies the Detection method used for the Reference Channel. Detection is used to produce the desired measurement result (peak or average) and to reduce the results of a measurement to the desired number of trace points.
Avg (VRMS)	For each sweep, each point of the trace is the result of determining the RMS voltage value for the last 'n counts' of the collected traces for the same point. When 'n count' has not been reached, partial averaging results are displayed.
+Peak	Selects the +Peak detection method. With this method, the highest value is selected from the results to be compressed into a trace point.
Offsets	Specifies the detection method used for the offsets.
Avg (VRMS)	Selects the Average Vrms detection method. With this method, each point on the trace in each offset is the result of determining the RMS Voltage value for all of the results values it includes.
+Peak	Selects the +Peak detection method. With this method, the highest value is selected from the results to be compressed into a trace point.
Function (across multiple s	weeps)
Normal	When a new trace has been computed, it replaces the previous trace.
Max Hold	With each sweep, each trace point in the new trace is compared to the point's value in the old trace and the greater value is retained for display and subsequent comparisons.
Avg (VRMS)	For each sweep, each point on the trace is the result of determining the RMS Voltage value for all of the collected traces' values for the same point.
Count	Enter the Avg (VRMS) value. Displayed only when Avg (VRMS) is selected.

Offsets and Limits Table tab - LTE

The Offsets and Limits Table tab is used to specify parameters that define Offsets and masks for the LTE ACLR display. The following images show the tab and expanded view of the tab, respectively.

The following image shows the Offsets and Limits Table tab when Real-Time is selected in the Parameters tab.

LTE ACLR settings	Cha	innels	Pa	rameters Proce	ssing Offsets (& Limits Ta	ble Scale Pre	efs						
secongs	Γ		On	Freq Offset (Hz)	Bandwidth (Hz)	Side	Mask	Abs Limit (dBm)	Rel Limit (dB)		ľ	E	xpand	
		А		1.400M	1.095M	Both	AbsAndRel	-12.61	-44.2				Reset	
		в	√	2.800M	1.095M	Both	AbsAndRel	-12.61	-44.2		E		ayout	
		С		4.200M	1.095M	Both	AbsAndRel	-12.61	-44.2				oad	
		D		5.600M	1.095M	Both	AbsAndRel	-12.61	-44.2					
Standard Presets		Е		7.000M	1.095M	Both	AbsAndRel	-12.61	-44.2	_		S	ave	

The following image shows the Offsets and Limits Table tab when Real-Time is not selected in the Parameters tab (referred to as non-Real-Time mode).

			On	Start (Hz)	Stop (Hz)	Side	Mask	Abs Start (dBm)	Abs Stop (dBm)	Abs Same	Rel Start (dB)	Rel Stop (dB)	Rel Same	4	Expand
		A	\checkmark	50.000000k	1.450000M	Both	Abs	0.50	-9.50		0.000	0.000	1		Reset
		в	1	1.450000M	2.850000M	Both	Abs	-9.50	-9.50	1	0.000	0.000	1	Ξ	layout
		с	V	2.850000M	15.000000M	Both	Abs	-13.00	-13.00	√.	0.000	0.000	1		Load
		D		2.850000M	15.000000M	Both	Abs	-13.00	-13.00	V	0.000	0.000	V	ы.	L040
ndard	L	Ε		2.850000M	15.00000M	Both	Abs	-13.00	-13.00	V	0.000	0.000	V	*	Save

The following image shows the expanded view of the Offsets and Limits Table (click the **Expand** button to view).

	On	Freq Offset (Hz)	Bandwidth (Hz)	Side	RBW (Hz)	n (RBWs)	Filter BW (n x RBW)	VBW (Hz)	VBW On	Mask	Abs Limit (dBm)	Rel Limit (dB)	Reset layout
A	A.	1.400M	1.095M	Both	51.000k	1	51.000k	30.000k		AbsAndRel	-12.61	-44.2	
в	N.	2.800M	1.095M	Both	51.000k	1	51.000k	30.000k		AbsAndRel	-12.61	-44.2	Load
С		4.200M	1.095M	Both	51.000k	1	51.000k	30.000k		AbsAndRel	-12.61	-44.2	
D		5.600M	1.095M	Both	51.000k	1	51.000k	30.000k		AbsAndRel	-12.61	-44.2	Save As
Е		7.000M	1.095M	Both	51.000k	1	51.000k	30.000k		AbsAndRel	-12.61	-44.2	
F		8.400M	1.095M	Both	51.000k	1	51.000k	30.000k	1	AbsAndRel	-12.61	-44.2	

Setting	Description
Buttons	
Expand (button)	Displays the Offsets and Limits Table in a new, resizable window.
Reset Layout	Allows you to reorder columns in the Offsets & Limits Table by dragging the columns to a new position. Clicking Reset Layout returns the column order to the factory default order.
Load	Click to load a saved Offsets & Limits table from a file.
Save As	Click to save the current Offsets & Limits table to a file.
Done	When the table is expanded, click Done when you have finished editing the table to save your changes and close the expanded table display.
Table columns	
On	Specifies whether or not measurements are taken in the specified offset.
Freq Offset (Hz)	Specifies the frequency offset for the offset region (adjacent channel region) from the Center frequency of the Reference Channel. This offset is always specified from the center frequency of the Reference Channel to the center frequency of the Offset region.
Start (Hz)	Start Frequency of the selected offset.
Stop (Hz)	Stop Frequency of the selected offset.
Bandwidth (Hz)	Specifies the bandwidth of the Offset region.
Side	Specifies whether the specified range appears on both side of the carrier frequency or just one side (left or right).
RBW (Hz)	Specifies the RBW for the selected range.
n(RBWS)	An integer value that specifies how many times to multiply the RBW to set the Filter bandwidth.
Filter BW (n x RBW)	Displays the Filter BW. Filter BW is the equivalent BW of each point in the offset. When n > 1, an integration technique is used to achieve the Filter BW using narrower RBWs.
VBW (Hz)	Adjusts the VBW (Video Bandwidth) value. VBW Maximum: RBW current value; VBW Minimum: 1/10,000 RBW setting.
VBW (On)	Specifies whether the VBW filter is applied.
Mask	Select the type of limits used for Pass/Fail testing. Signal excursions that exceed the mask settings are considered violations. The available choices are Abs, Rel and Abs & Rel.
Abs Limit (dBm)	The offset region integrated power is compared against the Abs Limit value mentioned here.
Rel Limit (dB)	The offset region integrated power relative to the reference channel integrated power is compared with this limit.

Scale tab - LTE

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings. In effect, these controls operate like pan and zoom controls. The Scale tab values are unique to each display. Also, note that each display uses horizontal and vertical units that are appropriate for that display. There are three versions of the Scale tab for LTE displays.

LTE Power vs	Modulation F	Params Analysis Time	Prefs Scale	Limit		
Time Settings	Vertical		Horizontal	Full Burst		
	Scale:	100.00 dB	Start:	100.000 us		
	Position:	0.00 dBm	Stop:	0.000 s		
Standard Presets		Reset		Reset		

The following image shows the Scale tab for the LTE Power vs Time display.

Settings	Description	
Vertical	Controls the vertical position and scale of the trace display.	
Scale	Changes the vertical scale units.	
Position	Adjusts the reference level away from top of the graph.	
Reset	Resets the scale of the vertical axis to default values.	
Horizontal Full Burst	Controls the horizontal span.	
Start	Specifies the horizontal axis start point.	
Stop	Specifies the horizontal axis end point.	
Reset	Resets the scale of the horizontal axis to default values.	

The following image shows the Scale tab for the LTE Channel Spectrum and LTE ACLR displays.

LTE Channel	Freq & RBW	Measurement Params	Channels Scale	Prefs		
Spectrum Settings	Vertical				Horizontal	
	Scale:	100.00 dB			Scale:	6.27 MHz
	Position:	0.00 dBm	Reset	Scale	Position:	1.00000 GHz
Standard Presets		Autoscale				Autoscale

Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale units.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the horizontal span of the trace display and position of the trace.
Scale	Specifies the frequency range displayed in the graph
Position	Specifies the frequency shown at the center of the graph.
Autoscale	Resets the scale of the horizontal axis to optimize the display of the trace.
Reset Scale	Resets all settings to their default values.

The following image shows the Scale tab for the LTE Constellation display.

LTE	Modulation Params	Analysis Params	Analysis Time Trace Scale	
Constellation Settings	Zoom	1		
	S	cale: 3	Vertical Position:	0
			Horizontal Position:	0
Standard Presets				

Settings	Description
Zoom	
Scale	Zooms in and out of the constellation. As the scale is increased, it will zoom out.
Vertical Position	Adjusts the vertical position.
Horizontal Position	Adjusts the horizontal position.

Prefs tab - LTE

The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display, but include such items as enabling/disabling Marker Readout, switching the graticule display on/off, and Marker Noise mode. Some parameters appear with most displays, while others appear with only one display.

LTE ACLR settings	Channels Parameters Processing Offsets & Limits Table Scale Prefs
	Max Trace points: 801 - (per range)
	Show graticule Show Marker readout in graph (selected marker)
Standard Presets	Show Power Levels In Graph Show limits: Line only

The following image shows the Prefs tab for the LTE ACLR display.

The following image shows the Prefs tab for the LTE Channel Spectrum display.

LTE Channel Spectrum Settings	Freq & RBW Measurement Params Channels Scale Prefs	
	Trace points: 801 Trace detection: +Peak Show graticule Show Marker readout in graph (selected marker)	
Standard Presets		

The following image shows the Prefs tab for the LTE Power vs Time display.

LTE Power vs Time Settings	Modulation Params	Analysis Time	Prefs	Scale	Limit		
	🔽 Averag	e over offslot					Show graticule
Standard Presets							☑ Show marker readout

Setting	Description
Show graticule	Shows or hides the graticule.
Trace / Max Trace points	When the spectrum analysis produces more than the selected maximum number of points, the method specified in Detection control is used to decimate the result. This setting applies to both the reference channel and offsets.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Show Power Levels In Graph	This display the power level (calculated integrated power in the offset region) in the graph.
Show limits	
Shaded	Shows limits using a shaded area. Absolute limit and Relative limit shading colors can be set under Presets > Options.
Line only	Shows limits using only a line. Absolute limit and Relative limit line colors can be set under Presets > Options.
None	No lines or shading are used to indicate limits in the graph. Violations of the mask are still identified by red shading.
Average Over Offslot	Enables for averaging of offslot power in non-overlapping 70 μ s windows in the entire offslot region. If this option is disabled, the off slot power is measured only in the center 70 μ s window of the offslot region.

Freq and RBW tab - LTE

The Freq and RBW tab specifies frequency parameters for the Channel Power and ACPR measurements and the MCPR measurement. It is available for the LTE Channel Spectrum display.

LTE Channel Spectrum Settings	Freq & RBW Mea	surement Params	Channels	Scale	Prefs		
	Meas Freq:	1.00000 GHz			RBW:	3.000 kHz	🔲 Auto
Standard Presets	Step:	2.0000 MHz	🔽 Auto		VBW:		

Settings	Description						
Meas Freq	Specifies the center/measurement frequency						
RBW	Select Auto or Manual. Adjusts the RBW for the entire measurement. This setting is Independent of the Spectrum view's RBW setting.						
	Auto: When Auto is enabled, the step size is adjusted automatically based on the span setting.						
Step	The Step control sets the increment/decrement size for the adjustment of the center frequency. If Auto is enabled, the analyzer will adjust the Step size as required.						
	Auto: When Auto is enabled, the step size is adjusted automatically based on the span setting.						
VBW	Adjusts the Video Bandwidth value.						
	The maximum VBW value is the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.						

Measurement Params tab - LTE

The Measurement Params tab allows you to set parameters that control the ACPR and MCPR measurements. This is available for the LTE Channel Spectrum display.

LTE Channel Spectrum Settings	Freq & RBW	Measurement Params	Channels	Scale	Prefs
	Average:	Off	•		
Standard Presets					

Settings	Description
Average	
Off	
Frequency-domain	This setting takes the average linear value of the traces (so that RMS values are preserved). The number of averages is user-defined. Frequency domain averaging is available in spans larger (or smaller) than the maximum real time bandwidth. This is the mode to use unless you need to extract maximum dynamic range from an ACPR measurement.
Time-domain	This setting takes the average linear value of the traces. It is useful if you need to extract maximum dynamic range from an ACPR measurement. The number of traces is user defined, however, the signals must be triggered and repeating (meaning the signal needs to be exactly the same for each acquisition). When this condition is met, each waveform contains the same signal, but the random noise changes from acquisition to acquisition and the average value of the random noise is lowered, while the signal value remains constant. Time domain averaging is not available in spans wider than the maximum real-time bandwidth.

Modulation Params tab - LTE

The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that define the signal format. This tab is available for the LTE Constellation and Power vs Time displays.

LTE Power vs	Modulation Params	Analysis Time	Prefs	Scale	Limit]		
Time Settings	Frame Structure:	Downlink FDD	•			Bandwidth and Spacir Channel Bandwidth:		•
						(FFT Length:	512
						Subcarrier Spacing: 1	15 KHz	
Standard Presets								

Settings	Description
Frame Structure	Select the frame structure to set how the demodulation is done.
Downlink FDD	
Downlink TDD	
Bandwidth and Spacing	
Channel Bandwidth	Select from 6 bandwidths: 1.4, 3, 5, 10, 15, 20 MHz
Subcarrier Spacing (readout)	This readout shows the subcarrier spacing. It is always at 15 kHz for LTE.

Analysis Params tab - LTE

The Analysis Params tab allows you to enable equalization on the demodulated LTE packet. The equalization is based on PSS (Primary Synchronization Signal). This tab is only available for the LTE Constellation display.

LTE	Modulation Params Analysis Params Analysis Time Trace Scale
Constellation Settings	
	Enable Equalization
Standard Presets	

Settings	Description
Enable Equalization	Allows you to enable Equalization based on PSS (Primary Synchronization Signal).

Analysis Time tab - LTE

The Analysis Time tab contains parameters that define how the signal is analyzed in the LTE Analysis displays. This tab is available for the LTE Constellation and Power vs Time displays.

LTE Power vs Time Settings	Modulation Params	Analysis Time	Prefs	Scale	Limit				
	Analysis Offset:	0.000 Symbo	7/	🔽 Au	uto	Time Zero Reference:	Trigger	•	
	Analysis Length:	: 187.500 Syn	nbol	🔽 A.	uto	Units:	Symbols	•	
Standard Presets	Actual	: 0.000 Syn	lodr						

Settings	Description
Analysis Offset	Specifies the location of the first time sample to use in measurements.
Auto	When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.
Analysis Length	Specifies the length of the analysis period to use in measurements. Length is specified in either symbols or seconds, depending on the Units setting.
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.
Actual	This is a displayed value, not a setting. It is the Analysis Length (time or symbols) being used by the analyzer. This value may not match the Analysis Length requested (in manual mode).
Time Zero Reference	Specifies the zero point for the analysis time.
Units	Specifies the units of the Analysis Length to either Symbols or Seconds.

Analysis Offset

Use analysis offset to specify where measurements begin. Be aware that you cannot set the Analysis Offset outside the range of time covered by the current acquisition data. (All time values are relative to the Time Zero Reference.)

You can set the Analysis Length so that the requested analysis period falls partly or entirely outside the current range of acquisition data settings. When the next acquisition is taken, its Acquisition Length will be increased to cover the new Analysis Length, as long as the Sampling controls are set to Auto. If the Sampling parameters are set to manual, or if the instrument is analyzing saved data, the actual analysis length will be constrained by the available data length, but in most cases, measurements are able to be made anyway. The instrument will display a notification when measurement results are computed from less data than requested. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed. As you adjust this value, the actual amount of time for Analysis Length, in Symbol or Seconds units, is shown below the control in the "Available" readout. This setting is not available when Auto is checked. Range: minimum value depends on the standard. Resolution: 1 symbol.

Time Zero Reference

All time values are measured from this point (such as marker position or horizontal position (in Y vs Time displays). Choices are: Acquisition Start or Trigger.

Parameter	Description
Acquisition Start	Time zero starts from the point at which the acquisition begins.
Trigger	Time zero starts from the trigger point.

Trace tab - LTE

The Trace tab allows you to set the trace display characteristics of the LTE Constellation display.

LTE Constellation	Modula	tion	Params Analysis Params Analysis Time Trace Scale	
Settings		On	Measurement Name	
	•	\checkmark	Primary Synchronization Signal	
		√	Secondary Synchronization Signal	
Standard Presets				

Setting	Description	
>	The arrow indicates which measurement name is active so that you can check it (on) or uncheck it (off).	
On	Check the box next the measurement name you want to turn on.	
Measurement Name	Selections are PSS (Primary Synchronization Signal) or SSS (Secondary Synchronization Signal)	

Limit tab - LTE

The Limit tab is only available for the LTE Power vs Time display. It enables you to specify the limit used for comparison against measured values of T_{OFF} measurement.

LTE Power vs Time Settings	Modulation Params	Analysis Time	Prefs	Scale	Limit
	Toff psd:	-83 dBm			
Standard Presets					

Setting	Description
Toff psd	Specifies the limit that is used for comparison against measured values of T _{OFF} measurement. Pass/ Fail is determined with this limit.

Bluetooth Analysis

Overview

The Bluetooth Analysis option allows you to evaluate short range RF signals to ensure that they meet Bluetooth standard per Bluetooth Special Interests Group (SIG) Test Specifications for version 4.1. This analysis option enables measurements and supports detection, demodulation, and decoding of packet information for the following three standards: Basic Rate, Low Energy, and Enhanced Data Rate (EDR). You can also select from three RF test presets for the Low Energy standard and four test presets for the Basic Rate standard. This analysis option includes modulation, power, carrier drift, and spectral measurements as mentioned in the Radio Frequency test specification document by the Bluetooth SIG. These measurements are also compared with the limits provided by the standard to give pass/fail results. (There are no pass/fail results for EDR.)

With the Bluetooth Analysis test suite, test engineers can simplify the execution of a number of transmitter tests while still enabled to modify signal parameters for in-depth signal analysis. The analysis results give multiple views of Bluetooth signal characteristics to allow the diagnosis of signal imperfections and impairments quickly and easily. Display controls allow you to selectively display the analysis results to help locate trouble spots in the signal.

Bluetooth topics in this Help

The following information about the Bluetooth Analysis option is available:

- Bluetooth key features (see page 341)
- Reference table of supported Bluetooth measurements
- Bluetooth measurements and test setups (see page 345)
- Bluetooth status messages (see page 350)
- Bluetooth Standards presets (see page 342)
- Bluetooth displays (see page 345)
- Bluetooth Settings (see page 376)

Bluetooth key features

- Modulation/Carrier Drift/Output Power test setup in Bluetooth Standards Preset that will calculate results and compare against recommended or user defined limits or Basic Rate and Low Energy.
- In-band Emission measurement preset with capability to compare results against recommended or user defined limits for Basic Rate and Low Energy.
- 20 dB Bandwidth and Frequency Range measurement preset with capability to compare results against recommended or user defined limits for Basic Rate.
- Appropriate masks for Out-of-band Spurious measurements for ETSI and FCC specifications.

- Enhanced Data Rate (EDR) demodulation of GFSK and PSK data and relative power measurement preset.
- Automatic detection of standards (see page 342).
- Automatic detection of test pattern.
- Automatic determination of packet type.
- Summary display with decoded preamble, access code, packet header, payload header, and CRC packet information along with other scalar measurements.
- Symbol Table display with color coding to show different regions in the packet.
- Freq Dev vs Time display with zoomed Octet viewing to help you understand how the modulation characteristics measurement is done.
- CF Offset & Drift display with offset (calculated in preamble and 10 bit intervals in payload) and drift results in a tabular view.
- Summary display that allows you to edit pass/fail limits for comparison with actual results. (Default is recommended limits from the Bluetooth SIG Radio Frequency test specification document.)

Automatic detection of standards. This function can be enabled from the Standard Parameters control panel. This automatically detects whether the Bluetooth standard is Basic Rate, Low Energy, or Enhanced Data Rate (EDR). This function is not available as a test setup from the Standards Presets window.

Bluetooth measurement	Bluetooth standard(s)
Modulation characteristics	Basic Rate
	Low Energy
Carrier frequency offset and drift	Basic Rate
	Low Energy
Output power	Basic Rate
	Low Energy
In-band emission /ACPR	Basic Rate
	Low Energy
Out-of-band spurious emission	Basic Rate
	Low Energy
20 dB bandwidth	Basic Rate
Frequency range	Basic Rate
Power density	Basic Rate
Relative power	Enhanced Data Rate (EDR)

Supported automated Bluetooth measurements

Bluetooth Standards presets

Presets > **Standards**

The Bluetooth Standards preset allows you to access displays preconfigured for the Bluetooth standard and test setup you select. The test setups load the displays and control setting options suggested by the standard to perform the measurements. You can read more about how Presets work (see page 20).

There are four test setups for the Low Energy standard and eight test setups for the Basic Rate standard. There is one preset (no test setups) for the EDR standard.

The following table shows the set of Preset displays that load when the specified standards and test setups are selected.

Standard	Test setup	Displays loaded with preset	
Low Energy	Modulation/Frequency Offset/Drift/Output Power	BT Eye Diagram, BT Freq Dev vs Time, BT Summary, BT CF Offset and Drift, Spectrum, Time Overview	
	In-band Emissions	BT InBand Emission, Spectrum, Time Overview	
	Non-compliance	BT Freq Dev vs Time, BT Constellation, BT Summary, Spectrum, Spectrogram, Time Overview	
Basic Rate	Modulation/Frequency Offset/Drift/Output Power	BT Eye Diagram, BT Freq Dev vs Time, BT Summary, BT CF Offset and Drift, Spectrum, Time Overview	
	In-band Emissions	BT InBand Emission, Spectrum, Time Overview	
	Tx Output Spectrum — 20dB Bandwidth	Bluetooth 20 dB BW, Spectrum, Time Overview	
	Non-compliance	BT Freq Dev vs Time, BT Constellation, BT Summary, Spectrum, Spectrogram, Time Overview	
Enhanced Data Rate (EDR)	Generic	BT Eye Diagram, BT Constellation, BT Summary, BT Symbol Table, Spectrum, Time Overview	

 Table 6: Bluetooth standards, test setups, and Preset displays

Retain current center frequency and reference level settings

The **Retain current Center Frequency setting** appears when the Bluetooth Standards Preset is chosen. This setting allows you to retain the previously used center frequency.

The **Retain current Ref Level setting** appears when the Bluetooth Standards Preset is chosen. This setting allows you to retain the previously used reference level.

To activate these settings, check the box next to the desired setting.

Preset:	Bluetooth			
Preset displays:				
BT Eye Diagram B1	Freq Dev vs BT Summary BT CF Offset Spectrum			
	Time and Drift			
Standard:	Basic Rate			
Test Setup:	Modulation/Frequency Offset/Drift/Output Power			
Retain current Center Frequency setting				
Retain current	Ref Level setting			
To go directly to a pre	set in the future, use Tools->Options->Presets->Preset action			
	OK Cancel			

By default, the Ref Level setting box is checked.

By default, the Center Frequency setting box is unchecked and the Bluetooth preset displays will load with one of the center frequency values shown in the following table.

Standard	Test setup	Center frequency
Basic Rate	Modulation/Frequency Offset/Drift/Output Power	2.441 GHz
Low Energy		
Basic Rate	In-band Emissions	2.441 GHz
Low Energy		
Basic Rate	Out-of-band Spurious Emissions	2.441 GHz
Low Energy		
Basic Rate	Tx Output Spectrum — 20dB Bandwidth	2.441 GHz
Basic Rate	Tx Output Spectrum — Power Density	2.441 GHz
Basic Rate	Non-compliance	2.441 GHz
Low Energy		
Basic Rate	Tx Output Spectrum — Frequency Range Lower	2.402 GHz
Basic Rate	Tx Output Spectrum — Frequency Range Higher	2.480 GHz
Enhanced Data Rate	Generic	2.441 GHz

NOTE. Changing analysis and display parameters recalculates the measurement results, but does not affect acquisitions.

Bluetooth displays

The displays in Bluetooth Analysis (Setup > Displays > Measurements: Bluetooth Analysis) are:

- Bluetooth 20dB Bandwidth
- Bluetooth Center Frequency Offset and Drift
- Bluetooth Constellation
- Bluetooth Eye Diagram
- Bluetooth Frequency Dev vs Time
- Bluetooth InBand Emission
- Bluetooth Summary
- Bluetooth Symbol Table
- Time Overview

Bluetooth measurements and test setups

A variety of measurements and test setups are provided by the Bluetooth Analysis option for use in performance testing of transmitters. These test setups allow the analyzer to compare the measurement result to the standards limit. Test engineers can select from the test setups and measurements described here. The following topics contain important information you should know about specific Bluetooth measurements and test setups.

NOTE. Although the following information describes test setups for measurements recommended by the standard document, other measurement results may also be provided as additional information for a given measurement. For example, carrier frequency offset and drift results may be provided for modulation characteristics test setups.

Modulation characteristics (Basic Rate and Low Energy)

This measurement verifies that the modulation characteristics of the transmitted signal are correct. The Bluetooth test specification recommends this measurement be done using fixed frequency, also known as *hopping off*, and can be done in Direct Tx mode. This measurement can only be done if the payload has the bit pattern 10101010 or 11110000. This measurement and test setup are set to Free Run mode by default. However, you can set the analyzer to Triggered mode (Setup > Trigger) to do the measurements.

More information about this measurement:

Select the Modulation/Frequency Offset/Drift/Output Power test setup from Presets > Standards to perform modulation characteristics measurements. This will load the displays found in the <u>Bluetooth</u>

standards, test setups, and Preset displays table. Additionally, you can choose to load the BT Symbol Table and BT Constellation displays, which can provide useful information.

- The Bluetooth Analysis splits the frequency deviation results in the payload region into octets (8 bit intervals). If the payload pattern is 10101010, the maximum frequency deviation is calculated in every bit interval within an octet and recorded as Δ fmax. The Δ fmax results are averaged to give Δ f2avg. The percentage of Δ fmax values greater than recommended lower limit is also found.
- If the payload is 11110000, the average frequency deviation is found in 4 bit intervals (2, 3, 6 and 7) and the average of these values is calculated as Δ flavg. The ratio of Δ f2avg and Δ flavg is also found.
- BT Freq Dev vs Time display has an octet view (zoomed view of the 8 bit intervals in Payload) and also shows the bit intervals in which the Δfmax values are computed. The octet view option also allows you to see the regions in which the calculations are done.

NOTE. The octet view option is only available when Preamble is detected.

- Specify an octet to view by entering a value in the Octet # field in the BT Freq Dev vs Time display. This also shows the maximum number of octets used for analysis. The start and end point for every octet can be clearly seen using the octet view.
- In the Summary display, the scalar results (Δflavg, Δf2avg, Ratio, Percentage of Δfmax values greater than a limit) averaged over the last 10 packets analyzed are shown along with the packet count. These averaged results can be compared against limits set in the Limits tab of the Settings control panel.
- The Points/symbol option in the Trace tab can be used to control how many samples per symbol should be used for computation of these measurements. The standard recommends 32 samples per symbol for Low Energy and 4 samples per symbol for Basic Rate. These are the default values provided for the respective standards in the Bluetooth Standards presets.

Carrier frequency offset and drift (Basic Rate and Low Energy)

This measurement verifies that the carrier frequency offset and carrier drift of the transmitted signal is within the specified limits for the specified standard. The Bluetooth test specification recommends this measurement be done using fixed frequency, also known as *hopping off*, and can be done in Direct Tx mode. This test can be done only if the payload contains 10101010 bit pattern. This measurement and test setup are set to Free Run mode by default. However, you can set the analyzer to Triggered mode (Setup > Trigger) to do the measurements.

More information about this measurement:

Select the Modulation/Frequency Offset/Drift/Output Power test setup from Presets > Standards to perform carrier frequency offset and drift measurements. This will load the displays found in the

<u>Bluetooth standards, test setups, and Preset displays table</u>. Additionally, you can choose to load the BT Symbol Table and BT Constellation displays, which can provide useful information.

- This measurement calculates the following:
 - Frequency offset in Preamble (initial Carrier Frequency Offset).
 - Frequency offset in Payload (calculated in 10 bit intervals in Payload).
 - Drift (the difference in frequency offset calculated in Payload from that calculated in Preamble).
 - Drift/50 μs (the difference in frequency offset calculated in two 10 bit intervals in Payload separated by 50 μs (5 intervals away).
- The BT CF Offset and Drift display shows all results in a table.
- The measurements shows the following scalar results:
 - Preamble frequency offset (initial carrier frequency offset).
 - Maximum frequency offset in Payload (along with the index number at which the offset is at maximum).
 - Drift of frequency offset from Preamble to first 10 bit interval in Payload (f1-f0).
 - Maximum drift between Payload and Preamble (fn-f0) (along with index number at which the drift is maximum).
 - Maximum drift between two 10 bit intervals spaced 50 μs away (fn-fn-5) (along with index number at which the drift is maximum).
- The Preamble region in which the Preamble offset is calculated is shown in the BT Freq Dev vs Time display along with markings to show the region in which maximum drift occurred. Maximum drift between Payload and Preamble is shown from the end of Preamble to the end of 10 bit interval in Payload in which maximum drift occurred. Maximum drift in payload (in 50 µs duration) is also shown.
- In the Summary display, the scalar results (mentioned above) averaged over the last 10 packets are shown along with the packet count. The results are compared against recommended limits. You can set these limits in the Limits tab of the Settings control panel.

In-band Emissions (Basic Rate and Low Energy)

This measurement verifies that the in-band spectral emissions are within limits. The standard document recommends that this measurement be done with Hopping off, finding the integrated power in 1 MHz band (with RBW 100 kHz) in 80 channels starting from 2401 MHz to 2481 MHz. The test can be done in Direct Tx mode. The integrated power values calculated in the adjacent channels are compared against recommended limits (except the three channels around transmitted frequency). This measurement is referred to as ACPR in the Radio Frequency Test Specification for Basic Rate. It is recommended to do this measurement in Free Run mode (set in Setup > Trigger) if the analyzer does not support the required BW (80 MHz). The measurement internally searches for burst and aligns the measurement to the on-slot region.

NOTE. For analyzers with limited bandwidth, this measurement will be done over multiple acquisitions to generate the data required for the entire span. Therefore, it is important for the user to set an analysis length that will ensure that on slot region is always included.

More information about this measurement:

- Select the In-band Emissions test setup from Presets > Standards to perform the in-band emissions measurements. This will load the displays found in the <u>Bluetooth standards, test setups, and Preset</u> displays table.
- The In-band Emissions display will set the Center Frequency to 2.441 GHz by default. When the Retain CF option is not enabled from Standards Presets, 80 bands (each of bandwidth 1 MHz) are analyzed and the integrated power is found (indicated by Blue lines in the plot).
- The integrated power is compared against limits for comparison (shown by white masks) in all bands except the three channels around the transmitted frequency. If any band fails, that band is shown in red color. If more than three channels fail to meet the recommended limits, a FAIL is shown in the top left corner of the display.
- The table below the plot shows the integrated power and also the limit for comparison.
- The limits for comparison are set to the values given by the standard by default, but you can manually set them from the Limits tab of the Settings control panel.
- This measurement is done only on the on slot region if a ramp-up and ramp-down portions are available. However, the measurement is done on the complete analysis region if a ramp up or ramp down is not available. It is recommended that a complete packet is included in the analysis region.
- When the analyzer does not support the 80 MHz bandwidth requirement, multiple acquisitions are taken in different bands and stitched together. This measurement is therefore best done in Free Run mode (set in Setup > Trigger) as Triggered mode might not find a proper edge in an acquisition taken for stitching purposes.

Output Power (Basic Rate and Low Energy)

This test verifies the maximum peak and average power emitted from the EUT. The standards document recommends this test be done for a PRBS payload pattern. Also, the measurement must be done over the duration of a burst starting at preamble position. The Bluetooth test specification recommends this measurement be done using fixed frequency, also known as *hopping off*, and can be done in Direct Tx mode.

More information about this measurement:

- Select the Modulation/Frequency Offset/Drift/Output Power test setup from Presets > Standards to perform carrier frequency offset and drift measurements. This will load the displays found in the Bluetooth standards, test setups, and Preset displays table.
- Calculates the average power and peak power for any Bluetooth signal. The peak power is the peak
 power value in the chosen on slot region.
- The measurement is done only on preamble detection; otherwise, it is invalid.
- The BT Summary display shows the averaged result over 10 packets.

20dB Bandwidth (Basic Rate)

This measurement verifies if the emissions inside the operating frequency range are within limits. This measurement is done with Hopping off. The difference between frequency points at which the power level drops to 20 dB below the peak power of the emission is found at 20 dB Bandwidth.

More information about this measurement:

- Select the 20dB Bandwidth test setup from Presets > Standards to perform the 20 dB emissions measurements. This will load the displays found in the <u>Bluetooth standards, test setups, and Preset</u> displays table.
- The BT 20 dB BW display allows you to set the relative power level (x dB BW) compared to the peak power at which the frequency points are to be found.
- When you select the 20dB Bandwidth test setup, the center frequency (CF), span, and relative bandwidth (RBW) are set as recommended by the standard document.
- It is recommended this measurement be done over three different center frequencies. You can do this by changing the center frequency as needed.
- From the Params tab of the Settings control panel, you can select that the search for the x dB relative power (20 dB in this case) be performed in one of two modes: from the edges towards the peak power (inwards) or vice versa (outwards). The default for this setting is Inwards (from edges to peak power) when this measurement is chosen from the Standards Preset menu, as recommended.
- The blue markings in the plot indicate the 20 dB bandwidth and the frequency points at which the power level drops down by 20 dB from the peak power.
- The resulting 20 dB bandwidth is compared with the limits recommended by the standard document and Pass/Fail is shown in the top left corner of the plot. This is not user defined.

If the highest power value measured in step d) is equal or higher than 0 dBm: $f = |fH - fL| \le 1.0$ MHz.

If the highest power value measured in step d) is lower than 0 dBm: $f = |fH - fL| \le 1.5$ MHz.

Frequency Range (Basic Rate)

These measurements verify if the emissions inside the operating frequency range are within limits. These measurements are done with Hopping off in two steps. The first measurement is done at the lower frequency spectrum of the Bluetooth band. (Start – 2399 MHz and Stop 2405 MHz). The second is done at the higher frequency spectrum of the Bluetooth band (Start -2475 MHz and Stop at 2485 MHz). The difference between the frequency point at which the power level drops to -30 dBm from the center frequency is measured. fL is the difference on the lower side from the center frequency when the lower end of the spectrum is being analyzed. fH is the difference from the center frequency on the higher side when the higher end of the spectrum is analyzed. fH – fL is the Frequency Range.

More information about these measurements:

The BT 20dB BW display allows you to set the absolute power level (x dBm level) from the Parameters tab of the Settings control panel. The Bluetooth SIG Radio Frequency test specification document suggests that this value be set to -30 dBm for doing the Frequency Range measurement. If you chose to set up this measurement using start and stop frequencies and RBW, those should be set as recommended by the standard. Separate start and stop frequencies are given for the two steps of this measurement.

- You can select for the analysis to find the x dBm frequency difference from the center frequency either on the lower side, higher side, or both sides. This option (Meas Range) can be set from the Params tab of the Settings control panel.
- The blue marking indicates the frequency difference from the center frequency based on the Meas Range option choice. You can set this option to Low while analyzing in the lower range of the frequency spectrum, and set it to High when analyzing the higher range of the frequency spectrum.

Power Density (Basic Rate)

This measurement verifies the maximum RF output power density.

More information about this measurement:

- This measurement can be done using the Spectrum display (Displays > Measurements > General Signal Viewing) and by setting appropriate parameters as recommended in the Bluetooth SIG Radio Frequency test specification document.
- The Bluetooth test specification recommends this measurement be done using fixed frequency, also known as *hopping off*, and can be done in Direct Tx mode.

Out-of-band Spurious Emission (Basic Rate and Low Energy)

This measurement can be done for FCC or ETSI masks using the Spurious display.

Relative Power (Enhanced Data Rate)

This measurement calculates the relative power in the GFSK and PSK part of the Enhanced Data Rate (EDR) signal. This measurement is supported only when an EDR signal is detected.

Select the Enhanced Data Rate standard from Presets > Standards to perform the measurement. This will load the displays found in the Bluetooth standards, test setups, and Preset displays table.

Bluetooth Status Messages

The following status messages may appear. Each message indicates the related condition (Description) shown in the following table.

Status message	Description
Bluetooth Analysis: Preamble Not Detected	Shown in the display and status bar when no valid Sync and Preamble are found for the chosen standard. Also shown when no preamble is found for any of the standards in Automatic Standard Detection mode.
Bluetooth Analysis: Low Energy Sequence Detected	Shown in the status bar when the Low Energy standard is detected in Automatic Standard Detection mode.
Bluetooth Analysis: Basic Rate Sequence Detected	Shown in the status bar when the Basic Rate standard is detected in Automatic Standard Detection mode.
Bluetooth Analysis: EDR Signal Detected	Shown in the status bar when the EDR standard is detected in Automatic Standard Detection mode.
Bluetooth Analysis: EDR Sync Word Not Detected	Shown in the display and status bar when EDR Sync Word is not found (when EDR standard is selected).
Bluetooth Analysis: Not enough payload data for Bluetooth measurements	Shown in the display and status bar when Preamble and Access Address/Sync Word is detected but there is not enough payload data for Modulation Characteristics and CF Offset and Drift measurement.
Bluetooth Analysis: Meas BW may be too low	Shown in the InBand Emission display and in status bar when Measurement Bandwidth is too low.
Bluetooth Analysis: BT x dB BW detection failed	Shown in the BT 20 dB BW display when x dB measurement detection fails.
Bluetooth Analysis: BT x dBm BW detection failed	Shown in the BT 20 dB BW display when x dBm measurement detection fails.

Bluetooth Constellation display

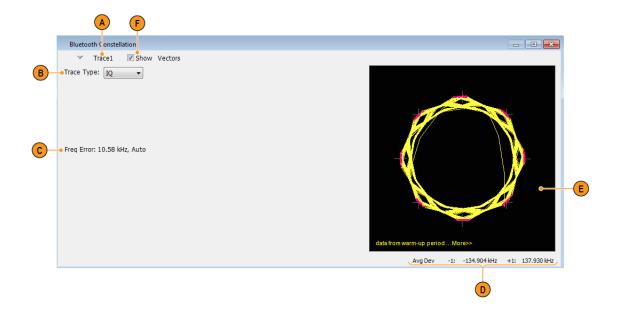
The BT Constellation display shows a digitally modulated signal in constellation form. The constellation can be viewed either as IQ or Freq Dev. The default view is Freq Dev. The frequency deviation result that is shown in the Constellation display is compensated for the frequency error (shown as readout).

To show the BT Constellation display you can select **Presets** > **Standards** > **Bluetooth** or do the following:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays window, select Bluetooth Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **BT Constellation** icon or select the icon and click **Add**. The BT Constellation icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click the **OK** button to show the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the Standard Params tab. Set the Standard, Power class (if required), and Measurement and Reference filters as appropriate for the input signal. You can also check the Auto Detect Standard box.
- 7. Select the Trace tab and set the Trace Type to Freq Dev or IQ, as required.
- 8. Select Replay/Run to take measurements on the acquired data.

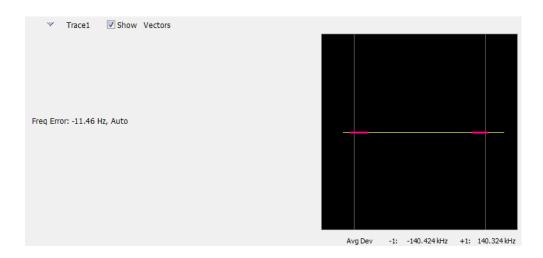
Elements of the Display

The following image shows the BT Constellation display of QPSK data in an EDR signal. Trace Type is set to IQ.



Item	Display element	Description
A	Trace	Select and enable a trace.
В	Trace Type	Specifies Trace type (choice between Freq Dev and IQ). This option appears only when EDR signal is detected.
С	Freq Eror / Freq Offset / marker readouts	The Freq Error, Freq Offset, and marker readout values appear here or below the plot, depending on the display view and size.
		The Freq Error value is the difference between the maximum and the minimum values of signal frequency during the measurement time. The Freq Error (Auto) value is displayed when the Auto check box is selected in the Analysis Params tab in the Settings control panel.
		The Freq Offset (Manual) value is displayed when the Auto check box is unselected in the Analysis Params tab in the Settings control panel.
		When markers are enabled, marker information (including time, magnitude, phase, symbol, and value) is displayed.
D	Avg Dev	Shows the average deviation result at every symbol point.
E	Plot	Bluetooth constellation graph. Shown as either IQ or as Frequency Deviation. The trace type is controlled from the Settings > Trace tab.
F	Show Vectors	Specifies whether to show or hide the selected trace.

The following image shows the BT Constellation display of GFSK data in a Basic Rate signal. Trace Type is set to Freq Dev.



BT Constellation Settings

Application Toolbar: 🕸

The BT Constellation Settings control panel provides access to settings that control parameters of the Constellation Display.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Trace	Allows you to select the trace to view, the trace type (IQ or Freq Dev), the number of points per symbol (when trace content is set to Vectors or Lines), and to show or freeze the selected trace.
Prefs	Allows you to select to show or hide the graticule and marker readouts.

Bluetooth Eye Diagram display

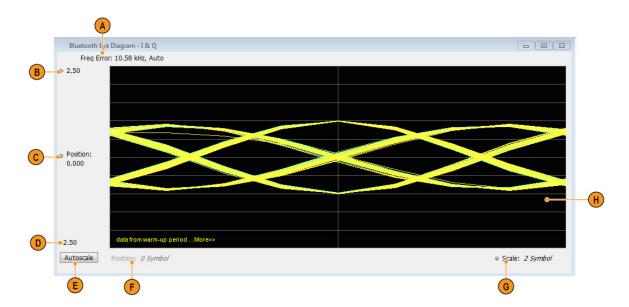
The BT Eye Diagram display shows a digitally modulated signal overlapped on itself to reveal variations in the signal.

To show the BT Eye Diagram display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. From the Measurements box, select Bluetooth Analysis.
- **3.** Double-click the **BT Eye Diagram** icon in the **Available Displays** box. This adds the BT Eye Diagram icon to the **Selected displays** box.
- 4. Click OK button. This displays the BT Eye Diagram view.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the **Standard Params** tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the **Auto Detect Standard** box.
- 7. Select the Trace tab and set the Trace Type to Freq Dev or IQ, as required...
- 8. Select Replay/Run to take measurements on the acquired data.

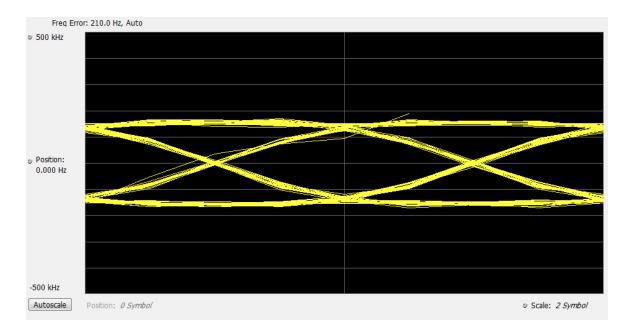
Elements of the Display

The following image shows the BT Eye display of a basic rate signal with Trace Type set to IQ.



ltem	Display element	Description
A	Freq Error / Freq Offset	The Freq Error value is the difference between the maximum and the minimum values of signal frequency during the measurement time. The Freq Error (Auto) value is displayed when the Auto check box is selected in the Analysis Params tab in the Settings control panel.
		The Freq Offset (Manual) value is displayed when the Auto check box is unselected in the Analysis Params tab in the Settings control panel.
В	Top of graph	The vertical scale is normalized with no units (for IQ) and with Hz (for Freq Dev).
С	Position	Specifies the value shown at the center of the graph display.
D	Bottom Readout	Displays the value indicated by the bottom of graph.
E	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
F	Position	Displays the horizontal position of the trace on the graph display.
G	Scale	Adjusts the span of the graph in symbols.
Н	Plot	Displays the input signal.

The following image shows the BT Eye display of a Basic Rate signal with Trace Type set to Freq Dev.



BT Eye Diagram Settings

Application Toolbar: 🥨

The settings for the BT Eye Diagram display are shown in the following table.

NOTE. You might save time configuring the BT Eye Diagram display by selecting the Standard Presets button in the Bluetooth Eye Diagram Settings control panel. This allows you to select a preset optimized for the selected standard.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Trace	Allows you to select the trace to view, the trace type (IQ or Freq Dev), the number of points per symbol (when trace content is set to Vectors or Lines), and to show or freeze the selected trace.
Scale	Allows you to specify the horizontal and vertical scale settings.
Prefs	Allows you to select to show or hide the graticule and marker readouts.

Bluetooth Carrier Frequency Offset and Drift display

The BT CF (Carrier Frequency) Offset and Drift display shows the frequency offset preamble, payload regions, and the drift result values are shown in this display. You can also view the values of frequency offset calculated in every ten bit interval in the payload and look for excursions.

To show the BT CF (Carrier Frequency) Offset and Drift display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select Bluetooth Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **BT CF Offset and Drift** icon or select the icon and click **Add**. The BT CF Offset and Drift icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the **Standard Params** tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the **Auto Detect Standard** box.
- 7. Select the Limits tab and set the limits , as required.
- 8. Select Replay/Run to take measurements on the acquired data.

Max Drift fig-fig-si: -127.7 Hz / 271

Elements of the Display

The following image shows the frequency offset and drift values of a basic rate signal in the BT Freq Offset and Drift display.

Limits Interval#	fn (-150.0kHz to +150.0kHz)	fn-f0(-40.00kHz to +40.00kHz) f1-f0(-20.00kHz to +20.00kHz)	fn-f(n-5) (-20.00kHz to +20.00kHz)	
	139.2751			
1	-96.15504	-235.4302		
2	7.167774	-132.1074		
3	-0.01093826	-139.2861		
4	0.01212997	-139.263		
5	-0.003742599	-139.2789		
6	0.007567215	-139.2676	96.16261	
7	-0.002672958	-139.2778	-7.170447	
8	-0.007925415	-139.2831	0.003012847	
9	-0.01031799	-139.2855	-0.02244797	
10	0.001925278	-139.2732	0.005667877	
11	0.001144409	-139.274	-0.006422806	
12	-0.004858398	-139.28	-0.00218544	
13	0.001594162	-139.2736	0.009519577	
14	-0.001327515	-139.2765	0.008990479	
15	0.01260147	-139.2625	0.01067619	
16	0.008859253	-139.2663	0.007714843	
17	-0.003403854	-139.2785	0.001454544	
18	-0.0007839203	-139.2759	-0.002378082	
19	0.001569366	-139.2736	0.002896881	
20	0.007740402	-139.2674	-0.004861068	
21	-0.001542282	-139.2767	-0.01040153	
22	0.009552765	-139.2656	0.01295662	
23	-0.006316376	-139.2815	-0.005532456	
24	-0.001724243	-139.2769	-0.00329361	
25	-0.01467628	-139.2898	-0.02241669	
26	-0.004405975	-139.2796	-0.002863693	
27	0.0005382538	-139.2746	-0.009014511	
28	-0.01394348	-139.2891	-0.007627105	

- Freq Offset Preamble: 139.3 Hz Max Freq Offset (Payload): -127.7 Hz / 271
- Drift fi-fe: -235.4 Hz Max Drift frj-fe: -267.0 Hz / 271

Display element	Description
Column 1	Indicates ten bit interval numbers. Zero indicates preamble region and the non-zero number indicate the ten bit intervals in payload.
Column 2	Shows the calculated frequency offset in the preamble and the ten bit intervals in the payload.
Column 3	Shows the drift of offset from the preamble and over a 50 μ s duration.
Column 4	Shows the drift of offset over a 50 µs duration.
_	Results that do not meet the limits are shown with a red colored background, indicating failure. (Limits can be set in the Limits tab from the Settings control panel.)
Scalar results	The scalar results show below the table. They are as follows: Freq Offset Preamble
	Max Freq Offset (Payload)
	Drift f_1 - f_0
	Max Drift f _n -f
	Max Drift fn-f(n-5)

BT CF Offset and Drift Settings

Application Toolbar: 🕸

The settings for the BT CF Offset and Drift display are shown in the following table.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Limits	Allows you to load and define Bluetooth measurement limits for Pass/Fail comparison. You can save defined limits as a .csv file and also load previously saved .csv files. These limits also apply to the Settings control panel Limits tab of the BT Summary display.

Bluetooth Summary display

The BT Summary display shows a summary of all the scalar measurements done on the acquired test pattern. The summary display and contents will vary according to the selected standard.

Pass/Fail information is also provided in this display for all enabled scalar measurements. You can set limits and choose which measurement to compare for Pass/Fail from the Limits tab of the BT Summary

Settings control panel. The default limits come from the performance recommendation limits given by the Standards document. The default limits can be reloaded by selecting the Bluetooth Standards Preset option.

The results presented in the BT Summary display include scalar results of modulation characteristics, frequency offset and drift and, output power measurements (these are averaged over the last 10 acquired packets). The display also shows packet related information for the current acquired packet.

To show the BT Summary display you can select **Presets** > **Standards** > **Bluetooth** or do the following:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select Bluetooth Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **BT Summary** icon or select the icon and click **Add**. The BT Summary icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the **Standard Params** tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the **Auto Detect Standard** box.
- 7. Select the Limits tab and set the limits, as required.
- 8. Select Replay/Run to take measurements on the acquired data.

Elements of the display

The following image shows all average scalar results and packet information for a Basic Rate signal in the BT Summary display. Modulation characteristics, carrier frequency offset and drift, and power measurements, along with packet information, are shown. The packet information will vary depending on the chosen or detected standard. For more information about specific measurement results, see the Bluetooth measurements and test setups section here (see page 307).

tandard: Basic Rate		Class3			Clear
Modulation Characteristic	s [10 packet-average]			Packet Information	
ΔF1avg:	Hz of 10		Packet Type	DH5	
ΔF2avg:	135.4 kHz		Preamble (4 bits)	0101	
∆F2Max% >= 115 kHz:	100.0 %	PASS			
	2 of 10		Sync Word (64 bits)	0x4F36F2CEE85390CB	
ΔF2avg/ΔF1avg:	-	N/A	Packet Header (18 bits)		
Frequency Offset and Drif	t [10 packet-average]		LT_ADDR (3 bits)	010	
Freq Offset (Preamble):	139.3 Hz	PASS	Type (4 bits)	1111	
Max FreqOffset:	-127.7 Hz	PASS	Flow (1 bit)	0	
Drift f1-f0:	-235.4 Hz	PASS	ARQN (1 bit)	1	
Max Drift fn-fo:	-267.0 Hz	PASS	SEQN (1 bit)	0	
Max Drift fŋ-ftŋ-5;:	-127.7 Hz 2 of 10	PASS	HEC (8 bits)	00110001	
Output Power [10 packe	t-average]		PayLoad Length	0101010011	
Peak Power Ppk:	-29.72 dBm	PASS	_		
Average Power Pavg:	-30.00 dBm 2 of 10	PASS	CRC (16 bits)	0x9DB0	

Element	Description
Standard	Display of the selected standard or the detected standard (if the Auto Detect Standard setting is chosen in the Standard Params tab of the Settings control panel).
Power class	Display of the Power class in the Standard Params tab of the Settings control panel. Only available when Basic Rate is the selected or detected standard.
Clear	Click button to reset measurement. Clears all values and all results in the queue used for average computation.
Modulation characteristics (ten packet average)	Display of a group of scalar results related to Modulation Characteristics measurements. These scalar results are only populated in the BT Summary display if preamble is detected in the acquired data. The four scalar results are:
	Δ f1avg is calculated when analyzed test pattern (payload) is 11110000.
	Δ f2avg and the percentage of Δ f2max value (greater than a given limit) are calculated only when analyzed test pattern (payload) is 10101010.
	The ratio of $\Delta f2$ avg and $\Delta f1$ avg is calculated provided both the results are available (or have been done before).
	All the results given are averaged over the last ten packets. The scalar results can be compared with pass/fail limits set in the Limits tab of the Settings control panel.
	More information can be found here (see page 307).
Frequency offset and drift (ten packet average)	Display of a group of five scalar results related to the carrier frequency offset and drift measurement. These scalar results are only populated in the BT Summary display if preamble is detected and if the test pattern payload is a 10101010 pattern. All the results given are averaged over the last ten packets. The scalar results can be compared with pass/fail limits set in the Limits tab of the Settings control panel.
	The five scalar results are:
	Preamble offset.
	Maximum offset in Payload (calculated over 10 bit intervals).
	Drift (f ₁ -f ₀)
	Max Drift (f_n - f_0).
	Max Drift (f _n -f _n -5).
	For more information about this measurement, see the <u>Carrier frequency offset and</u> <u>drift (Basic Rate and Low Energy) (see page 346)</u> topic in <i>Bluetooth Measurements</i> <i>and test setups.</i>
Output power	Display of Average Power and Peak Power scalar results for Output Power. All the results given are averaged over the last ten packets. The scalar results can be compared with pass/fail limits set in the Limits tab of the Settings control panel.
	For Enhanced Data Rate signals, the relative power in GFSK and PSK regions is measured.
	For more information about this measurement, see the <u>Output Power (Basic Rate and</u> <u>Low Energy) (see page 313)</u> topic in <i>Bluetooth Measurements and test setups</i> .
Packet information	The Packet information includes the Packet type, Preamble, Synchronization Word or Access Code, Packet Header, Payload length, and CRC details. The decoded bits are shown for the current analyzed packet.

The following image shows all average scalar results and packet information for a Low Energy signal in the BT Summary display.

Modulation Characteristic	s [10 packet	:-av	erage]	P	Packet Information	
ΔF1avg:	Hz		of 10	Packet Type	BLE_TEST	
ΔF2avg:	231.9 kHz			Preamble(8 bits)	01010101	
ΔF2Max% >= 185 kHz:	100.0 %	1	of 10	Access Address (32 bits)	0x71764129	
ΔF2avg/ΔF1avg:				PDU Header (16 bits)		
Frequency Offset and Drif	t [10 packet	t-av	erage]	PDU Type (4 bits)	0010	
Freq Offset (Preamble):	-19.59 Hz		PASS	Tx Address (1 bit)	0	
Max FreqOffset:	-110.5 Hz			Rx Address (1 bit)	0	
Drift fı-fo:	-51.84 Hz			Length (6 bits)	100101	
Max Drift fŋ-fo:	-90.95 Hz					
Max Drift քղ-քլղ-5չ:	-148.5 Hz	1	of 10 PASS	CRC (24 bits)	0x8CB786	
Output Power [10 packe	t-average]					
Peak Power Ppk:	4.192 dBm	1	PASS			
Average Power Pavg:	3.695 dBm	1	of 10 PASS			

The following image shows all average scalar results and packet information for an EDR signal in the BT Summary display.

standard: EDR					Clear
Modulation Characteristic	s [10 packet-a	verage]	P	acket Information	
ΔFavg:	Hz O) of 10	Packet Type	EDR_2DH1	
			Preamble (4 bits)	0101	
			Sync Word (64 bits)	0x4F36F2CEE85390CB	
			Packet Header (18 bits)		
Frequency Offset and Drif	t [10 packet-a	verage]	LT_ADDR (3 bits)	001	
Freq Offset (Preamble):	Hz	N/A	Type (4 bits)	0100	
Max FreqOffset:	Hz		Flow (1 bit)	1	
Drift fi-fo:	Hz		ARQN (1 bit)	0	
Max Drift fŋ-f₀:	Hz		SEQN (1 bit)	1	
Max Drift fŋ-fլŋ-s:	Hz -	- of 10 N/A	HEC (8 bits)	11010111	
Output Power [10 packe	t-average]		PayLoad Length	110110	
POWER GFSK:	-28.42 dBm				
POWER DPSK:	-28.51 dBm ₁	of 10	CRC (16 bits)		

BT Summary Settings

Application Toolbar: 🥨

The settings for the BT Summary display are shown in the following table.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Limits	Allows you to load and define Bluetooth measurement limits for Pass/Fail comparison. You can save defined limits as a .csv file and also load previously saved .csv files. The frequency offset and drift limits set here also apply to the CF Offset and Drift display.

Bluetooth Symbol Table display

The BT Symbol Table display shows decoded data values for each data symbol in the analyzed signal packet. It is like the BT Constellation display except that a text table is used to display data instead of a graph.

To show the BT Symbol Table display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select Bluetooth Analysis in the Measurements box.
- **3.** In the Available displays box, double-click the **BT Symbol Table** icon or select the icon and click **Add**. The BT Symbol Table icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select Setup > Settings to display the control panel.
- 6. Select the **Standard Params** tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the **Auto Detect Standard** box.
- 7. Select the Limits tab and set the limits, as required.
- 8. Select Replay/Run to take measurements on the acquired data.

Regions of the Display

The BT Symbol Table is color coded to indicate different regions of the packet. The legend at the bottom of the symbol table lists the packet contents in their associated colors. The following image shows values for a Basic Rate signal.

208 0	o O	1	1		-	_	et Head	-		-	yload			-	-	
) ()	1	1	1	-	U	•									
				1	1	0	0	0	0	1	1	1	1	0	0	
92 0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
.76 0) ()	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
160 0) ()	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
44 0) 0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
28 0) 1	0	1	0	1	0	0	0	0	1	1	1	1	0	0	
12 1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	0	
96 0	0 0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	
80 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
64 0		1	0	0	0	0	0	0	0	0	0	0	1	1	1	
48 1		1	1	0	1	1	0	1	1	0	0	1	1	1	1	
32 0		1	1	0	1	1	1	0	0	1	1	0	1	0	0	
0 1 16 1		1	0	1	1	0	1	0	0	1	1	0	0	0	0	

Packet standard	Associated regions					
Basic rate	4 bit preamble					
	64 bit access code					
	4 bit trailer					
	54 bit packet header					
	8 or 16 bit payload header based on packet type					
	Variable length payload data					
	16 bit CRC (Cyclic Redundancy Check)					
Low energy	8 bit preamble					
	32 bit access address / synchronization word					
	16 bit payload header					
	Variable length payload data (37 bytes)					
	24 bit CRC (Cyclic Redundancy Check)					
Enhanced Data Rate (EDR)	4 bit preamble					
	64 bit access code					
	4 bit trailer (if present, shown in black)					
	54 bit packet header					
	Guard region (shown as X)					
	EDR sync sequence (QPSK or 8PSK symbols)					
	16 bit payload header (QPSK or 8PSK symbols)					
	Variable length payload data (QPSK or 8PSK symbols)					
	16 bit CRC (Cyclic Redundancy Check) (QPSK or 8PSK symbols)					

The following image shows values for a Low Energy signal.

0 16	1	0		0	1	0	1	0	1	0	0	1	0	1	0	0	
	1	0	1	0	0	0	1	0	0	1	1	0	1	1	1	0	
32	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	
48	1	0	1	0	0	1	0	0	0	1	0	1	0	1	0	1	
64	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
80	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
96	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
112	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
128	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
144	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
160	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
176	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
192	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
208	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
224	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
240	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
256	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
272	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
288	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
304	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
S173		1	0	1	0	1	n	1	n	1	n	1	n	1	n	1	

		Address (nc Sequen			CRC (PSK)							
		le (GFSK)				Dackat	Header (G			oad (PSK)							
220	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 F
304	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
288	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
272	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
256	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
240	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
224	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
208	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
192	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
176	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
160	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
144	3	1	2	0	0	0	1	1	1	1	1	1	1	1	1	1	
128	x	x	X	0	1	3	1	3	1	3	3	1	1	1	2	2	
112	0	0	1	1	1	0	0	0	1	1	1	1	1	1	х	х	
96	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
80	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	
64	0	0	1	0	1	0	1	0	1	1	1	0	0	0	0	0	
48	1	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1	
32	0	1	1	1	0	1	1	1	0	0	1	1	0	1	0	0	
16	1	0	0	1	1	1	0	0	1	0	1	0	0	0	0	0	
0	1	0	1	0		4	ò	1	0	0	1	1	0	0	0	0	

The following image shows values for an EDR signal.

Markers and the BT Symbol Table. Markers are indicators in the display that you can position on a trace to measure values such as frequency, power, and time. A Marker always displays its position and, if the Delta Marker (M1-M4) readout is enabled, will display the difference between its position and that of the Marker Reference (MR). In the BT Symbol Table, colored cells indicate the location of markers. The selected Marker is highlighted with a light green background. All other markers are highlighted with a light gray background. In the BT Symbol Table, the marker readout below the table shows the marker location in time, symbol numbers and symbol value.

BT Symbol Table Settings

Application Toolbar: 🕮

The settings for the BT Symbol Table display are shown in the following table.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Prefs	Allows you to select to show or hide the marker readouts and set the radix of shown symbols.

Bluetooth Frequency Dev vs Time display

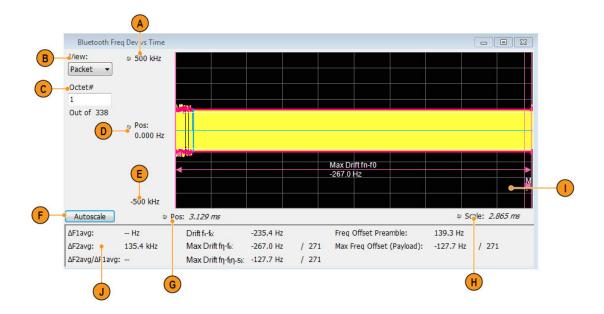
The BT Freq Dev vs. Time display shows how the signal frequency varies with time.

To display the BT Freq Dev vs. Time display:

- 1. Select the **Displays** button or **Setup** > **Displays**.
- 2. In the Select Displays dialog, select Bluetooth Analysis in the Measurements box.
- **3.** In the **Available displays** box, double-click the **BT Freq Dev vs. Time** icon or select the icon and click **Add**. The BT Freq Dev vs. Time icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select the Standard Params tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the Auto Detect Standard box.
- 6. Select the Trace tab and set the Content to Vectors or Points, as required.
- 7. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the frequency deviation of the complete packet of a Basic Rate signal in the BT Freq Dev vs. Time display.



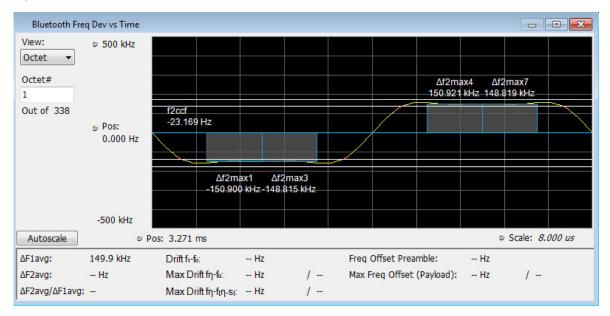
ltem	Display element	Description
A	Top of graph	The vertical scale is normalized with Hz.
В	View	(This option is visible only when Preamble is detected.)
		Select one of the following:
		Packet: view frequency deviation for an entire packet.
		Octet: view frequency deviation for a specified octet duration (8 µs). The Octet is specified in the Octet # field.
С	Octet # (xx of total)	(This option is visible only when Preamble is detected and Octet is selected as the View.)
		Specifies the Octet number. (The total number of octets is also indicated.) When View is set to Octet, you can enter a particular octet in the Octet # field for zoom view. The plot will show only 8 µs of information corresponding to the octet number chosen in the payload. The regions that are used for doing the exact measurements are highlighted in the Octet View. For F0F0 (Low Deviation) pattern in payload, bit intervals 2,3,6,7 regions are highlighted and for 1010 (high deviation) pattern, all bit regions are highlighted with appropriate results. The offset calculated for every octet region (f1ccf or f2ccf) are also shown.
D	Position (center)	Adjust the frequency shown at the center of the display.
F	Autoscale button	Adjusts the offset and range for both vertical and horizontal to provide the best display.
G	Position	Displays the horizontal position of the trace on the graph display.
Н	Scale	Adjusts the horizontal scale (time).
I	Plot	Displays the last analyzed complete packet or the selected octet (Octet zoom view) of the signal.
J	Scalar results	The Scalar results for Modulation Characteristics and Frequency Offset and Drift measurements are captured here. These results are from the last analyzed packet and therefore could be different from the Averaged Scalar results shown in the BT Summary display.
		For Drift results, the index is also shown where the maximum drift occurred. The Drift results are shown only when the preamble is detected and the test pattern payload detected is 10101010. Δ F1avg or Δ F2avg is shown only when the detected test pattern payload is (10101010) or (11110000).

NOTE. This display shows the frequency deviation results without compensating for the frequency error.

The following image shows the frequency deviation of the first octet in the payload of a Basic Rate signal (high deviation).

Bluetooth Free	q Dev vs Time								-	
View: Octet -	© 500 kHz									
Octet# 1 Out of 338	- 1 m	∆f1max1 33.861 kHz f1ccf		max3 97 kHz		Δf1max5 135.833 kHz			1max7 146 kHz	
out of 550	。 Pos:	-34.495 Hz								
	0.000 Hz				\searrow		\searrow			
		∆f1ma -135.063			\f1max4 6.103 kHz		∆f1m -135.23(Δf1max8 135.169 kHz
	-500 kHz									
Autoscale	Pos	: 3.271 ms						4	Scale:	8.000 us
ΔF1avg:	Hz	Drift fi-fo:	-235.4 Hz	:	Freq (Offset Pream	ble:	139.3 H	Iz	
ΔF2avg:	135.4 kHz	Max Drift fŋ-f₀:	-267.0 Hz	/ 27:	L Max F	req Offset (P	ayload):	-127.7	Hz / 2	71
Δ F2avg/ Δ F1avg:		Max Drift fŋ-ftŋ-s:	-127.7 Hz	/ 27:	L _e					

The following image shows the frequency deviation of the first octet in the payload of a Basic Rate signal (low deviation).



BT Frequency Dev Vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 鄻

The Setup settings for BT Freq Dev vs. Time are shown in the following table.

Settings tab	Description
Standard Params	Select the standard, measurement filters, and power class (when applicable). You can also set the analyzer to auto detect the standard.
Analysis Params	Specifies frequency error, frequency offset, measurement BW, and test patterns. You can also select to auto detect test patterns. These parameters are used by the instrument to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) and Time Zero Reference (Trigger or Acquisition Start) for Bluetooth Analysis displays.
Trace	Allows you to select the number of points per symbol, content, and to choose between entire packet view or zoom Octet view for a chosen octet number in a packet.
Scale	Allows you to specify the horizontal and vertical scale settings.
Prefs	Allows you to select to show or hide the graticule and marker readouts.

Bluetooth 20dB Bandwidth display

The BT 20dB BW display shows the results of two Bluetooth measurements: 20dB Bandwidth and Frequency Range. When the xdB BW is chosen, the display shows the x dB bandwidth from the peak power. More detailed information about this measurement is available here (see page 307).

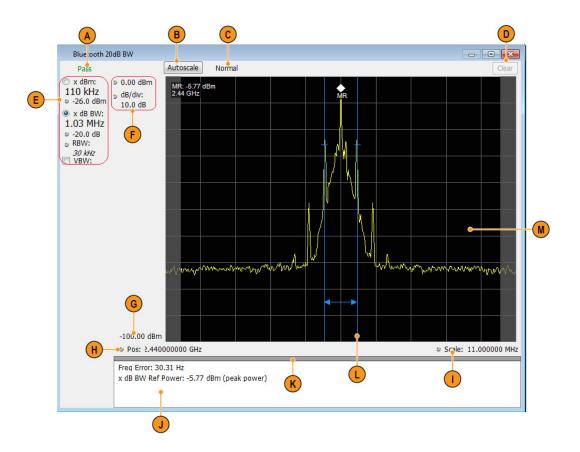
To display the BT 20dB BW display:

- 1. Select the **Displays** button or **Setup** > **Displays**.
- 2. In the Select Displays dialog, select Bluetooth Analysis in the Measurements box.
- **3.** In the **Available displays** box, double-click the **BT 20dB BW** icon or select the icon and click **Add**. The BT 20dB BW icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select the Standard Params tab. Set the Standard, Power class (when appropriate), and Measurement and Reference filters as appropriate for the input signal. You can also check the Auto Detect Standard box.

- 6. Select the Trace tab and set the Content to Vectors or Points, as required.
- 7. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image of the BT 20dB BW display shows a Basic Rate signal that would allow you to measure 20 dB bandwidth.



ltem	Display element	Description
A	PASS / FAIL	Indicates Pass or Fail for the 20 dB BW measurement.
В	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.
С	Normal / MaxHold	Indicates whether the measurement is done with a MaxHold or a Normal condition.
D	Clear	Resets count for Average and MaxHold functions. Enabled only when Averaging or MaxHold is enabled. Pressing Clear will clear the trace and, if acquisition is running, restart the averaging or hold process.
E	Main results area	Shows the xdBm and xdB results. The requested dB or dBm value can be set in the controls below the result readout. Use the two radio buttons to select which of the two results are illustrated in the graph with the blue lines and arrows. RBW also can be set using the control. VBW enables the VBW (Video Bandwidth) filter. Displays current VBW filter setting. See Setup > Settings > Freq & RBW tab.
F	Position and dB/div	Position sets the top of graph value. The dB/div setting is the vertical scale value.
G	Bottom readout	Displays the value indicated by the bottom of graph.
Н	Position	Displays the horizontal position of the trace on the graph display.
I	Scale	Adjust the span of the graph in symbols.
J	Detailed results	Displays the following additional measurements results:
		Freq Error: The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the analyzer.
		x db BW Ref Power : The peak power measured within the measurement bandwidth.
К	Grid divider	Determines the portion of the display allocated to the graph and detailed results area. You can move the grid divider all the way to the top or bottom and any position in between.
L	Blue lines	Indicates the measurement positions.
М	Plot	Displays the input signal. Shaded areas indicate the measurement bandwidth (Settings > Parameters tab > Measurement BW).

BT 20dB BW settings

Menu Bar: Setup > Settings

Application Toolbar: 🕸

The Setup settings for BT 20dB BW are shown in the following table.

Settings tab	Description
Freq & RBW	Allows you to specify the frequency, resolution bandwidth (RBW), step, and VBW used for the MCPR measurements.
Parameters	Allows you to specify the x dB level, Measurement Direction, Measurement BW, xdBm level, xdBm Range, and to enable averaging and the Max Hold function.
Scale	Allows you to define the vertical and horizontal axes.
Prefs	Allows you to specify the radix of the marker readout and whether elements of the graphs are displayed.

Bluetooth InBand Emission display

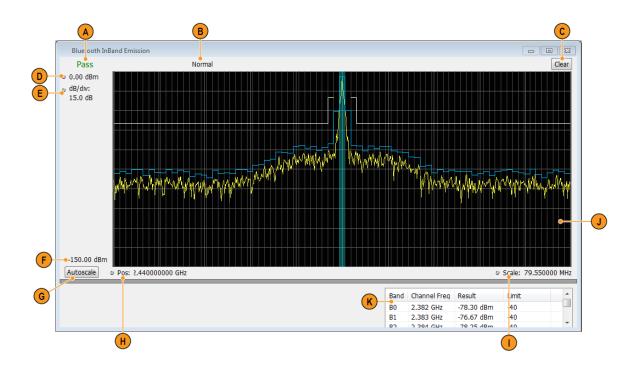
The BT InBand Emission display verifies whether the emissions inside the operating frequency range are within limits. The power in adjacent channels of 1 MHz bandwidth around the frequency of transmission are calculated and compared against limits. The integrated power in the 1 MHz band for the adjacent channels is shown in a table below the plot.

To display the BT InBand Emission display:

- 1. Select the **Displays** button or **Setup** > **Displays**.
- 2. In the Select Displays dialog, select BT Inband Emission in the Measurements box.
- 3. In the Available displays box, double-click the BT Inband Emission icon or select the icon and click Add. The BT Inband Emission icon will appear in the Selected displays box and will no longer appear under Available displays.
- 4. Click **OK** to show the display.
- 5. Select the Standard Params tab and select the appropriate standard.
- 6. Select the Measurement Params tab and turn on averaging, if desired.
- 7. Select the Limits tab and set the desired limits.
- 8. Select Replay/Run to take measurements on the acquired data.

Elements of the Display

The following image shows the BT Inband Emission display of a Basic Rate signal operating at 2.441 GHz (showing 80 adjacent bands).



ltem	Display element	Description
A	PASS / FAIL	Indicates Pass or Fail based on the number of adjacent channels that are below an upper limit. A maximum of 3 adjacent channels can have integrated power higher than an upper limit (Pass); otherwise, Fail is reported.
В	Normal	Displays Average Count if Average is turned on (set to Time Domain or Frequency Domain) from the Measurement Params tab in the Settings control panel.
С	Clear	Resets measurement. Clears all values.
D	Top of graph	The vertical scale is normalized with appropriate power units.
E	dB/div	The vertical scale value.
F	Bottom readout	Displays the value indicated by the bottom of graph.
G	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.
Н	Position	Displays the horizontal position of the trace on the graph display.
I	Scale	Adjust the span of the graph in symbols.
J	Plot	Divides the spectrum into different adjacent channels (each of 1 MHz bandwidth) as suggested in the standard document. You can select to show integrated power by checking the <i>Show power levels in graph</i> box in the Prefs tab in the Settings control panel). The integrated power level is shown in blue and the prescribed limits for comparison (set in the Limits tab of the Settings control panel) are shown in white. The region around the frequency of transmission is shown in a different color.
К	Results table	Reports the integrated power results (Channel frequency, Integrated power, and Limits) from the display in a table.

Bluetooth Analysis Measurement Settings

Application Toolbar: 💐

The control panel tabs in this section are shared between the displays in Bluetooth Analysis (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a subset of displays. The settings available on some tabs change depending on the selected display.

Settings tab	Description		
<u>Standard Params (see page 377)</u>	Specifies the input signal standard and additional user-settable signal parameters.		
Analysis Params (see page 379)	Specifies parameters used by the application to analyze the input signal.		
Analysis Time (see page 380)	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for Bluetooth Analysis displays.		
Trace (see page 383)	Specifies the trace type (Vectors, Points, and Lines), the number of points per symbol when chosen to view as Vectors or Lines, and to control the view as Freq Dev or IQ.		
Prefs (see page 385)	Allows preferences with Radix display and marker readouts.		
Scale (see page 382)	Defines the vertical and horizontal axes.		
Parameters (see page 386)	Specifies parameters used to analyze the signal.		
Freq RBW (see page 388)	Allows you to set Frequency and RBW settings for the BT 20 dB BW display.		
Limits (see page 381)	Allows you to define limits for pass/fail comparison with calculated values. The default values are as recommended in the test specification.		
Measurement Params (see page 389)	Allows you to set average (Time Domain, Off, or Frequency Domain) and to correct for noise floor.		

Common controls for Bluetooth Analysis displays

Standard Params tab - BT

The Standard Params tab allows you to specify the standard, measurement and reference filters, power class (for some standards), and set standard auto detect.

The following image shows the tab for all of the Bluetooth displays except for the BT InBand Emission display. The Power Class menu only appears when Basic Rate is the selected standard.

Standard Params	Analysis Params Analysis Time	e Trace Prefs	
Standa	ard: Basic Rate 🔹	Measurement Filter:	None
Channel Bandwid	ith: 1MHz	Reference Filter:	None 🔻
Power C	ass: 1		

The following image shows the tab for the BT InBand Emission display.

Standard Params	Analysis Params Analysis Time Trace Prefs
Standa	rd: Basic Rate 👻

Settings	Description	
Standard Select the appropriate standard: Basic Rate, Low Energy, or Rate.		
Auto Detect Standard	Check box to enable automatic detection of the Bluetooth standard (Basic Rate, Low Energy, or Enhanced Data Rate). A status message will appear indicating which of the three standards is detected and the result will show as Standard selection.	
Measurement Filter	Specifies the filter used for measurement. The default filters for the Low Ener and Basic Rate standards are LE-Recommended and BR-Recommended, respectively.	
Reference Filter	Specifies the filter used as a reference.	
Power Class (only available for Basic Rate)	Select one out of three available power classes. This sets the default limits for comparison (set in the Limits tab of the Settings control panel) for Average and Peak power measurements.	

Power class for the Basic Rate standard

The power class for Basic Rate is the reference receive power range as specified by the standard. It sets the default limits for comparison in the Limits tab of the control panel for Average and Peak power measurements. The power classes are specified as follows:

Class 1: max power 20 dBm (100 mW) with mandatory power control.

Class 2: max power 6 dBm (4 mW) with optional power control.

Class 3: max power 0 dBm (1 mW) with optional power control.

Recommended measurement and reference filters

The available measurement and reference filters depend on the selected standard. You can use the filters recommended by the standard (shown in following table) or load your own filters by selecting one of the User defined filters from a file.

The measurement filter is applied before the demodulation bit is detected and the ideal reference is calculated.

The reference filter is applied to the internally generated ideal reference signal.



CAUTION. Although there may be other filter types listed in the drop down menu, if you select any filter other than that which is recommended, the measurement results may not be accurate.

Standard	Measurement filters Reference filters		
Basic Rate	BR-Recommended	None	
Low Energy	LE-Recommended	None	
Enhanced Data Rate	BR-Recommended	None	

How to select filters

In a signal transmitter/receiver system, the baseband signal might be filtered for bandwidth limiting or for another kind of necessary shaping that needs to be applied. Normally, a filter in the transmitter (Ft) and a filter in the receiver (Fr) are applied.

The Measurement Filter setting in the analyzer corresponds to the baseband filter in the receiver (Fr): This setting tells the analyzer what filter your receiver uses. When the analyzer is set to the same filter used by the receiver, the analyzer sees the signal as your receiver would. The Measurement Filter setting should be the same as the filter used in the receiver under normal operation (as opposed to testing).

Analysis Params tab - Bluetooth

The Analysis Params tab contains parameters that control the analysis of the input signal. The Test Patterns menu only appears when the Auto Detect Test Pattern is not checked. This tab is available for all displays except for the BT 20dB BW and the BT InBand Emission displays.

Standard Params Analysis Params	Analysis Time Limits	
Frequency Offset: 552.5 Hz	Auto	Auto detect Test Pattern
Measurement BW: 6.401 MHz	Auto 💌	Test Patterns: Other High Deviation (01010101) Low Deviation (00001111) Other

Settings	Description	
Frequency Error	When the Auto box is checked, the analysis determines the Frequency Error and the measured Frequency Error is displayed. When the Auto box is unchecked, the entered value is used by the analysis as a fixed frequency offset. This is useful when the exact frequency offset of the signal is known.	
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made. Select Manual, Auto, or Link to Span.	
Auto Detect Test Pattern	When this box is checked, automatic detection of the test pattern is enabled. When this box is unchecked (Manual mode), automatic detection id disabled and you can select the test pattern and specify the Δ favg for the other pattern for ratio computation.	
Test Pattern	Allows you to select the test pattern to be analyzed. This choice is available only when Auto Detect Test Pattern is disabled.	

Analysis Time tab - Bluetooth

The Analysis Time tab contains parameters that define how the signal is analyzed in the Bluetooth Analysis displays. This tab is available for all displays except for the BT 20dB BW and the BT InBand Emission displays.

Standard Params An	alysis Params	nalysis Time Trace	Prefs	
Analysis Offset:	0.000 s	🗹 Auto	Time Zero Reference:	Trigger 🔹
Analysis Length:		🗖 Auto	Units:	Seconds 🔹
Available:	0.000 s			

Description		
Specifies the location of the first time sample to use in measurements.		
When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.		
Specifies the length of the analysis period to use in measurements. Length is specified in either symbols or seconds, depending on the Units setting.		
When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.		
This is a displayed value, not a setting. It is the Analysis Length (time or symbols) being used by the analyzer. This value may not match the Analysis Length requested (in manual mode).		
Specifies the zero point for the analysis time.		
Specifies the units of the Analysis Length to either Symbols or Seconds.		

Analysis Offset

Use analysis offset to specify where measurements begin. Be aware that you cannot set the Analysis Offset outside the range of time covered by the current acquisition data. (All time values are relative to the Time Zero Reference.)

You can set the Analysis Length so that the requested analysis period falls partly or entirely outside the current range of acquisition data settings. When the next acquisition is taken, its Acquisition Length will be increased to cover the new Analysis Length, as long as the Sampling controls are set to Auto. If the Sampling parameters are set to manual, or if the instrument is analyzing saved data, the actual analysis length will be constrained by the available data length, but in most cases, measurements are able to be made anyway. The instrument will display a notification when measurement results are computed from less data than requested. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed. As you adjust this value, the actual amount of time for Analysis Length, in Symbol or Seconds units, is shown below the control in the "Available" readout. This setting is not available when Auto is checked. Range: minimum value depends on the standard. Resolution: 1 symbol.

Time Zero Reference

All time values are measured from this point (such as marker position or horizontal position (in Y vs Time displays). Choices are: Acquisition Start or Trigger.

Parameter	Description
Acquisition Start	Time zero starts from the point at which the acquisition begins.
Trigger	Time zero starts from the trigger point.

Limits tab - Bluetooth

This tab is only available for the BT CF Offset and Drift, BT InBand Emission, and BT Summary displays. It enables you to load an existing limits table, save a limits table, or edit limits values. The content under Measurement Name varies based on the chosen standard and power class.

Some measurements are done only when a specific test pattern is detected. If the specific pattern is not detected, then N/A appears in blue in the BT Summary display because the measurement is not done. If the measurement is done, Pass or Fail is shown in the BT Summary display.

The following image shows the Limits tab for the BT CF Offset and Drift and BT Summary displays.

Standa	rd Pa	rams Analysis Params Analysis T	Time Limits		
	On	Measurement Name	Limit	-]
	\checkmark	BDR_DeltaF1Avg_Max	175.0 kHz	=	l r
	√	BDR_DeltaF1Avg_Min	140.0 kHz		ĮĮ
	√	BDR_DeltaFResult	115.0 kHz		
	√	BDR_DeltaFPercent	99.00 Percent		
	√	F2F1AvgRatio	0.8000		
	√	BDR_FreqOffsetPreamble	150.0 kHz	-	

The following image shows the Limits tab for the BT InBand Emission display.

Standard Params Freq & RB	W Measurement Params	Scale Prefs	Limits
fTX +\- 2 MHz Limit :	-20.0 dBm		
fTX +\- [3+n] MHz Limit:	-40.0 dBm		

Settings	Description
Load	Click to load a saved Limits table from a .csv file.
Save	Click to save the current Limits table to a .csv file.

Edit limits

To directly edit measurement limits in the table, click on the value in the Limit column that you want to change. The following table describes the parameters that are set in the Limits Table.

Settings	Description				
On	Click on the cell in the On column next to the measurement to specify whether or not measurements are selected for limit comparison to indicate Pass or Fail. A check mark means the measurement will be taken. An empty box means it will not be taken.				
Measurement Name	Specifies the name of the measurement related to the limit. (Not editable.) The content under Measurement Name varies based on the chosen standard and power class.				
Limit	Specifies the value of the limit to the related measurement. When the cell is selected, the value is shown along with the units.				

Scale tab - Bluetooth

The Scale tab allows you to change the scale settings that control how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls. The Scale tab values are unique to each display. Also, note that each display uses horizontal and vertical units that are appropriate for that display. There are three versions of the Scale tab for Bluetooth displays.

The following image shows the Scale tab for the BT 20dB BW and BT InBand Emission displays.

Standard Para	ams Freq & RBW M	leasurement Params Scale	Prefs Lim	iits		
Vertical			-H	Horizontal		
Scale:	200.00 dB			Scale:	79.550000 MHz	
Position:	0.00 dBm	Reset Scale		Position:	2.441000000 GHz	
	Autoscale				Autoscale	

The following image shows the Scale tab for the BT Eye Diagram display.

Standard Par	ams Analysis Params	Analysis Time	Trace	Scale	Prefs		
Vertical						Horizontal	
Scale:	100 GHz					Scale:	2 Symbol
Position:	0.000 Hz					Position:	0 Symbol
	Autoscale						Autoscale

The following image shows the Scale tab for the BT Freq Dev vs Time display.

Standard Par	ams Analysis Params	Analysis Time	Trace Scale	e Prefs		
Vertical					Horizontal	
Scale:	100 GHz				Scale:	0.000 s
Position:	0.000 Hz				Position:	0.000 s
	Autoscale				🔽 Auto	Autoscale

Settings	Description			
Vertical	Controls the vertical position and scale of the trace display.			
Scale Changes the vertical scale of the graph.				
Position Adjusts the reference level away from top of the graph.				
Autoscale Resets the scale of the vertical axis to contain the complete trace.				
Horizontal	Controls the horizontal span of the trace display and position of the trace.			
Scale	Allows you to, in effect, change the horizontal span.			
Position	Allows you to pan a zoomed trace without changing the frequency.			
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.			
Auto	When Auto is checked, the scale and position values for the Symbols graph are automatically adjusted to maintain the optimal display.			
Reset Scale	Resets all settings to their default values.			

NOTE. The Units used for the horizontal scale for the BT Freq Dev vs Time display can be either Seconds or Symbols. To set the units for the horizontal scale, display the Analysis Time tab. On the tab, select the appropriate units from the Units drop-down list.

Trace tab - Bluetooth

The Trace tab allows you to set the trace display characteristics of the BT Constellation, BT Eye Diagram, and BT Freq Dev vs Time displays. The selections vary depending on the selected display.

The following image shows the tab for the BT Constellation display.

Standard Params Ana	alysis Params	Analysis T	ime Trace I	Prefs	
Trace:	Trace1	•	Show	Freeze	
Points/Symbol:	4	•	Trace Type:	Freq Dev 🔻	
Content:	Vectors	•			

The following image shows the tab for the BT Eye Diagram display.

Standard Params	Analysis Params	Analysis Time	Trace g	Scale Prefs	
Points/Symb	ool: 4	▼ Trac	ce Type:	Freq Dev	•

The following image shows the tab for the BT Freq Dev vs Time display.

Standard Params	Analysis Params	Analysis Time	Trace	Scale	Prefs
Points/symbol:	4 •				
Content:	Vectors 🔻				

Setting	Description		
Trace	Select the trace to display.		
Show	Shows / hides the selected by trace.		
Freeze	Halts updates to the selected trace.		
Points/Symbol	Select how many points to use between symbols when connecting the dots. Values: 1, 2, 4, 8, 16, and 32.		
Content	Select whether to display the trace as vectors (points connected by lines), points (symbols only without lines), or lines (lines drawn between symbols, but no symbols are displayed). The choices available depend on the display.		
Trace Type	Select to specify whether the plot is shown as IQ or as Frequency Deviation.		
View	Allows you to see the full packet or only the chosen Octet.		
Octet # (of xx)	Allows you to view the specified octet. You can also select from the list of the available number of Payload octets in the packet.		

Comparing two traces in the BT Constellation display

You can use the Traces tab to enable the display of a second trace. The second trace is a version of the current acquisition. You can choose to freeze a trace in order to display the current live trace to an earlier version of itself, you can display the trace as a second trace, or you can choose to display both traces frozen in order to compare the trace to itself at different times.

To display a second trace in the BT Constellation display:

- 1. If more than one display is present, select the BT Constellation display to ensure it is the selected display.
- 2. Click 🥮.
- 3. Select the Trace tab.
- 4. Select Trace 2 from the Trace drop-down list.
- 5. Click the Show check box so that it is checked.
- 6. Specify the Content as desired.

The Trace 2 lines will appear in blue to help you distinguish Trace 2 from Trace 1.

Prefs tab - Bluetooth

The Prefs tab enables you to change appearance characteristics of some of the Bluetooth Analysis displays.

The following image shows the Prefs tab for the BT 20dB BW, BT Freq Dev vs Time, BT Eye Diagram, and BT Constellation displays.



The following image shows the Prefs tab for the BT InBand Emission display.

Standard Params	Freq & RBW	Measurement Params	Scale	Prefs	Limits
Trace points	801	 Trace detection 	tion:	+Peak	•
🔽 Show gra	ticule	🔽 Show Ma	rker rea	idout in	graph (selected marker)
		Show po	wer lev	els in gra	aph

The following image shows the Prefs tab for the BT Symbol Table display.

Standard Params Analysis Params Analysis Time Prefs
Radix: Binary 👻
🖾 Charry Markes seadout is small (selected markes)
Show Marker readout in graph (selected marker)

Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Radix	Specifies how symbols are displayed in the Symbol Table display and in the Marker readout in the display. There are three choices for Radix: Binary (0,1) and Modulation Symbols (+1,-1). When EDR is detected, the symbol table will always show results in Hex for the PSK region (after guard).
Trace detection	+Peak : Shows the peak power in a bin (of chosen RBW) if there are multiple points to choose from within a bin.
	Avg (VRMS): Shows the average power in a bin (of chosen RBW) if there are multiple points to choose from within a bin.
Show power levels graph	Displays the calculated power levels in graph in each band.

Parameters tab - Bluetooth

The Parameters tab enables you to specify several parameters that control signal acquisition in the BT 20dB BW display.

Freq & RBW Parameters Sc	ale Prefs				
x dB level:	-26.0 dB	x dBm level:	-26.0 dBm	🔲 Max Hold spectral da	ata
Meas Direction:	Inwards 👻	Meas Range:	Lower -		Count:
Measurement BW:	10.00 MHz			Average results	10

Setting	Description
x dB level	x dB level defines the x dB BW level search threshold.
Meas Direction	Specifies which way the search for the x dB level is done. Selecting Inwards directs the search for x dB from the edges towards maximum power. Selecting Outwards directs the search for x dB from maximum power (x dB ref power) to edges.
x dBm level	x dBm level defines the x dBm BW level search threshold.
x dBm range	Specifies the search direction for the x dBm level. The choices are Lower, Higher, or Both.
Measurement BW	Specifies the frequency range used by the measurement.
Max Hold spectral data	Enables the Max Hold function.
Average results	Enables/disables results average across acquisitions. (This is averaging of the results, not of the trace.)
Count	Specifies the number of results averaged to calculate the Occupied BW. Range: 2 to 10,000.

x dB level

The x dB level determines the x dB bandwidth. The analyzer analyses the spectrum trace to locate the frequencies at which the level is x dB down from the peak level, calculated over the measurement bandwidth. The frequency difference between the upper and lower crossing thresholds is the x dB BW.

Range: -80.0 to -1.0 dB; Resolution: 0.1%; Inc/dec small: 0.1%, large: 1%; Default: -20 dB

Meas Direction

The search for the x dB level or x dBm level can be done by selecting Inwards or Outwards in Meas Direction. Selecting Inwards directs the search from the edges towards maximum power. Selecting Outwards directs the search from maximum power (x dB ref power or CF for x dBm) to edges.

x dBm level

The x dBm level determines the x dBm bandwidth. The analyzer analyzes the spectrum trace to locate the frequencies at which the level is x dBm down from the Center frequency. The frequency range is calculated based on the choice of x dBm Range. The value of x dBm is set to -30 dBm when the BT 20dB BW display is launched from the Bluetooth Standards Presets.

Meas Range (Higher, Lower, Both)

This determines the search range for the x dB level. The options are as follows:

- Lower: Indicates the frequency range from center to the lower frequency at which the power level drops to x dBm.
- Higher: Indicates the frequency range from center to the higher frequency at which power level drops to x dBm.
- **Both**: Indicates the frequency between the upper and the lower crossing thresholds at which the power level drops to x dBm.

Max Hold spectral data

Max Hold displays the maximum value in the acquisition record for each display point. Each new trace display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons.

Freq & RBW tab - Bluetooth

The Freq & RBW tab allows you to specify the bandwidth parameters used for setting measurement bandwidth in the BT 20dB BW display. This determines what acquisition bandwidth the measurement will request.

Freq & RBW Parameters Scale Prefs					
Meas Freq:	2.44100 GHz		RBW:	30 kHz	🔽 Auto
Step:	1.0000 MHz	🔽 Auto	VBW:		

Setting	Description	
Meas Freq	Specifies the measurement frequency.	
RBW	Select Auto or Manual. Adjusts the resolution bandwidth for the entire measurement This setting is independent of the Spectrum display's RBW setting.	
Step	Sets the increment/decrement size for the adjustment of the center frequency. If Auto is enabled, the analyzer will adjust the step size as required.	
VBW	Adjusts the video bandwidth.	

Measurement Params tab - Bluetooth

The Measurement Params tab is only available for the BT InBand Emission display. It allows you to select the average domain and if you want to correct for noise floor.

Standard Par	ams Freq & RBW	Measurement Paran	ns Scale	Prefs L	imits
Average:	Frequency Domai	n 🔻 Number:	10]	
Correct f	for Noise Floor				

Setting	Description
Average	Specify the average domain (Time Domain, Frequency Domain) or set Average to Off. If a domain is selected, then you can also specify the number.
Number Specify the number value associated with the Average setting.	
Correct for Noise Floor	Check the box next to this setting to correct for noise floor. This is disabled (unchecked) by default.

Overview

Audio Analysis measures basic time- and frequency-domain parameters of analog audio signals modulated on a carrier (AM, FM and PM modulation) or unmodulated (non-carrier) audio signals (Direct).

For modulated signals, the measurement analysis first demodulates the signal to provide the *Audio signal* waveform. Direct input signals bypass the demodulation step. For FM and PM demodulation, the carrier frequency error is estimated during demodulation.

The Audio signal waveform excursions are then measured to determine the Peak and RMS waveform parameters. Next, the analysis detects the highest-amplitude frequency component within the audio bandwidth, and makes a high-accuracy frequency measurement of the frequency component. This value is called the *Audio Frequency*.

A spectral analysis of the Audio signal waveform is performed to determine the presence and level of harmonically- and/or non-harmonically-related narrowband spurs and wideband noise. The Audio signal, harmonic and non-harmonic spurs, and noise level data are combined to produce signal summary parameters including SINAD, Modulation Distortion, Signal-to-Noise, Total Harmonic Distortion, and Total Non-Harmonic Distortion.

Controls are provided to allow the user to select audio filters of Low Pass, High Pass, FM De-emphassis, or Standard-defined response, as well as completely user-definable filter response. Filtering can be applied as needed to modify the audio spectrum result before measurement to remove unwanted spurs or noise.

Flexible control parameters are provided to allow setting the Audio Bandwidth for analysis, the Resolution Bandwidth (RBW) and RBW filter type of the spectral analysis, and number and level qualifications for Harmonic and Non-harmonic spur detection. Multiple-spectrum averaging can be enabled to provide a smoothed spectrum for results with less variability than single-spectrum results.

The Audio Spectrum display shows the frequency spectrum waveform with detected harmonic and non-harmonic components identified by markers, and a corresponding table of frequency and level values for the spur components. The markers and table provide easy visualization of the significant spurs and their relation to the fundamental Audio frequency signal.

Audio Spectrum Display

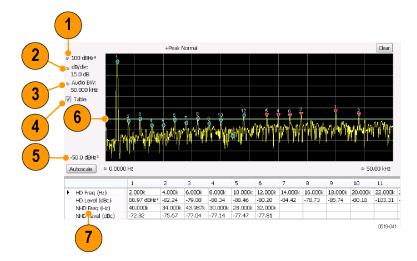
The Audio Spectrum display shows audio modulation characteristics. You can choose to show just the spectrum of the audio signal or show the audio spectrum of the signal and the results of distortion measurements. The Audio Spectrum display can show a table listing the frequency of a Harmonic Distortion (HD) and Non-Harmonic Distortion (NHD) and its level. The Spectrum graph indicates these harmonics and non-harmonics with special markers.

To display the Audio Spectrum display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select Audio Analysis.

- **3.** Double-click the **Audio Spectrum** icon in the **Available Displays** box. This adds the Audio Spectrum icon to the **Selected displays** box.
- 4. Click the **OK** button. This shows the Audio Spectrum display.

Elements of the Audio Spectrum Display



ltem	Display element	Description		
1	Vertical position Sets the top of graph value.			
2	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.		
3	Audio BW	Specifies the measurement bandwidth of the Audio Spectrum display, which in turn can influence the acquisition bandwidth.		
4	Table	Displays a table that shows the distortion measurement results and displays indicators on the graph that highlight the location of the harmonics on the trace.		
5	Bottom of graph readout	Displays the bottom of graph value.		
6	Non-harmonic threshold indicator	Displays the threshold for detecting non-harmonic components.		
7	Analysis results	Display of the audio analysis results.		

Audio Spectrum Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The measurement settings for the Audio Spectrum display are shown in the following table.

Settings tab	Description
Params1 Tab (see page 395)	Specifies signal type, Audio Bandwidth, RBW, RBW filter, and Ref Audio Frequency.
Params2 Tab (see page 397)	Specifies Harmonics and Non-Harmonics measurement parameters.
Audio Filters Tab (see page 398)	Specifies the audio filter characteristics.
Scale Tab (see page 400)	Sets vertical and horizontal scale and position parameters.
Prefs Tab (see page 403)	Specifies vertical units, and whether on not some features are displayed in the graph.

Audio Summary Display

To display the Audio Summary display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select Audio Analysis.
- **3.** Double-click the **Audio Summary** icon in the **Available Displays** box. This adds the Audio Summary icon to the **Selected displays** box.
- 4. Click the **OK** button. This shows the Audio Summary display.

The Audio Summary Display

Audio Summary Displayed Measurements

Table 8: Audio Summary Measurements

Signal type	Item	Description	
		Average power of the carrier signal with modulation removed.	
Direct	Signal Power	Average power of the input signal	
FM, PM	Carr Freq Err	Carrier frequency error	
AM, FM, PM. Direct	Audio Freq	Fundamental audio frequency	
	+Peak	+Peak modulation excursion (where the modulation excursion readout depends on the signal type) ¹	
	-Peak	-Peak modulation excursion (where the modulation excursion readout depends on the signal type) ¹	
	Peak-Peak/2	Half peak-peak modulation excursion (where the modulation excursion readout depends on the signal type) ¹	
	RMS	RMS modulation excursion (where the modulation excursion readout depends on the signal type) ¹	
	SINAD	Signal to noise and distortion	

Signal type	Item	Description	
	Mod Distor	Modulation distortion	
S/N	An estimate of the Signal level to Noise (only) level, with the HD and NHD components removed		
	THD	Total harmonic distortion	
TNHD Ref Diff	Total non-harmonic distortion		
	Ref	Ref is the RMS modulation value stored when the Capture Reference button is pressed. (Displayed only when Hum & Noise is enabled.)	
	Diff	Diff is the difference between the current RMS mod value and the Ref value captured previously. (Displayed only when Hum & Noise is enabled.)	

Table 8: Audio Summary Measurements (cont.)

¹ For AM signal types, modulation excursion is "% Modulation Depth". For FM signal types, modulation excursion is "Frequency Deviation". For PM signal types, modulation excursion, it is actually "signal excursion".

Audio Summary Settings

Application Toolbar: 🕮

The measurement settings for the Audio Summary display are shown in the following table.

Settings tab	Description
Params1 Tab (see page 395)	Specifies signal type, Audio Bandwidth, RBW, RBW filter, and Ref Audio Frequency.
Params2 Tab (see page 397)	Specifies Harmonics and Non-Harmonics measurement parameters.
Audio Filters Tab (see page 398)	Specifies the audio filter characteristics.
Hum Noise Tab (see page 402)	Specifies whether or not Hum & Noise is measured and enables the capture of a signal to be used as a reference of the Hum & Noise measurement.

Audio Analysis Measurement Settings

The control panel tabs in this section are shared by the displays in the Audio Analysis folder (Setup > Displays).

Settings tab	Description
Params1 Tab (see page 395)	Specifies characteristics about the audio signal and how measurements are made.
Params2 Tab (see page 397)	Specifies parameters that control how measurements are made on harmonics.
Audio Filters Tab (see page 398)	Specifies characteristics of filters applied to the signal before measurements are taken.
Scale Tab (see page 400)	Sets vertical and horizontal scale and position parameters.
Prefs Tab for Audio Analysis (see page 403)	The Prefs tab enables you to change appearance characteristics of the Audio Analysis displays.

Common controls for Audio Analysis displays

Params1 Tab

The Params1 tab is used to specify characteristics of the audio signal to be measured and how the signal will be measured.

Params1	Params2 Au	idio Filters 🛛 Hu	m & Noise			
	Signal Type:	AM 👻]			
	Audio BW:	20.000 kHz]	RBW:	40.0 Hz	📝 Auto
Re	f Audio Freq:	2.000 kHz	🔽 Auto	RBW Filter:	Kaiser 🔻	

Params1 tab for AM signal types

Setting	Description		
Signal Type	Specifies the type of signal to be analyzed. The available choices are AM, FM, PM, and Direct.		
Audio BW	Specifies the bandwidth used for audio analysis.		
Ref Audio Freq	A measured value when Auto is selected. If you want to specify the reference audio frequency, uncheck Auto and enter a value manually. If Ref Audio Freq is set manual be aware that the automated detection is still performed, but it is limited to a frequen range of $\pm 1\%$ of the Audio BW centered around the manually specified value.		
Carrier Freq Error / Carrier Freq Offset	(FM and PM only) A measured value, when Auto is selected. If Auto is unchecked, you can specify the Carrier Frequency Offset.		
RBW	Displays the Resolution Bandwidth for Audio measurements. This value is automatically set by default to 1/500 of the measurement bandwidth. To manually specify the RBW, uncheck Auto. The minimum RBW value is limited to the larger of 1 Hz or AudioBW/10000. The maximum is limited to AudioBW/100.		
RBW Filter	Specifies the windowing method used for the transform.		

Setting Frequency for Direct Signal Types

Direct (unmodulated) signal analysis is only possible with the instrument Frequency control set to 0 Hz. You will receive a warning to set Frequency to 0 Hz when Direct signal type is selected, if you haven't already done so. Modulated signal types may be selected with Frequency set to 0 Hz, but results are not meaningful in that case. For modulated signals, Frequency should always be set to a value \geq Audio Bandwidth to avoid self-interference of the signal due to spectral folding.

Setting Audio Bandwidth

For AM, FM and PM, the Audio Bandwidth control sets not only the demodulated signal bandwidth, but also determines the pre-demodulation bandwidth. Set it to a value at least half the pre-demodulation signal bandwidth, as in this equation:

```
Audio BW \geq Signal Bandwidth / 2
```

NOTE. When performing audio analysis, you should allow the Audio BW control to automatically set the acquisition bandwidth, rather than manually adjusting the Acq BW control on the Sampling Parameters tab of the Acquire control panel. The audio measurement will cause the Acq BW setting to be \geq Audio BW (Direct) or $\geq 2 \times$ Audio BW (AM, FM, PM).

For Direct signals, set Audio Bandwidth large enough to include any significant harmonics/non-harmonics or other signal component of interest. For example, to measure up to the 10th harmonic of a signal with a 5 kHz fundamental component, set Audio Bandwidth to $10 \times 5 \text{ kHz} = 50 \text{ kHz}$.

For modulated signals, Audio Bandwidth must be set wide enough to include all significant signal modulation components in addition to the desired audio analysis bandwidth. For AM this is similar to Direct. For example, to measure up to the 10th harmonic of an AM signal with 3 kHz fundamental component, set Audio Bandwidth to $10 \times 3 \text{ kHz} = 30 \text{ kHz}$. This ensures that the bandwidth of the data provided by the system to the measurement will be at least of 60 kHz (2 x 30 kHz) which is sufficient for this signal and analysis requirement.

FM and PM are more complex. For FM, the analysis bandwidth needs to be at least twice as wide as the the sum of peak Frequency Deviation and the Fundamental Frequency (Carsons rule). This is a parallel condition along with setting Audio Bandwidth large enough for the maximum audio bandwidth to analyze. Therefore, for FM, Audio Bandwidth should be:

AudioBW (FM) = MAX(MaxAudioAnalysisFreq, FreqDeviation+FundamentalFreq)

where MaxAudioAnalysisFreq is the highest audio frequency desired in the analysis. For example, for an FM signal with fundamental signal of 5 kHz and peak frequency deviation (one-sided) of 10 kHz, Acquisition Bandwidth should be at least (2*(10k+5k)) = 30 kHz, or an Audio Bandwidth of 15 kHz. Also if the analysis should extend to the 8th harmonic, then the Audio Bandwidth needs to be at least 8*5 kHz = 40 kHz. So Audio Bandwidth should be set to 40 kHz. Using the equation:

AudioBW(FM) = MAX(8x5kHz, (10+5)kHz) = MAX(40 kHz, 15kHz) = 40 kHz

The formula for PM is:

```
AudioBW (PM) = MAX (MaxAudioAnalysisFreq, PMFreqDeviation+FundamentalFreq)
```

where

```
PMFreqDeviation = PMPhaseDeviationInRadians x FundamentalFreq
```

RBW Filter Shape

Select Kaiser in most cases for best measurement performance. Select Flattop only if you want to use standard markers to measure signal amplitude with highest accuracy.

Params2 Tab

The Params2 tab is used to specify how the signal harmonics are measured and to control spectrum averaging.

Params1 Params2 A	udio Filters So	cale	Prefs		
				-Non-Harmonics only	/
No. of Harmonics	5: 12			Ignore region:	0.0 Hz
No. of Non-Harmonics	5: 12			Threshold:	-65.0 dBc
Averaging	: 10			Excursion:	6.0 dB

Setting	Description	
No. of Harmonics	Specifies the number of harmonics to detect. The detected harmonics are tagged with a number on the spectrum trace. The available range is 1–20.	
No. of Non-Harmonics Specifies the number of non-harmonics to detect. The detected non-harmonics tagged with a number on the spectrum trace. The available range is 0–20.		
Averaging	Specifies the number of averages used to compute the results. Range: 2–100.	
Ignore region Specifies the region about the signal frequency where the instrument will ig non-harmonics.		
Non-Harmonic Threshold Specifies the level which a spectrum peak must exceed to be declared a non signal component.		
Non-Harmonic Excursion	Specifies the difference in level between a spectrum peak and the average noise level that must be exceeded for the peak to be declared a non-harmonic signal component.	

About Averaging In Audio Analysis Displays

Analysis averaging is implemented using a "block" method. This means that the entire record required for multiple spectrum computations is acquired and analyzed within one analysis cycle. The result of each analysis update is a complete, independent result from a set of N spectrums averaged together, where N is the Averaging control value.. Since each update is a fully averaged result, no partially averaged results are output before a final result is available, so each output is fully valid. However, with large Averaging values, acquisition record sizes and measurement times may become large, so care should be taken to select the minimum amount of averaging needed.

Audio Filters Tab

The Audio Filters tab is used to specify filters to be applied to the acquired audio signal before measurements are taken. You can select from pre-defined filters or use a filter you define in a text file. You can also specify the de-emphasis time constant applied to the audio signal and the telecom weighting filters used to measure noise.

Params1 Params2 Audio Filters Scale Prefs	
● Pre-defined Filters ✓ LPF: 300 Hz ▼	De-emphasis: 25 µsec 🔻
HPF: 50 Hz	Standard: CCITT 🔹
© File:	

Pre-defined Filters

You can specify low-pass filter (LPF) and high-pass filter (HPF) settings, a de-emphasis time constant and/or a telecom weighting filter to match the response of your receiver. Alternatively, you can create a text file to specify the frequency response points.

To use pre-defined filters:

- 1. Select the Pre-defined Filters option button.
- 2. Select the LPF, HPF, De-emphasis and Standard check boxes as appropriate.
- **3.** Select the desired filter parameter from the drop-down list for each of the enabled filters or select User from the list if you wish to use a custom value. For LPF and HPF, the listed frequencies represent the 3dB cutoff point of the filter.
- 4. If you select User from the drop-down list, enter a value in the text entry box that appears.

To disable all filtering:

- 1. Select the Pre-defined Filters option button.
- 2. Deselect all four filter check boxes.

Filter type	Available settings		
LPF (Low Pass Filter)	300 Hz		
(5th-order Butterworth response)	3 kHz		
	15 kHz		
	30 kHz		
	80 kHz		
	300 kHz		
	User 1		
HPF (High Pass Filter)	20 Hz		
(5th-order Butterworth response)	50 Hz		
	300 Hz		
	400 Hz		
	User ¹		
De-emphasis (FM only)	25 µs		
	50 µs		
	75 μs		
	750 µs		
	User. Range: 25 µs to 10 ms		
Standard	CCITT		
	C-message		

Table 9: Predefined audio filters

¹ User-entered values are restricted to maximum of 0.9 * Audio BW, and will automatically adjust downward to meet this limit (if required) when AudioBW is decreased.

Standard. Use this setting to specify the telecom weighting filter. The characteristics of these filters are described in ITU-T Recommendation O.41, Psophometer for Use on Telephone-type Circuits.

Using Custom Audio Filters

If you want to use audio filters that have a different response shape than the pre-defined filters, you can create a custom audio filter using a text or CSV file to specify the desired filter frequency response.

To use a custom audio filter:

- 1. Verify that Audio Spectrum or Audio Summary is the selected display.
- 2. Click the Settings icon or select Setup > Settings.
- 3. Select the Audio Filters tab.
- 4. Click the File button.
- 5. Click the ... button and navigate to the location of the custom audio filter file you wish to use. Select the file you want to use and click Open.
- 6. Acquire a new trace or replay a saved file to see the effect of the custom filter.

Creating a Custom Audio Filter. A custom audio filter file is either a plain text file or a CSV format file. The file contains frequency (in Hz) and amplitude (in dB) value pairs which specify the filter frequency response shape. Each pair must be on a separate line. The filter response between the points is interpolated using a cubic spline fit.

The following table shows the first few lines of a custom audio filter text file.

0,	-100
16.66,	-85
50,	-63
100,	-41
200,	-21
300,	-10.6
400,	-6.3
500,	-3.6
600,	-2
700,	-0.9
800,	0

Format and rule-checking on custom audio filter files is performed as follows:

- The maximum number of frequency and amplitude pairs is 1000.
- Column 1 (frequency values in Hertz).
 - Non-negative values only (zero is allowed).
 - Strictly increasing order of frequencies (frequency value on each line > frequency value on previous line).
 - There is no upper limit on the frequency value.
- Column 2 (amplitude values in dB units, where gain is a positive value and attenuation is a negative value).
 - Values are restricted to the range -200 to +20 dB.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change acquisition control settings. In effect, these controls operate like pan and zoom controls.

Params1 Param	ns2 Audio Filters S	cale Prefs		
Vertical			Horizontal	
Scale:	100 dB		Left:	0.0000 Hz
Position:	101 dBHz²	Reset Scale	Right:	200.0 kHz
	Autoscale		🔳 Log	Autoscale

Setting	Description	
Vertical		
Scale	Changes the range shown between the top and bottom of the graph.	
Position	Adjusts the level shown at the top of the graph for linear units or the top of the graph for log units (for example, dBm).	
Autoscale	Resets the Position so that the highest trace points are in the graph. For linear units (Volts, Watts), the Autoscale also adjusts Scale.	
Horizontal		
Left	Changes the frequency shown at the left side of the graph.	
Right	Changes the frequency shown at the right side of the graph.	
Autoscale	Resets the Left and Right settings to show the entire trace.	
Log	Sets the graph horizontal axis to a logarithmic scale.	
eset Scale Resets the Vertical and Horizontal settings to their default values.		

Hum & Noise Tab

Hum & Noise (available only when the Audio Summary display is the active display) is useful for comparing residual power or modulation if the Ref value is captured when the Signal is On (Direct) or modulated (AM/FM/PM). When the signal is turned off (Direct) or modulation turned off (AM/FM/PM), Diff indicates how much residual Hum and Noise are still present in the measurement value.

Params1	Params2	Audio Filters	Hum & Noise	
	🔽 Mea:	sure Hum & No	ise:	
	Captur	e reference no		

To display Hum & Noise measurement:

- 1. Select Setup > Displays.
- 2. In the Select Displays window, select the Audio Analysis folder.
- 3. Double-click the Audio Summary icon so that it appears in the Selected displays box.
- 4. Click OK
- 5. With the Audio Summary display selected, select Setup > Settings.
- 6. Select the Hum & Noise tab. Click on the Measure Hum & Noise checkbox so that it is checked.

The Hum & Noise values appear at the bottom list of measurements in the Audio Summary display.

- 7. Acquire an appropriate signal.
- 8. While the analyzer is analyzing a signal you want to use as a reference, click the **Capture reference now** button to save a reference value.

The Hum & Noise measurement compares the value of a specific signal quantity captured by the **Capture reference now** button with the current measured value of that quantity. For Direct signal types (set on the Params1 tab), the Signal Level is captured and compared. The Diff measurement is:

SignalLevel(current) - SignalLevel(Ref)

in dB.

For AM, FM, and PM signal types, the RMS modulation value (related to Modulation Depth, Frequency Deviation or Phase Deviation) is captured and compared. The Diff measurement is:

20 x log₁₀ (RMS(current)/RMS(Ref))

in dB.

Prefs Tab

The Prefs tab enables you to change appearance characteristics of the Audio Spectrum display.

Params1 Params2 Audio Filters Scale	Prefs
Units: dBHz ²	Trace points: 801 -
Show graticule	Show Marker readout in graph (selected marker)
	Show Non-Harm Threshold: Line Only 🔻

Setting	Description
Units:	Specifies the vertical scale units. The units available depend on the signal type selected.
Show graticule	Select to display or hide the graticule.
Trace points	Sets the number of trace points used for marker measurements and for results export.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Show Non-Harm Threshold	Shows or hides the non-harmonic threshold line.

Overview

The displays in General Purpose (GP) Digital Modulation (Displays > Measurements > GP Digital Modulation) are:

- Constellation
- Demod I & Q vs Time
- EVM vs Time
- Eye Diagram
- Frequency Deviation vs Time
- Magnitude Error vs Time
- Phase Error vs Time
- Signal Quality
- Symbol Table
- Trellis Diagram

The General Purpose Digital Modulation Analysis (Option 21) provides vector signal analyzer functionality. A wide variety of modulation types are supported, allowing you to view your signals in Constellation, Eye and Trellis diagrams, measure the quality of the modulation, display time-domain waveforms for demodulated I & Q signals, EVM, Phase Error, Magnitude Error, and more.

Modulation Measurements

NOTE. A maximum of approximately 80,000 samples can be analyzed by the General Purpose Digital Modulation measurements (the actual value varies with modulation type).

Measurement	Description
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and can be reported in units of percent or dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed.
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal.
Magnitude Error	The RMS magnitude difference between the measured signal and the ideal reference signal.
IQ Origin Offset	The magnitude of the DC offset of the signal measured at the symbol times. It indicates the magnitude of the carrier feed-through signal.
Gain Imbalance	The gain difference between the I and Q channels in the signal generation path. Constellations with gain imbalance show a pattern with a width that is different from height.
Rho ρ	The normalized correlated power of the measured signal and the ideal reference signal. Like EVM, Rho is a measure of modulation quality. The value of Rho is less than 1 in all practical cases and is equal to 1 for a perfect signal measured in a perfect receiver.
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the analyzer.
Quadrature Error	The orthogonal error between the I and Q channels. The error shows the phase difference between I and Q channels away from the ideal 90 degrees expected from the perfect I/Q modulation. Constellations with quadrature error will show some leakage of I into Q and vice versa.

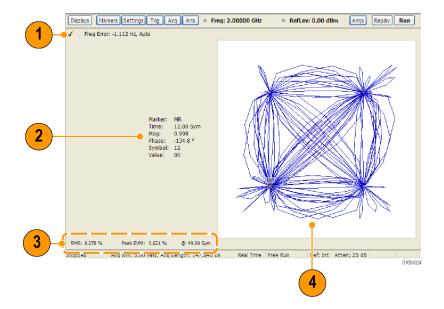
Constellation Display

The Constellation Display shows a digitally-modulated signal in constellation form.

To show the Constellation Display:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.
- **3.** Double-click the **Constellation** icon in the **Available Displays** box. This adds the Constellation icon to the **Selected displays** box.
- 4. Click the **OK** button. This shows the Constellation display.

Elements of the Constellation Display



ltem	Display element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Constellation display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Marker Readout	Located to the left of the constellation plot or below it, depending on the size of the window. If markers are enabled, the marker readout shows the time, mag, phase, symbol marker and symbol value of the point with the selected marker.
3	EVM Readouts	The EVM readouts are located below the Constellation plot. The readout shows EVM Peak (%) and location, RMS (%).
4	Plot	Constellation graph.

Changing Constellation Settings (see page 407)

Constellation Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the Constellation view are shown in the following table.

NOTE. You might be able to save time configuring the Constellation display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See Standard Settings Button. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation, symbol rate, and filters to be used in demodulating the input signal.
Freq & BW (see page 435)	Sets values for frequency error/offset, measurement bandwidth, and frequency deviation (not every control is present for every modulation type).
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters that are less frequently used.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

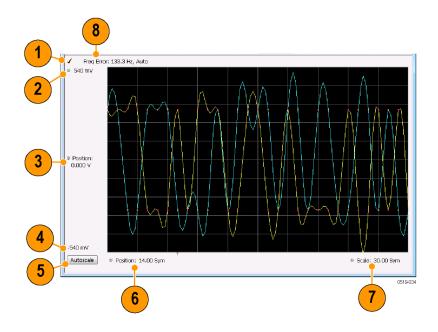
Demod I & Q vs Time Display

The Demod I & Q vs Time displays demodulated I and Q vs. Time. You can choose to display I only, Q only, or both.

Elements of the Display

To show the Demod I & Q vs Time display:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.
- **3.** Double-click the **Demod I&Q vs Time** icon in the **Available Displays** box. This adds the Demod I&Q vs Time icon to the **Selected displays** box.
- 4. Click the OK button. This shows the Demod I&Q vs Time display.



ltem	Element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Demod I & Q vs Time display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Top of Graph	Sets the I and Q amplitude value indicated at the top of the graph. Changing the top value affects the bottom of graph readout. Also, note that the top of graph setting interacts with the internal vertical scale setting (which is not user settable) such that the range between the top and bottom of the graph increases or decreases automatically.
3	Position	Specifies the I and Q amplitude value shown at the center of the graph display.
4	Bottom Readout	Displays the I and Q amplitude value shown at the bottom of graph.
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
6	Position	Specifies the horizontal position of the trace on the graph display.
7	Scale	Adjusts the span of the graph. By decreasing the scale (time per division), the graph essentially becomes a window that you can move over the acquisition record by adjusting the offset.
8	Freq Error	This readout can show Freq Error or Freq Offset. When it displays Freq Error, it shows the difference between the instrument Frequency setting and the measured value of the signal's carrier frequency. When it displays Freq Offset, it shows the frequency offset specified on the <u>Settings > Freq & BW</u> (see page 435) tab. If Freq Error is displayed, it also indicates that the Carrier frequency detection setting is Auto. If Freq Offset is displayed, it indicates that the Carrier that the Carrier frequency detection setting is manual.

Changing Demod I&Q Settings. (see page 410)

Demod I & Q vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the Demod I & Q vs Time display are shown in the following table.

NOTE. You might be able to save time configuring the Demod I & Q display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

EVM vs Time Display

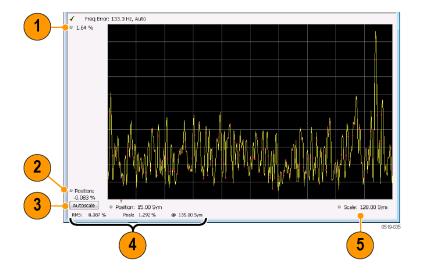
The EVM vs. Time Display shows the Error Vector Magnitude plotted over Time.

NOTE. A maximum of approximately 80,000 samples can be analyzed by the General Purpose Digital Modulation measurements (the actual value varies with modulation type).

To show an EVM vs. Time display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.
- **3.** Double-click the **EVM vs. Time** icon in the **Available Displays** box. This adds the EVM vs. Time icon to the **Selected displays** box.
- 4. Click the OK button. This displays the EVM vs. Time view.

Elements of the EVM vs Time Display



ltem	Display element	Description
1	Top of graph adjustment	Use the knob to adjust the vertical scale.
2	Position	Adjusts the vertical position.
3	Autoscale	Adjusts the Horizontal and Vertical scale to show the entire trace.
4	Peak and RMS value readout	Shows the maximum result, the time it occurred, and the RMS of the result over the entire analysis length.
5	Scale	Sets the length of time shown in the graph.

Changing the EVM vs Time Display Settings (see page 411)

EVM vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the EVM vs. Time display are shown in the following table.

NOTE. You might be able to save time configuring the EVM vs. Time display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See Standard Settings Button. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used in the input signal and other parameters that controls the demodulation of the input signal.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies Freq Offset, Magnitude normalization parameters, and enables swapping I and Q.
Find (see page 441)	The Find tab is used to set parameters for finding bursts within the data record.
Analysis Time (see page 441)	The Analysis Time tab contains parameters that define how the signal is analyzed in the general purpose digital modulation displays.
Trace (see page 443)	Specifies the display characteristics of the displayed trace.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Specifies whether certain display elements are visible.

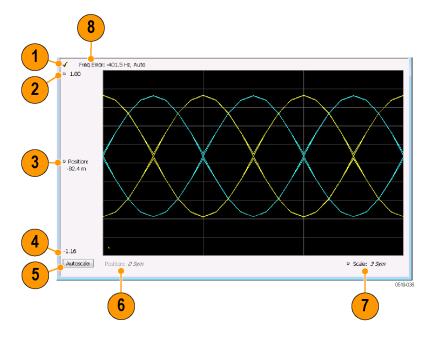
Eye Diagram Display

The Eye Diagram Display shows a digitally modulated signal overlapped on itself to reveal variations in the signal.

To show an Eye Diagram display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.
- 3. Double-click the Eye Diagram icon in the Available Displays box. This adds the Eye Diagram icon to the Selected displays box.
- 4. Click the OK button. This displays the Eye Diagram view.

Elements of the Display



ltem	Element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Frequency Deviation vs Time display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Top of Graph	The vertical scale is normalized with no units (except for nFSK and C4FM modulation types where the vertical units are Hz).
3	Position	Specifies the value shown at the center of the graph display.
4	Bottom Readout	Displays the value indicated by the bottom of graph.
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
6	Position	Displays the horizontal position of the trace on the graph display.
7	Scale	Adjusts the span of the graph in symbols.
8	Freq Error	Displays the difference between the maximum and minimum measured values of the signal frequency during the Measurement Time. The displayed frequency error is followed by either Auto or Manual . This indicates the selected carrier frequency detection method (see Settings > Freq & BW).

Changing Eye Diagram Settings (see page 414)

Eye Diagram Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the Eye Diagram display are shown in the following table.

NOTE. You might be able to save time configuring the Eye Diagram display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

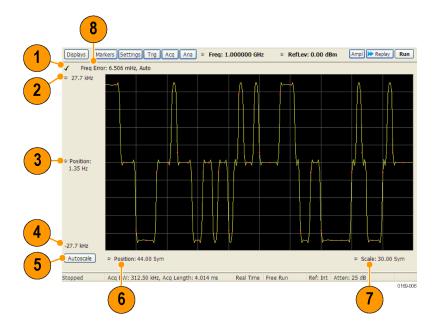
Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

Frequency Deviation vs Time Display

To show a Frequency Deviation vs Time display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select Frequency Deviation vs Time.
- **3.** Double-click the **Frequency Deviation vs Time** icon in the **Available Displays** box. This adds the Frequency Deviation vs Time icon to the **Selected displays** box.
- 4. Click the OK button. This displays the Frequency Deviation vs Time view.

Elements of the Display



ltem	Element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Frequency Deviation vs Time display is the optimized display.
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.
2	Top of Graph	Sets the frequency deviation value indicated at the top of the graph. Changing the top value affects the bottom of graph readout. Also, note that the top of graph setting interacts with the internal vertical scale setting (which is not user settable) such that the range between the top and bottom of the graph increases or decreases automatically.
3	Position	Specifies the frequency deviation value shown at the center of the graph display.
4	Bottom Readout	Displays the value of the frequency deviation value shown at the bottom of graph.
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
6	Position	Specifies the horizontal position of the trace on the graph display.
7	Scale	Adjusts the span of the graph. By decreasing the scale (time per division), the graph essentially becomes a window that you can move over the acquisition record by adjusting the offset.
8	Freq Error	Displays the difference between the maximum and minimum measured values of the signal frequency during the Measurement Time. The displayed frequency error is followed by either Auto or Manual . This indicates the selected carrier frequency detection method (see Settings > Freq & BW).

Changing Frequency Deviation vs Time Settings (see page 416)

Frequency Deviation vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The Setup settings for Frequency Deviation vs. Time are shown in the following table.

NOTE. You might be able to save time configuring the Frequency vs. Time display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

Magnitude Error vs Time Display

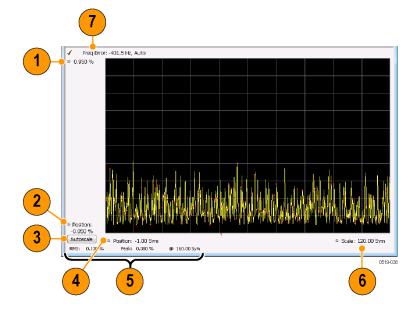
The Magnitude Error displays the magnitude of the symbol error. The amplitude appears on the vertical axis while time is plotted along the horizontal axis.

NOTE. A maximum of approximately 80,000 samples can be analyzed by the General Purpose Digital Modulation measurements (the actual value varies with modulation type).

To display Magnitude Error vs. Time:

- 1. Select the **Displays** button or **Setup** > **Displays**. This displays the Select Displays dialog box.
- 2. Select GP Digital Modulation in the Measurements box.
- **3.** Double-click the **Mag Error vs. Time** icon or select the icon and click **Add**. The icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click OK.

Elements of the Display



ltem	Display element	Description	
1	Top of graph adjustment	Use the knob to adjust the value of the vertical scale.	
2	Position	Adjusts the level shown at the bottom of the display.	
3	Autoscale button	Adjusts the vertical and horizontal settings to provide the best display.	
4	Horizontal Position	Adjusts the horizontal position of the signal. Units can be either Symbols or Seconds (Settings > Analysis Time tab > Units).	
5	Peak and RMS value readout	Displays the Peak value of the magnitude error, the RMS value of the magnitude error, and the time at which it occurs within the acquisition. Units can be either Symbols or Seconds (Settings > Analysis Time tab > Units).	
6	Horizontal Scale	Sets the time spanned by the graph. Units can be either Symbols or Seconds (Settings > Analysis Time tab > Units).	
7	Freq Error	Freq Error is the difference between the Center Frequency and the measured frequency of the signal being tested. This readout will be Freq Offset if the Freq Offset parameter on the Settings > <u>Advanced Params (see page 438)</u> tab is set to Manual.	

Changing Magnitude Error vs Time Display Settings (see page 418)

Magnitude Error vs Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The Setup settings for Magnitude Errors vs. Time are shown in the following table.

NOTE. You might be able to save time configuring the Magnitude vs. Time display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

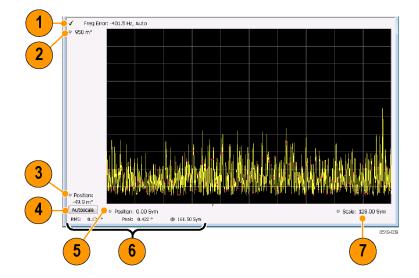
Phase Error vs Time Display

The Phase Error vs. Time display shows the phase angle of the symbol error over time. The phase is plotted along the vertical axis while time is plotted along the horizontal axis.

NOTE. A maximum of approximately 80,000 samples can be analyzed by the General Purpose Digital Modulation measurements (the actual value varies with modulation type).

To show the Phase Error display:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays dialog, select GP Digital Modulation in the Measurements box.
- **3.** In the **Available displays** box, double-click the **Phase Error** icon or select the icon and click **Add**. The Phase Error icon will appear in the **Selected displays** box and will no longer appear under Available displays.
- 4. Click **OK** to display the Phase Error.



Elements of the Phase Error vs Time Display

ltem	Display element	Description	
1	Freq Error	Freq Error is the difference between the Center Frequency and the measured frequency of the signal being tested. This readout will be Freq Offset if the Freq Offset parameter on the Settings > <u>Advanced Params (see page 438)</u> tab is set to Manual.	
2	Top of graph adjustment	Adjusts the phase angle shown at the top of the graph.	
3	Position	Adjusts the vertical offset.	
4	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.	
5	Offset	Adjusts the horizontal offset.	
6	Peak and RMS readouts	Displays the Peak value of the phase error and the time at which it occurred. Also displays the RMS value over the analysis length.	
7	Scale	Sets the time spanned by the graph.	

Changing the Phase Error vs Time Display Settings (see page 420)

Phase Error vs. Time Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The settings for the Phase Error vs. Time display are shown in the following table.

NOTE. You might be able to save time configuring the Phase Error vs. Time display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

Signal Quality Display

The Signal Quality display shows several measurements of signal quality. The measurements displayed depend on the modulation type. There is a set of measurements displayed for all modulation types except nFSK and C4FM. There is a second set of measurements displayed for nFSK and C4FM modulation types.

💢 Signal Quality			- • •
1			
	RMS	Peak	Location
EVM:	47.893 %	97.092 %	4.14 kSym
	-6.395 dB	-0.256 dB	
Phase Error:	25.803 °	46.376 °	4.26 kSym
Mag Error:	18.943 %	54.693 %	848.00 Sym
MER (RMS):	6.395 dB	Rho:	0.783798
IQ Origin Offset:	-48.637 dB	Frequency Error:	-542.2 kHz
Gain Imbalance:	-0.019 dB	Quadrature Error:	0.211 °

Signal Quality display for all modulation types except nFSK, C4FM, OQPSK, and SOQPSK

🔝 Signal Quality			- • •
4			
EVM:	<i>RMS</i> 0.213 % -53.426 dB	<i>Peak</i> 0.562 % -45.012 dB	<i>Location</i> 161.50 Sym
Offset EVM:	0.197 % -54.106 dB	0.398 % -47.996 dB	65.00 Sym
Phase Error:	0.131°	0.422 °	161.50 Sym
Mag Error:	0.139 %	0.380 %	160.00 Sym
MER (RMS): IQ Origin Offset: Gain Imbalance:	53.426 dB -70.413 dB -0.014 dB	Rho: Frequency Error: Quadrature Error:	

Signal Quality display for OQPSK and SOQPSK modulation types

🚺 Signal Q	uality		c	
1				
RMS F9 Peak Ma	Ж Err: 4.043 ° Ж Err: 1.814 ° ag Err: 5.791 ° ag Err: 2.363 °	% Fre %	Freq Error: -4 q Deviation: 99	
Deviations	-3	-1	+1	+3
Max	-104.301 kHz	-34.966 kHz	34.623 kHz	103.370 kHz
Min	-96.517 kHz	-32.409 kHz	31.454 kHz	97.410 kHz
Avg	-100.366 kHz	-33.300 kHz	33.066 kHz	99.425 kHz

Signal Quality display for nFSK modulation type

0.116 %	
111.2 mHz	
399.2 Hz	
128 Sym	
	0.116 % 111.2 mHz 399.2 Hz 128 Sym

Signal Quality display for C4FM modulation type

Elements of the Display

Measurements for all modulation types except nFSK, C4FM, OQPSK and SOQPSK

Measurement	Description	
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.	
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.	
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.	
MER (RMS)	The MER is defined as the ratio of I/Q signal power to I/Q noise power; the result is indicated in dB.	
IQ Origin Offset	The magnitude of the DC offset of the signal measured at the symbol times. It indicates the magnitude of the carrier feed-through signal.	
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.	
Gain Imbalance	The gain difference between the I and Q channels in the signal generation path. Constellations with gain imbalance show a pattern with a width that is different form height.	
Quadrature Error	The orthogonal error between the I and Q channels. The error shows the phase difference between I and Q channels away from the ideal 90 degrees expected from the perfect I/Q modulation. Not valid for BPSK modulation type.	
Rho	The normalized correlated power of the measured signal and the ideal reference signal. Like EVM, Rho is a measure of modulation quality. The value of Rho is less than 1 in all practical cases and is equal to 1 for a perfect signal measured in a perfect receiver.	

Measurements for OQPSK and SOQPSK modulation types

Measurement	Description
EVM	The normalized RMS value of the error vector between the measured signal and the ideal reference signal over the analysis length. The EVM is generally measured on symbol or chip instants and is reported in units of percent and dB. EVM is usually measured after best-fit estimates of the frequency error and a fixed phase offset have been removed. These estimates are made over the analysis length. Displays RMS and Peak values with location of Peak value.
Offset EVM	Offset EVM is like EVM except for a difference in the time alignment of the I and Q samples. For EVM, I and Q samples are collected at the same time, for every symbol decision point (twice the symbol rate for offset modulations). For Offset EVM, the I and Q symbol decision points are time-aligned before collecting the I and Q samples. In this case, one I and one Q sample is collected for each symbol (half as many samples as the same number of symbols for (non-offset) EVM.
Phase Error	The RMS phase difference between the measured signal and the ideal reference signal. Displays RMS and Peak values with location of Peak value.
Mag Error	The RMS magnitude difference between the measured signal and the reference signal magnitude. Displays RMS and Peak values with location of Peak value.
MER (RMS)	The MER is defined as the ratio of I/Q signal power to I/Q noise power; the result is indicated in dB.
IQ Origin Offset	The magnitude of the DC offset of the signal measured at the symbol times. It indicates the magnitude of the carrier feed-through signal.
Frequency Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.
Gain Imbalance	The gain difference between the I and Q channels in the signal generation path. Constellations with gain imbalance show a pattern with a width that is different form height.
Quadrature Error	The orthogonal error between the I and Q channels. The error shows the phase difference between I and Q channels away from the ideal 90 degrees expected from the perfect I/Q modulation. Not valid for BPSK modulation type.
Rho	The normalized correlated power of the measured signal and the ideal reference signal. Like EVM, Rho is a measure of modulation quality. The value of Rho is less than 1 in all practical cases and is equal to 1 for a perfect signal measured in a perfect receiver.

Measurement	Description		
Peak FSK err	Peak value of the frequency deviation error at the symbol point.		
RMS FSK Err	RMS value of the frequency deviation error at the symbol point.		
Peak Mag Err	The Peak magnitude difference between the measured signal and the reference signal magnitude.		
RMS Mag Err	The RMS magnitude difference between the measured signal and the reference signal magnitude.		
Freq Error	The frequency difference between the measured carrier frequency of the signal and the user-selected center frequency of the instrument.		
Freq Deviation	Frequency distance from the center frequency at the symbol point.		
Symbol Rate Error	This compares the user-entered symbol rate to the instrument calculated symbol rate of the analyzed signal.		
Symbol Rate	When in Auto-symbol rate, the instrument calculates the symbol rate of the signal and the instrument calculates the error between the user entered value and the instrument calculated value.		

Measurements for nFSK modulation types

Measurements for C4FM modulation type

Measurement	Description
RMS Error Magnitude	RMS value of the frequency deviation error at the symbol point.
Carrier Frequency Error	Frequency difference between averaged signal frequency and the center frequency.
Deviation	Frequency distance from the center frequency at the symbol point.
Length	Number of symbols in the analysis area.

Changing the Signal Quality Display Settings (see page 425)

Signal Quality Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The Setup settings for Signal Quality are accessible only when the Signal Quality display is selected.

NOTE. You might be able to save time configuring the Signal Quality display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	The Modulation tab specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	The Advanced Params tab specifies frequency offset, magnitude normalization method and allows you to swap the I and Q signals.
Find (see page 441)	Find tab is used to set parameters for finding bursts within the data record.
Analysis Time (see page 441)	The Analysis Time tab contains parameters that define the portion of the acquisition record that is used for analysis.
Prefs (see page 445)	The Prefs tab enables you to set characteristics of the measurement display.

Symbol Table Display

The Symbol Table Display is like the Constellation Display except that a text table is used to display data bits at a symbol rather than a graph. The Synch Word characters, if used, are in bold font.

To display the Symbol Table:

- 1. Select the **Displays** button or select **Setup** > **Displays**. This displays the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.
- **3.** Double-click the **Symbol Table** icon in the **Available Displays** box. This adds the Symbol Table icon to the **Selected displays** box.
- 4. Click the OK button. This displays the Symbol Table view.

. 0 10 00 16 01 32 10 48 11 64 01 00 11 80 10 96 10 11 01 01 11 11 01 10 00 112 01 128 01 144 01 160 11 176 10 10 10 00 00 11 10 00 00 11 10 11 192 00 208 11 01 10 11 00 01 11 10 11 11 224 10 240 11 Symbol: 0 Marker: M1 Time: 0.00 Sym Value: 10

Using Markers

Markers are indicators in the display that you can position on a trace to measure values such as frequency, power, and time. A Marker always displays its position and, if the Delta readout is enabled, will display the difference between its position and that of the Marker Reference. Within the Symbol Table, colored cells indicate the location of markers. The selected Marker is highlighted with a light green background. All other markers are highlighted with a light gray background. In the Symbol Table, the marker readout below the table shows the marker location in time, symbol numbers and symbol value.

Changing the Symbol Table Display Settings (see page 427)

Symbol Table Settings

Menu Bar: Setup > Settings

Application Toolbar: 🕮

The Setup settings for the Symbol Table view are shown in the following table.

NOTE. You might be able to save time configuring the Symbol Table display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

The Modulation tab specifies the type of modulation used for the input signal and other parameters.
Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Enable the Equalizer and adjust its parameters.
The Advanced Params tab specifies additional parameters.
Find tab is used to set parameters for finding bursts within the data record.
The Analysis Time tab contains parameters that define the portion of the acquisition record that is used for analysis.
The Prefs tab enables you to set characteristics of the measurement display.

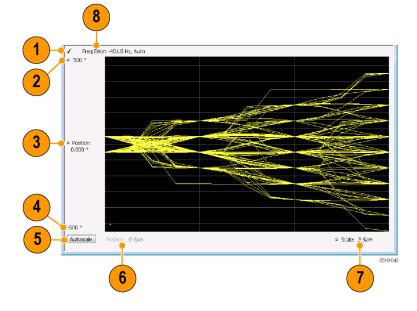
Trellis Diagram Display

To show an Trellis Diagram display:

- 1. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
- 2. From the Measurements box, select GP Digital Modulation.

- 3. Double-click the **Trellis Diagram** icon in the **Available Displays** box. This adds the Trellis Diagram icon to the **Selected displays** box.
- 4. Click the **OK** button. This displays the Trellis Diagram view.

Elements of the Display



ltem	Element	Description						
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the Frequency Deviation vs Time display is the optimized display.						
		NOTE. When Best for multiple windows is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.						
2	Top of Graph	Sets the phase value indicated at the top of the graph. Changing the top value affects the bottom of graph readout. Also, note that the top of graph setting interacts with the internal vertical scale setting (which is not user settable) such that the range between the top and bottom of the graph increases or decreases automatically.						
3	Position	Specifies the phase value shown at the center of the graph display.						
4	Bottom Readout	Displays the value of the phase value shown at the bottom of graph.						
5	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.						
6	Position	Displays the horizontal position of the trace on the graph display.						
7	Scale	Adjusts the span of the graph in symbols.						
8	Freq Error	Displays the difference between the maximum and minimum measured values of the signal frequency during the Measurement Time. The displayed frequency error is followed by either Auto or Manual . This indicates the selected carrier frequency detection method (see Settings > Freq & BW).						

Changing the Trellis Diagram Settings (see page 429)

Trellis Diagram Settings

Menu Bar: Setup > Settings

Application Toolbar: 🥨

The settings for the Trellis Diagram display are shown in the following table.

NOTE. You might be able to save time configuring the Trellis Diagram display by pressing the Standard Settings button from the Settings control panel. This allows you to select a preset optimized for a standard from the Select Standard dialog box. See <u>Standard Settings Button</u>. (see page 430)

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW (see page 435)	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Scale (see page 445)	Specifies the horizontal and vertical scale settings.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

GP Digital Modulation Shared Measurement Settings

The displays in the GP Digital Modulation folder (Setup > Displays) are each a different format for presenting the results of a single underlying analysis. For this reason, all controls that affect the analysis parameters are shared by all the displays in the GP Digital Modulation folder.

Changing a setting on one tab changes that setting for all the GP Digital Modulation displays. For example, if you change the Modulation Type for the Constellation Display, it also changes the Modulation type setting for the Signal Quality display. There are some controls that affect only the way an individual display presents its results, such as graph scaling.

Settings tab	Description
Modulation Params (see page 431)	Specifies the type of modulation, symbol rate, and filters to be used in demodulating the input signal.
Freq & BW (see page 435)	Sets values for frequency error/offset, measurement bandwidth, and frequency deviation (not every control is present for every modulation type).
Equalizer Tab (see page 436)	Enable the Equalizer and adjust its parameters.
Advanced Params (see page 438)	Specifies additional parameters that are less frequently used.
Find (see page 441)	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time (see page 441)	Contains parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Seconds or Symbols) for the GP Digital Modulation displays.
Trace (see page 443)	Allows you to set the trace display characteristics.
Prefs (see page 445)	Enables you to set characteristics of the measurement display.

Common controls for GP digital modulation displays

Standard Settings Button

On every GP Digital Modulation control panel there is a button labeled **Standard Settings**. This button is used to recall settings optimized for analyzing the selected standard. See the following table for a list of the standards for which standard settings are available. Choosing a standard from the dialog box changes only settings for GP Digital Modulation displays.

All of the presets in the Standard Settings Dialog make the following settings:

- Analysis Length: Auto
- Points per Symbol: 4
- Data Differential: No
- Burst Mode: Off
- Burst Detection Threshold: -10 dBc

Standard	Modula- tion	Symbol Rate	Meas. Filter	Reference Filter	Filter Parameter	Other
802.15.4	OQPSK	1e6	None	Half sine	NA	
SBPSK-MIL	SBPSK	2.4e3	None	SBPSK- MIL	NA	
SOQPSK-MIL	SOQPSK	2.4e3	None	SOQPSK- MIL	NA	1
CPM-MIL	СРМ	19.2e3	None	None	NA	
SOQPSK-ARTM Tier 1	SOQPSK	2.5e6	None	SOQPSK- ARTM	NA	1
Project25 Phase 1	C4FM	4.8e3	C4FM-P25	RC	0.2	
CDMA2000-Base	QPSK	1.2288e6	IS-95 TXE- Q_MEA	IS-95 REF	NA	
W-CDMA	QPSK	3.84e6	RRC	RC	0.22	

Parameter values set by presets in the standard settings dialog

1 Center Symbol Position, Half Shift Removed

Modulation Params Tab

Menu bar: Setup > Settings > Modulation Params

The Modulation Params tab specifies the type of modulation on the input signal and other parameters that control the demodulation of the input signal.

Modulation Params	Freq & BW Adv	anced Params	Find	Analysis Time	e Trace	Scale	Prefs		
Modulation type	e: QPSK	•	Measure	ement Filter: (Root raise	ed cosin	e	•	
Symbol Rate	e: 40 kHz		Refe	erence Filter: (Raised co	sine		•	
			Filte	r Parameter:	0.300				

Parameter	Description
Modulation type	Specifies the type of modulation on the input signal.
Symbol Rate	Specifies the symbol rate in Hertz.
Measurement Filter	Specifies the filter used for measurements.
Reference Filter	Specifies the filter used as a reference.
Filter Parameter	Enter a value used for defining the Reference Filter. (Not present for some filter types)
Modulation index	(Present only for CPM modulation type)

Modulation Type

The modulation types that can be demodulated and analyzed are:

Description
Quadrature Phase Shift Keying
8-Phase Shift Keying
Differential Eight Phase Shift Keying
Differential Sixteen Phase Shift Keying
Pi/2 Differential Binary Phase Shift Keying
Differential Quadrature Phase Shift Keying
Pi/4 Differential Quadrature Phase Shift Keying
Binary Phase Shift Keying
Offset Quadrature Phase Shift Keying
16-state Quadrature Amplitude Modulation
32-state Quadrature Amplitude Modulation
64-state Quadrature Amplitude Modulation
128-state Quadrature Amplitude Modulation
256-state Quadrature Amplitude Modulation
Minimum Shift Keying
2-Frequency Shift Keying
4-Frequency Shift Keying
8-Frequency Shift Keying
16-Frequency Shift Keying
Continuous Phase Modulation
Shaped Offset Quadrature Phase Shift Keying
Shaped Binary Phase Shift Keying
Constant Envelope 4-Level Frequency Modulation

Symbol Rate

Specifies the symbol rate for demodulating digitally modulated signals. The symbol rate and the bit rate are related as follows:

(Symbol rate) = (Bit rate)/(Number of bits per symbol)

For example, the number of bits per symbol is 3 for 8PSK.

Measurement and Reference Filters

The available measurement and reference filters depend on the selected modulation type. If a particular filter is not practical for a selected modulation type, it is not presented as an available filter. To determine which filters are available, make certain that your desired modulation type is selected. See the following table.

Modulation type	Measurement filters	Reference filters
BPSK	None	None
PI/2DBPSK	RootRaisedCosine	RaisedCosine
8PSK	RaisedCosine	Gaussian
D8PSK	Gaussian	User
DQPSK	User	Rectangular (freq)
PI/4DQPSK	Rectangular (freq)	IS-95REF
16QAM	IS-95TX_MEA	
32QAM	IS-95TXEQ_MEA	
64QAM		
128QAM		
256QAM		
QPSK		
MSK	None	None
MSK	Root Raised Cosine	Gaussian
	Root Raised Cosine RaisedCosine	
	Gaussian	User
	User	
OQPSK	Rectangular (freq) None	None
UQPSK	RootRaisedCosine	None Half sine
	User	RaisedCosine
	IS-95TX_MEA IS-95TXEQ_MEA	User IS-95REF
HDQPSK	HDQPSK-P25	None
HDQP3K	HDQF5K-F25	RaisedCosine
		Gaussian
		User
		Rectangular (freq)
SOQPSK	None	SOQPSK-MIL
SUQESK	User	SOQPSK-ARTM
	User	User
СРМ	Nana	
	None	None
	User	User
2FSK	None	None
4FSK	Gaussian RootRaisedCosine	Gaussian Baiaed Casing
8FSK	RootRaisedCosine	RaisedCosine
16FSK		User
	Rectangular (freq)	
	User	

Modulation type	Measurement filters	Reference filters	
C4FM	C4FM-P25	RaisedCosine	
		User	
SBPSK	None	SBPSK-MIL	
	User	User	

The measurement filter is applied before the demodulation bit is detected and the ideal reference is calculated.

The reference filter is applied to the internally generated ideal reference signal before the EVM is calculated.

How to Select Filters

In a signal transmitter/receiver system, the baseband signal might be filtered for bandwidth limiting or for another kind of necessary shaping that needs to be applied. Normally, a filter in the transmitter (Ft) and a filter in the receiver (Fr) are applied.

The Measurement Filter setting in the analyzer corresponds to the baseband filter in the receiver (Fr): This setting tells the analyzer what filter your receiver uses. When the analyzer is set to the same filter used by the receiver, the analyzer sees the signal as your receiver would. The Measurement Filter setting should be the same as the filter used in the receiver under normal operation (as opposed to testing).

The Reference Filter setting in the analyzer corresponds to the baseband filter in the transmitter-receiver combination (Fr * Ft). The baseband filter for the transmitter-receiver combination is often referred to as the *System Filter*. This filter is called the reference filter because it is used to recreate a reference signal that is compared to the received signal. This recreated reference signal is the *ideal signal* with Fr * Ft applied; differences between this *ideal signal* and the received signal enables the determination of signal quality, such as EVM measurements.

The following is an example of a hypothetical signal that is transmitted into a vector signal analyzer for analysis:

Assume that a signal is transmitted using a baseband filter (Ft). It then travels through a transmission medium (air/cable/etc) where it may affected by the communication channel (Fc). The signal is received and filtered by the receiver's filter (Fr). At this point, the signal has passed through Ft and Fr, and in addition, the communication channel might have affected it (so: Ft * Fr * Fc). This double-filtered signal is demodulated as it was received to determine the symbols/bits in it. The obtained bits are used to regenerate a baseband ideal signal that can be compared against the received signal to determine signal quality. However, to determine the effect of the environment on the signal quality, the ideal signal must be filtered by the REFERENCE FILTER (Ft * Fr), so that the ideal signal and the filtered signal differ only by the effect of the environment. So, the received signal is the ideal signal filtered by Ft * Fr & Fc and the reference signal is the ideal signal filtered by Ft * Fr, since they only differ by the effect of Fc, the comparison will show the effect of the communication channel on the signal. The communication channel can also include the hardware path the signal follows after (Tx) or before (Rx) digitizing; this would account for Tx/Rx hardware linear and non-linear distortion.

Common examples of how these filters are used are shown below:

- For Transmit Filter = Root Raised Cosine (RRC), Measurement Filter = RRC, the Reference Filter = RRC ^2 = Raised Cosine
- For Transmit Filter = Raised Cosine (RC), Measurement Filter = None, the Reference Filter = Raised Cosine (When the Measurement Filter = None, the Reference Filter = Transmit Filter)
- For Transmit Filter = Gaussian, Measurement Filter = None, the Reference Filter = Gaussian

Filter Parameter

The filter parameter specifies the alpha for the Root Raised Cosine or Raised Cosine filter, or the bandwidth-time product (BT) for the Gaussian filter, when selected as the Reference filter. Some filter types have a fixed parameter value that is specified by industry standard, while other filter types by definition have no filter parameter. For filter types with no filter parameter, there is no filter parameter control present in the control panel.

Freq & BW Tab

The Freq & BW tab specifies a group of settings that affect how measurements are made.

Modulation Params	Freq & BW	Advanced Pa	irams F	ind	Analysis	Time	Trace	Scale	Prefs	
Frequency E	rror: <i>133.3</i>	Hz	🔽 Auto	D						
Measurement	BW: <i>30.72</i>	MHz	Auto		•					
Frequency Devia	tion: <i>465.7</i>	kHz	🔽 Auto	D						

Freq & BW tab with nFSK or C4FM modulation type selected and Frequency Error readout enabled (Auto selected)

Modulation Params Free	a & BW Advance	d Params Find	Analysis Ti	me Trace	Scale	Prefs	
Frequency Error:	-401.8 Hz	📝 Auto					
Measurement BW:	640.0 kHz	Auto	•				

Freq & BW tab with SOQPSK modulation type selected and Frequency Offset enabled (Auto deselected)

Setting	Description
Frequency Error / Frequency Offset	When Auto is enabled, this readout displays frequency error and the measurement is made at the calculated frequency. When Auto is disabled, this setting changes to Frequency Offset. When set to Frequency Offset, this setting is used to demodulate a signal that is not at the center frequency. The measurement is made at the user-entered offset. The Measurement Filter (if any, specified on the Modulation Params tab) is applied about the offset frequency whether set automatically or manually.
Measurement BW	This setting allows you to override the automatic bandwidth calculation and directly enter a bandwidth value. If you enter a value for the measurement bandwidth, be aware that the actual bandwidth of data provided to the measurement will be at least as wide as the value you request and may be as much as two times wider than requested. This override of the selected measurement bandwidth is done so that the instrument uses sufficient bandwidth relative to the chosen symbol rate to ensure good signal quality measurements.
Frequency Deviation	For nFSK modulation types, this setting specifies the frequency deviation. Select Auto to make the instrument do this automatically. Deselect Auto to enter a value manually.
	This setting is present for only nFSK and C4FM modulation types.

Equalizer Tab

The Equalizer tab enables you to apply an adaptive equalizer to a digitally modulated signal to compensate for linear distortions in the signal. The Equalizer is available only for displays in the GP Digital Modulation folder (Select Displays window). The analyzer implements a decision directed, feed-forward FIR filter to correct linear distortion in the input signal.

Modulation Params Freq & BW	Equalizer Adva	nced Params	Find	Analysis Time	Trace	Scale	Prefs	
Enable Equalization	Mode:	Train	•	Taps/Symb	ol: 2	•		
Reset Equalization	Convergence:	0.0005		Taj	os: 41]	
Enable EQ Export				Lengt	th: 21	Symbol		

Parameter	Description				
Enable Equalization	This setting turns the Equalizer on and off.				
Reset Equalization Initializes the equalizer filter for training.					
Enable EQ Export	Exports a text file with equalizer taps in I/Q pairs.				
Mode Specifies whether the equalizer is in learning (Train) mode or analysis (Hold) mode					
Convergence	Specifies the update rate. Maximum value: 0.002. Default value: 0.0005				
Taps/SymbolThe number of filter coefficients per symbol used by the filter. Available cho1, 2, 4, and 8.					
Taps	The number of filter coefficients. Range: 3 to 100 (you can set a higher number, but 100 is the practical limit).				
Length Specifies the number of symbols analyzed (or filter length).					

Selecting the Mode

When enabled, the Equalizer is in either Train mode or Hold mode. When the equalizer is in Train mode, it will update internal filter parameters whenever you adjust the Convergence, Taps/Symbol, Taps, or Length values. When it is in Hold mode, the Equalizer uses the parameter values (both internal and the values accessible on the Equalizer tab) in effect when it was placed into Hold mode.

NOTE. The Equalizer does not need to be retrained if the modulation type is changed. You can train the Equalizer by using a simpler modulation type (such as QPSK), place the Equalizer into Hold mode and can then measure more complex modulation types such as QAM.

Training the Equalizer

To obtain the desired results using the Equalizer, you must first train the Equalizer. This is an iterative process where you adjust some filter parameters (and the analyzer adjusts internal parameters) to achieve the lowest error possible on the acquired signal.

To configure the Equalizer:

- 1. Press the **Displays** button or select **Setup** > **Displays**.
- 2. In the Select Displays window, select GP Digital Modulation from Measurements.
- 3. Add Signal Quality to the Selected Displays and select OK.
- 4. With the Signal Quality display selected, select Setup > Settings.
- 5. Select the Modulation Params tab set the parameters as necessary for the signal.
- 6. Select the Equalizer tab.
- 7. Set the Convergence value to 0.0005.
- 8. Set Taps/Symbol to 2.
- 9. Click the **Reset Equalization** button to reset the equalizer.
- 10. Set the Mode to Train.

- 11. Click Enable Equalization so it is checked.
- 12. On the Signal Quality display, examine the value for EVM.
- 13. Change the Convergence, Taps/Symbol, and Taps values iteratively to achieve a minimum EVM value.

NOTE. Changing the Taps/symbol or Taps values resets the equalizer.

Using the Equalizer

To use the equalizer:

- 1. Select and configure a GP Digital Modulation display.
- 2. Select Setup > Settings.
- 3. Select the Equalizer tab.
- 4. Select Enable Equalization so it is checked.
- 5. Verify that Mode is set to Hold if you have previously trained the Equalizer. If you have not previously trained the Equalizer, train the Equalizer (see page 437) and then set the Mode to Hold.

Exporting EQ Files

If the **Enable EQ Export** box is checked, the following outputs files are automatically generated to these locations after each measurement update cycle if the EQ coefficients change: *c:\temp\EqTaps.txt* and *c:\temp\EqTapsHdr.txt*. These files have EQ taps in I/Q pairs (one pair per row).

The *Hdr* version file has a five line header before the EQ tap data. Each line in the five line header of the Hdr version file has two data values, with the second one always being "0":

line1>Number_of_Header_Lines 0line2>EQ_Sample_Rate_Hz 0line3>Demod_Symbol_Rate_Sps 0line4>EQ_Samples_per_Symbol 0line5>Number_of_EQ_Taps_Following 0

Advanced Params Tab

The Advanced Params tab specifies additional parameters that control the demodulation of the signal.

Modulation Params Freq & BW	Advanced Params	Find	Analysis Time	Trace	Scale	Prefs	
			🔲 Swap I a	nd Q			
			🔲 Symbol r	ate sear	ch		
			🔲 User Sym	nbol Map) (per M	Iodulatio	on Type):

Advanced Params tab for modulation type nFSK

Modulation Params Freq & BW	Advanced Params	Find Analysis Time	Trace Scale	Prefs
		📄 Swap I a	nd Q	
		🔲 User Sym	bol Map (per M	Iodulation Type):

Advanced Params tab for modulation type C4FM

Parameter	Description				
Mag Normalize	Select RMS Symbol Magnitude or Max Symbol Magnitude. This setting applies to Mag				
(not present for nFSK or C4FM modulation types)	Error and EVM.				
Swap I and Q	When enabled, the I and Q data are exchanged before demodulating.				
Symbol rate search	Determines whether to automatically detect or manually set the symbol rate. When				
(Present only for nFSK modulation types)	selected, automatically detects the symbol rate to perform analysis. The calculated symbol rate is displayed in the Signal Quality display. The Symbol Rate Error is also calculated and displayed when Symbol rate search is enabled.				
User Symbol Map (per Modulation Type)	Enables the use of custom symbol maps. This enables you to specify the location of symbols in the display. This control can be set independently for each of the modulation types.				

Mag Normalize

Specifies whether Magnitude Normalization uses the RMS Symbol Magnitude or the Maximum Symbol Magnitude as the basis for normalization. Use RMS Symbol Magnitude on QPSK modulations (equal magnitude symbol locations), and use Maximum Symbol Magnitude for signals that have a large difference in magnitude among the symbol locations (such as 128QAM). It prevents the instrument from using the very low magnitude center symbols when normalizing the constellation. The outer symbols are a better normalization reference than the center in this case.

Swap I and Q

Use the Swap I and Q control to correct a signal sourced by a downconverter that inverts the frequency of the signal under test.

User Symbol Map

To specify a user symbol map:

- 1. Click the ... button.
- 2. Navigate to the directory containing the user symbol text file you want to use.
- 3. Select the desired file in the Open window and click Open.
- 4. Select User Symbol Map to enable the user symbol map.

Editing the User Symbol Map. The symbol map is a plain text file and can be edited with any plain text editor.



CAUTION. Whenever you reinstall the program software, the existing DefaultSymbolMaps.txt file will be overwritten. To create a custom symbol map, you should make a copy of the default symbol map file, edit the copy to suit your needs, and save it with a new name. Guidance on how to edit the symbol map file is contained within the default symbol map file.

The following excerpt from the default symbol map file explains the structure of the file and how to edit it. ## Symbol Mapping Definitions ## Version 1.2 ## This file defines the mapping of modulation states to symbol values. ## ## File Format : ## -----## 1. Comments begin with '##' and may appear after the last field in a line ## 2. A symbol map begins and ends with a line containing the name of the ## modulation type. These names must exactly match the name of one of the ## modulation types in the RSA software ## 3. Empty cells may be included to preserve the constellation shape. ## 4. Blank lines are ignored. ## 5. A modulation type which does not match the name of an existing ## type will be ignored. ## ## Usage : ## -----## 1. The file is intended to be edited with Notepad or similar text editor The following text is an example of a symbol map. ## Symbol Map for 32 QAM ## (Resembles the shape of the constellation) 320AM 00011 00010 00001 00000 01001 01000 00111 00110 00101 00100 01111 01110 01101 01100 01011 01010 10101 10100 10011 10010 10001 10000 11011 11010 11001 11000 10111 10110

11111 11110 11101 11100 32QAM

Find Tab

The Find tab is used to set parameters for finding bursts within the data record. This is a post-acquisition operation. Synch Word search controls are also on this tab.

Modulation Params Freq & BW Advanced Params	Find	Ana	ysis 7	Fime	Trac	e !	Scale	Pref	fs	
Burst Detection	🔽 Use	Sync	:h Wo	ord:			(Clear	
Mode: Off 🗾	0	00	00	00	01	00	10	00	11	*
Threshold: -10 dBc	16 24									Ŧ

Setting	Description					
Burst Detection: Mode	Select whether to analyze bursts					
	 Auto: If a burst is found, analyze just that burst period. If a burst is not found, analyze the whole analysis length. 					
	 On: If a burst is found, analyze just that burst period. If a burst is not found, display an error message. 					
	- Off: Analyze the whole analysis length.					
	If the signal isn't adequate for demodulation, an error message is shown.					
Burst Detection: Threshold	Sets the level required for the signal to qualify as a burst. Enter a value in dBc down from top of the signal.					
Use Synch Word	When enabled, specifies the string of symbols to look for. Enter the search string with external keyboard or the on-screen keyboard.					
Clear	Blanks the search string field.					

Analysis Time Tab

The Analysis Time tab contains parameters that define how the signal is analyzed in the general purpose digital modulation displays.

Modulation Params	Freq & BW	Equalizer	Advanced P	Params Find	Analysis	Time	Trace	Scale	Prefs
Analysis Offset:	-66.667 ns	Σ.	uto	Time Zero Re	ference:	Trigg	jer		•
Analysis Length		۵ 🔽	uto		Units:	Symt	ools		•
Actual	: 128 Sym								

The settings values on this tab are the same as those on the main Analysis control panel for the instrument with the only difference being that Analysis Length can be set in either Seconds or Symbols in this location.

Setting	Description					
Analysis Offset	Specifies the location of the first time sample to use in measurements.					
Auto	When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.					
Analysis Length	Specifies the length of the analysis period to use in measurements. Length is specified in either seconds or symbols, depending on the Units setting. For most modulation types, the Analysis Length set when Auto is enabled is 128 symbols. For some modulation types, a longer length is used.					
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.					
Time Zero Reference	Specifies the zero point for the analysis time.					
Actual	This is a displayed value, not a setting. It is the Analysis Length (time or symbols) being used by the analyzer; this value may not match the Analysis Length requested (in manual mode).					
Units	Sets the units of the Analysis Length to either Symbols or Seconds.					

Analysis Offset

Use analysis offset to specify where measurements begin. Be aware that you cannot set the Analysis Offset outside the range of time covered by the current acquisition data. (all time values are relative to the Time Zero Reference).

You can set the Analysis Length so that the requested analysis period falls partly or entirely outside the current range of acquisition data settings. When the next acquisition is taken, its Acquisition Length will be increased to cover the new Analysis Length, as long as the Sampling controls are set to Auto. If the Sampling parameters are set to manual, or if the instrument is analyzing saved data, the actual analysis length will be constrained by the available data length, but in most cases, measurements are able to be made anyway. The instrument will display a notification when measurement results are computed from less data than requested. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed by a measurement. As you adjust this value, the actual amount of time for Analysis Length, in Symbol or Seconds units, is shown below the control in the "Actual" readout. This setting is not available when Auto is checked. Range: minimum value depends on modulation type. Resolution: 1 symbol. A maximum of approximately 80,000 samples can be analyzed (the actual value varies with modulation type).

Time Zero Reference

All time values are measured from this point (such as marker position or horizontal position (in Y vs Time displays). Choices are: Acquisition Start or Trigger.

Parameter	Description
Acquisition Start	Offset is measured from the point at which acquisition begins.
Trigger	Offset is measured from the trigger point.

Trace Tab

Menu Bar: Setup > Settings > Trace

The Trace tab allows you to set the trace display characteristics of the selected display.

Modulation Params	Freq & BW	Equalizer	Advanced Params	Find	Analysis Time	Traces	Prefs
Trace:	Trace 2 🔻	🔽 Sho	w 📝 Freeze	-All GP I	Digital Modulatio	on display	s
Content:	Lines 🔻				Points/symbo	ol: 4	•
Q Offset:	Use shared Pre	ef 🔻		Symb	ol point locatio	n: Cento	er 🔻

Example traces tab for constellation display set to SOQPSK modulation type

Note that some settings are not present for all modulation types and some settings are not present for all displays.

Modulation Params	Freq & BW	Equalizer	Advanced Params	Find Analysis Time	Traces	Prefs
Trace:	Trace 1 💌	🔽 Sho	w 🔲 Freeze	-All GP Digital Modulatic	ın display	s
Content:	Vectors 👻			Points/symbo	d: 4	-
Phase multiplier:	1 •					

Example trace tab for constellation display set to CPM modulation type

Modulation Params	Freq & BW	Equalizer	Advanced Params	Find	Analysis Time	Trace	Scale	Prefs
Trace:	I	🔹 🔽 SI	how					
Points/symbol:	8	•						
Content:	Points	•	Symbol point locatio	on: Ce	enter	T		

Example trace tab for Demod I&Q display

Setting	Description
Trace	Selects the trace that is hidden or displayed based on whether or not Show is selected.
Show	Specifies whether the trace selected by Trace is displayed or hidden.
Freeze	Halts updates to the trace selected by the Trace setting. Present for the Constellation display only.
Content	Selects whether to display the trace as vectors (points connected by lines), points (symbols only without lines), or lines (lines drawn between symbols, but no symbols are displayed). The choices available depend on the display.
Q Offset	For traces with offset modulation (OQPSK and SOQPSK), this setting enables the trace to be displayed with Q offset or without Q offset. Choices available are Remove Q offset , Include Q Offset , and Use Shared Pref . Selecting Use Shared Pref causes the analyzer to add or remove Q offset according to the Remove Q Offset setting located on the Prefs tab. Setting the Q Offset on the Traces tab changes the Q offset only for the Constellation display. If other GP Digital Modulation displays are shown, they will use the use the Remove Q Offset setting on the Prefs tab regardless of the Q Offset setting on the traces tab for the Constellation display. The Q Offset setting is available only when the modulation type is set to OQPSK or SOQPSK.
Points/symbol	Select how many points to use between symbols when connecting the dots. Values: 1, 2, 4, 8.
Symbol point location	Selects whether to evaluate the symbol value at the center or the end of the eye opening. This control is only present for some of the supported modulation types.
Phase Multiplier	Sets the multiplication constant for the phase multiplication display: ×1 (default), ×2, ×4, ×8, ×16, or ×32. The phase multiplication display facilitates observation of noisy CPM signals by multiplying measurement signal phase by the constant to reduce the number of phase states and expand the phase difference between adjacent symbols.

Comparing Two Traces in the Constellation Display

When the Constellation display is the selected display, you can use the Traces tab to enable the display of a second trace. The second trace is a version of the current acquisition. You can choose to freeze a trace in order to display the current live trace to an earlier version of itself, you can display the trace as a second trace with or without Q Offset, or you can choose to display both traces frozen in order to compare the trace to itself at different times.

To display a second trace in the Constellation display:

- 1. If more than one display is present, select the Constellation display to ensure it is the selected display.
- 2. Click the settings icon or select **Setup** > **Settings** from the menu bar.
- 3. Select the Traces tab.
- 4. Select Trace 2 from the Trace drop-down list.
- 5. Click the Show checkbox so that it is checked.
- **6.** Specify the **Content** as desired. Trace 2 lines appear in blue to aid in distinguishing Trace 2 from Trace 1.

Scale Tab

The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency.

Modulation Para	ms Freq & BW	Equalizer	Advanced Params	Find	Analysis Time	Trace	Scale	Prefs
Vertical					Horizontal —			
Scale:	200 mV]			Scale:	128.00	0 Sym	
Position:	0.000 V]			Position:	-1.00	Sym	
	Autoscale]			🔽 Auto	Aut	oscale	

Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale units.
Position	Position adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the span of the trace display and position of the trace.
Scale	Allows you to, in effect, change the span.
Position	Allows you to pan a zoomed trace without changing the Measurement Frequency. Position is only enabled when the span, as specified by Freq/div, is less than the acquisition bandwidth.
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.
Auto	

A Note About Units

The Units used for the horizontal scale can be either Seconds or Symbols. To set the units for the horizontal scale, display the **Analysis Time** tab. On the tab, select the appropriate units from the **Units** drop-down list.

Prefs Tab

The Prefs tab enables you to change appearance characteristics of the GP Digital Modulation displays.

Modulation Params	Freq & BW	Equalizer	Advanced Params	Find	Analysis Time	Trace	Scale	Prefs
			Radix: Binary	•				
📝 Show gratic	tule		📝 Show Marker rea	dout in	graph (selected	l marker)	

Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Radix	Specifies how symbols are displayed in the Symbol Table display and in the Marker readout in the Constellation display.
Remove Q offset	The I and Q data traces are displayed with an offset of half a symbol when the modulation type is set to SOQPSK or OQPSK. You can remove this offset by selecting Remove Q offset. (Which is only present when the modulation type is set to OQPSK or SOQPSK.)
Show EVM and Offset EVM results	Adds EVM results in the display when enabled (Offset EVM is always displayed). Present only in Signal Quality display and with SOQPSK and OQPSK modulation types only

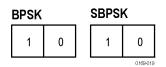
Symbol Maps

This topic shows the symbol mapping for each digital modulation technique.

QPSK			_	OQPSK			SOQPSK		
	1	3		01	11		01	11	
	0	2		00	10		00	10	
								0169-018	

8PSK

Left				Right
		3		
	2		1	
6				0
	7		4	
		5		
				0169-009



D8PSK

Phase shift (radians)	Symbol value (binary)	
0	000	
π/4	001	
π/2	011	
3π/4	010	
π	110	
5π/4	111	
3π/2	101	
7π/4	100	

Pi/2 DBPSK

Phase shift (radians)	Symbol value (binary)	
+π/2	0	
-π/2	1	

DQPSK

Phase shift (radians)	Symbol value (binary)	
0	00	
π/2	01	
π	11	
3π/2	10	

Pi/4 DQPSK

Phase shift (radians)	Symbol value (binary)	
+π/4	00	
+3π/4	01	
-π/4	10	
-3π/4	11	

MSK		
Phase shift direction	Symbol value (binary)	
-	0	
+	1	

16QAM

Left			Right
3	2	1	0
7	6	5	4
В	А	9	8
F	E	D	С
			0169-010

32QAM

Left					Right
	3	2	1	0	
9	8	7	6	5	4
F	E	D	С	В	A
15	14	13	12	11	10
1B	1A	19	18	17	16
	1F	1E	1D	1C	
					0169-011

64QAM

Left							Right
7	6	5	4	3	2	1	0
F	Е	D	С	В	А	9	8
17	16	15	14	13	12	11	10
1F	1E	1D	1C	1B	1A	19	18
27	26	25	24	23	22	21	20
2F	2E	2D	2C	2B	2A	29	28
37	36	35	34	33	32	31	30
3F	3E	3D	3C	3B	ЗA	39	38
							0169-012

128QAM

							-	-	-	-	
		5D	5F	4F	4D	1A	1B	0B	0A		
		5C	5E	4E	4C	18	19	09	08		
4A	48	54	56	46	44	10	11	15	14	1C	1D
4B	49	55	57	47	45	12	13	17	16	1E	1F
5B	59	51	53	43	41	02	03	07	06	0E	0F
5A	58	50	52	42	40	00	01	05	04	0C	0D
6D	6C	64	65	61	60	20	22	32	30	38	3A
6F	6E	66	67	63	62	21	23	33	31	39	3B
7F	7E	76	77	73	72	25	27	37	35	29	2B
7D	7C	74	75	71	70	24	26	36	34	28	2A
		68	69	79	78	2C	2E	3E	3C		
		6A	6B	7B	7A	2D	2F	3F	3D		
											0169-017

Left															Right
EF	FD	EB	F9	E7	F5	E3	F1	0F	3F	4F	7F	8F	BF	CF	FF
CE	DC	СА	D8	C6	D4	C2	D0	0C	3C	4C	7C	8C	BC	СС	FC
AF	BD	AB	B9	A7	B5	A3	B1	0B	3B	4B	7B	8B	BB	СВ	FB
8E	9C	8A	98	86	94	82	90	08	38	48	78	88	B8	C8	F8
6F	7D	6B	79	67	75	63	71	07	37	47	77	87	B7	C7	F7
4E	5C	4A	58	46	54	42	50	04	34	44	74	84	B4	C4	F4
2F	3D	2B	39	27	35	23	31	03	33	43	73	83	B3	C3	F3
0E	1C	0A	18	06	14	02	10	00	30	40	70	80	B0	C0	F0
E1	D1	A1	91	61	51	21	11	01	13	05	17	09	1B	0D	1F
E2	D2	A2	92	62	52	22	12	20	32	24	36	28	3A	2C	3E
E5	D5	A5	95	65	55	25	15	41	53	45	57	49	5B	4D	5F
E6	D6	A6	96	66	56	26	16	60	72	64	76	68	7A	6C	7E
E9	D9	A9	99	69	59	29	19	81	93	85	97	89	9B	8D	9F
EA	DA	AA	9A	6A	5A	2A	1A	A0	B2	A4	B6	A8	BA	AC	BE
ED	DD	AD	9D	6D	5D	2D	1D	C1	D3	C5	D7	C9	DB	CD	DF
EE	DE	AE	9E	6E	5E	2E	1E	E0	F2	E4	F6	E8	FA	EC	FE
				-			-	-		-		-			0 169-0 13

256QAM

2FSK		4FSK			
Left	Right	Left			Right
0	1	0	1	3	2
					0169-014

8FSK

Left							Right
0	1	2	3	7	6	5	4
	1						0169-015

16FSK

	Right
0 1 2 3 4 5 6 7 15 14 13 12 11 10 9	8

C4FM Left			Right
11	10	00	01
			0 169-020

СРМ		
Phase shift (h = modulation index)	Symbol value (binary)	
–3h	11	
h	10	
+h	01	
+3h	00	

Overview: User Defined Measurement and Reference Filters

The Modulation Parameters control tab for GP Digital Modulation displays enables you to load custom measurement and reference filters. If the existing filters do not meet your requirements, you can create your own filters for use in the measurement and reference settings. This section describes the structure of user filters and provides two examples of customized filters. See <u>User Filter File Format (see page 452)</u>.

Loading a User Measurement Filter

To load a your own measurement filter:

- 1. From the Modulation Params control tab (Settings > Modulation Params), click on the drop-down list for **Measurement Filter**.
- 2. Select one of the filter names that starts with User. This displays the Manage user filters window.
- **3.** Enter a name for the filter in one of the **Name (editable)** boxes. This name will appear in the drop-down list on the Modulation Params tab, prefaced with **User**. The maximum number of characters for the filter name is 20.

- 4. Click the **Browse** button and navigate to the directory containing the filter you want to load. Select the filter and click **Open**. If you wish to use a filter that is not in the list, select **User other** and locate and open the file you wish to use.
- 5. Click **OK** to load the filter and return to the Modulation Params page.

User Filter File Format

The filter file is selected on the Modulation Params control panel tab used by the GP Digital Modulation displays (Option 21 only). It stores the user-defined measurement or reference filter coefficient data in CSV format. The following figure shows the file structure.

# Rate 10	ight angle Oversampling rate of the filter (samples/symbol)
#Filiterl,FilterQ	٦́
0.97321,0.01947	
0.89559,0.04051	
0.77497,0.05942	
0.62333,0.07202	
0.45524,0.07438	➤ IQ pairs (1 to 1024) of the filter coefficient in time domain
0.28614,0.06354	
0.13045,0.01947	0189-023

User filter file structure

A filter file is a plain text file, in comma-separated-variable format. The file extension must be CSV.

The filter file contains the following variables:

Rate. Specifies the oversampling rate (the number of samples per symbol). The filter coefficient data will be interpolated by the specified rate.

Filterl, FilterQ. Specifies IQ pairs (1 to 1024) of the filter coefficient in time domain.

Rules for Creating a Filter File

- A line beginning with "#" is a comment line.
- Enter a positive value for the oversampling rate.
- A decimal number can be expressed by fixed point or floating point. For example, 0.01 and 1.0E-2 are both valid.
- "0" (zero) and ",0" (comma zero) can be omitted. For example, "1.5,0", "1.5,", and "1.5" are equivalent.
- Lines with only a comma and blank lines are skipped.

Example filters. For your reference, two example filters, Raised Cosine and Gaussian, are shown here. Both filters contain 65 data points with an oversampling rate of 8.

(Row 1 to 18)	(Row 19 to 36)	(Row 37 to 54)	(Row 55 to 68)
# Rate	0.0383599,0	0.973215,0	0.0743803,0
8	0,0	0.895591,0	0.0720253,0
# Filterl,FilterQ	-0.047715,0	0.774975,0	0.0594205,0
0,0	-0.0984502,0	0.623332,0	0.0405144,0
-0.0062255,0	-0.143898,0	0.455249,0	0.0194761,0
-0.0136498,0	-0.174718,0	0.286147,0	0,0
-0.0209294,0	-0.181776,0	0.130455,0	-0.0151973,0
-0.0263419,0	-0.157502,0	0,0	-0.0246357,0
-0.0280807,0	-0.0971877,0	-0.0971877,0	-0.0280807,0
0.0246357,0	0,0	-0.157502,0	-0.0263419,0
0.0151973,0	0.130455,0	-0.181776,0	-0.0209294,0
),0	0.286147,0	-0.174718,0	-0.0136498,0
0.0194761,0	0.455249,0	-0.143898,0	-0.0062255,0
).0405144,0	0.623332,0	-0.0984502,0	0,0
0.0594205,0	0.774975,0	-0.047715,0	
0.0720253,0	0.895591,0	0,0	
).0743803,0	0.973215,0	0.0383599,0	
0.063548,0	1,0	0.063548,0	

(Row 1 to 18)	(Row 19 to 36)	(Row 37 to 54)	(Row 55 to 68)
# Rate	0.00191127,0	0.978572,0	0.000401796,0
8	0.00390625,0	0.917004,0	0.000172633,0
# FilterI,FilterQ	0.00764509,0	0.822878,0	7.10E05,0
2.33E-10,0	0.0143282,0	0.707107,0	2.80E-05,0
9.11E-10,0	0.0257149,0	0.581862,0	1.06E-05,0
3.42E-09,0	0.0441942,0	0.458502,0	3.81E-06,0
1.23E- 08,0	0.0727328,0	0.345977,0	1.32E-06,0
l.21E-08,0	0.114626,0	0.25,0	4.37E-07,0
1.39E-07,0	0.172989,0	0.172989,0	1.39E-07,0
1.37E-07,0	0.25,0	0.114626,0	4.21E-08,0
1.32E-06,0	0.345977,0	0.0727328,0	1.23E-08,0
3.81E-06,0	0.458502,0	0.0441942,0	3.42E-09,0
1.06E-05,0	0.581862,0	0.0257149,0	9.11E-10,0
2.80E-05,0	0.707107,0	0.0143282,0	2.33E-10,0
7.10E-05,0	0.822878,0	0.00764509,0	
.000172633,0	0.917004,0	0.00390625,0	
.000401796,0	0.978572,0	0.00191127,0	
0.000895512,0	1,0	0.000895512,0	

Using Markers

Markers are indicators in the display that you can position on a trace to measure values for the X and Y axes, such as frequency, power, and time. A Marker always displays its position and, if enabled, will display the difference between its position and that of the Marker Reference (MR).

You can display up to five markers including the reference marker. Markers can all be placed on the same trace or they can be placed on different traces. There are three types of Markers: Reference, Delta, and Power Markers. The Marker Reference (labeled MR in the graph) makes absolute measurements and is also used for calculating differences when Delta or Power readouts are enabled. The Delta Markers (labeled M1 to M4 in the graph) are used to measure other points on the trace or the difference between the Marker Reference and the Delta marker. The Power Markers (labeled M1 to M4 in the graph) function the same way as the Delta Markers, except they show power density and integrated power density (dBm/Hz) instead of power level (dBm).

The following two tables show the appearance of the five types of marker readouts.

Marker Reference Readout	Absolute Marker Readout	Delta Marker Readout
Reference Marker label Power level at marker MR: 1000 dbm 1004 GHz Frequency at marker	Absolute Marker label Power level at marker	Delta Marker label Difference in power level between Delta Marker and Marker Reference AM1:-30 54 dB -51 Wiz Difference in frequency between Delta Marker and Marker Reference
Power Marker Readout		of times pixel has been
Power density at Power Marker	,	m

The following table shows the appearance of the marker indicators as they appear on the trace. Whichever marker is active will appear as a solid diamond.

Marker Reference

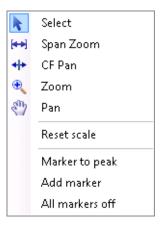
Absolute, Delta, and Power Marker



M1

Controlling Markers with the Touchscreen Actions Menu

In addition to controlling the marker actions from the front panel or screen menu items, you can use the touch screen actions menu to move markers or add and delete markers.



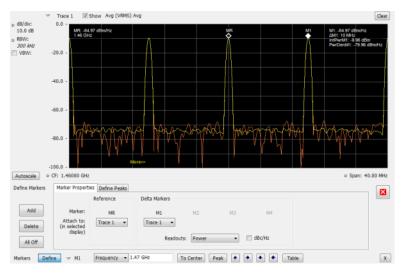
To use the Touchscreen Actions menu, touch the display and hold for one second, then remove your finger. You can also use a mouse to display the Touchscreen Action menu by clicking the right mouse button.

Menu item	Description
Marker to peak	Moves the selected marker to the highest peak. If no marker is turned on, this control automatically adds a marker.
Next Peak	Moves the selected marker to the next peak. Choices are Next left, Next right, Next lower (absolute), and Next higher (absolute).
Add marker	Defines a new marker located at the horizontal center of the graph.
Delete marker	Removes the last added marker.
All markers off	Removes all markers.

Measuring Frequency and Power in the Spectrum Display

To measure the frequency and power at a point on a Spectrum trace:

- 1. Select Markers > Define Markers.
- 2. Select the Marker Properties tab.
- **3.** Click **Add**. This displays a drop-down list under **MR** (Marker Reference), found inside the **Reference** box. The first marker defined is always designated the Marker Reference. Subsequently defined markers are Delta Markers for which readouts can be selected for Delta, Power, or Absolute. You can also select and adjust markers by clicking on an existing marker on a trace.
- 4. From the drop-down list, select the trace to which you want to assign the marker.



- 5. Click the close control panel button to remove the Define Markers control panel.
- 6. Click on the marker on the trace to activate that marker.
- 7. Use the knob or the arrow keys on the front panel to move the marker to the desired location on the trace. You can also click on the marker location text box in the Markers toolbar at the bottom of the screen and adjust it with your mouse wheel. The Peak button in the Markers toolbar and the arrow buttons to the right of it control marker peak searching on the trace.
- 8. Read the frequency and power level of the marker position on the display.
- 9. Read the signal density, frequency, and power level of the marker position on the display.
- 10. If Power markers are selected, read the point power density and the integrated power density.

Marker Action Controls

Controls for enabling and moving markers and for initiating marker peak searches are found in several locations. There are buttons for a few of the most common marker activities on the front panel of the instrument, used along with the knob for adjusting marker positions. The Markers menu contains selections for peak searches and the Marker toolbar also has buttons for peak searches. All graphs that support the markers offer a pop-up menu for marker actions.

Peak

Selecting **Peak** from the Markers menu moves the selected marker to the highest level peak within the acquisition record.

Next Peak

Selecting Next Peak displays a submenu that enables you to move the selected marker to the next peak.

Setting	Description
Next Left	Moves the selected marker to the next peak to the left of the current marker position.
Next Right	Moves the selected marker to the next peak to the right of the current marker position.
Next Lower (absolute)	Moves the selected marker to the lower level peak (in absolute terms) on the trace.
Next Higher (absolute)	Moves the selected marker to the higher level peak (in absolute terms) on the trace.

Marker to Center Frequency

Changes the center frequency to match the frequency of the selected marker.

Enabling Markers and Setting Marker Properties

The Define Markers Control Panel is used to enable markers and set their properties. You can set up to five markers including the marker reference. Markers are shown in most displays.

Markers have three types of on-screen readouts: Absolute, Delta, and Power. When **Readouts** is set to **Absolute**, each readout displays only the marker's position on the trace. In Frequency displays, this means the marker readout shows the frequency and power of the trace at the marker position. When **Readouts** is set to **Delta**, each delta marker (M1-M4) readout displays both the marker's position on the trace and the difference between its position and the position of the Reference Marker (MR). When **Readouts**

is set to **Power**, each delta marker (M1-M4) readout displays the marker's position on the trace, the difference between its position and the position of the Reference Marker (MR), the point power density, and the integrated power density.

Defining Markers

Define Markers	Marker Properti	es Define Peaks					
		Reference	Delta Markers				
Add	Marker: Attach to:	MR Trace 1 🗸	M1	M2	МЗ	M4	
Delete	(in selected display)	Hace I	Readouts:	Delta	•	🗐 dBc/Hz	
Markers Defin	e 🗸 MR	Frequency 👻 1.	5 GHz To	Center	Peak 🔶	• •	Table

- 1. Select Markers > Define Markers to display the Define Markers control panel.
- 2. Select Add to turn on the next marker. A drop-down list under the marker label allows you to assign the marker to a trace.

NOTE. The first marker defined will always be **MR**. The MR marker is the reference for delta marker readouts.

- 3. Select the trace to which the marker should be attached from the drop-down list.
- 4. Click Add to add additional markers.
- 5. Click on the **Readouts** drop down menu to select the readout to view. If you select Delta from the drop down menu, you can check the **dBc/Hz** box to measure noise in dBc/Hz and show that for the delta value. Checking this box if other readouts are selected will force the readout to Delta. You can read more about dBc/Hz mode here (see page 461).
- 6. Click the close button to remove the Define Markers control panel.

Defining Peaks

You can specify two amplitude values that define peaks. For the DPX display, you can also define peaks based on signal density characteristics.

Define Markers	Marker Properties Define	Peaks		
	Amplitude		DPX Signal Density	
Add	Peak Threshold:	-150 dBm	Density Threshold:	500
Delete	Minimum Excursion:	6 dB	Minimum Excursion:	
All Off			Smoothing (pixels so	quared): 5
Markers Defin	ne v MR Frequenc	y ▼ 1.5 GHz	To Center Peak	🔹 🔶 🔸 🛧 Table

Amplitude	
Peak Threshold	Peak Threshold specifies the level that the signal must exceed to be considered a peak.
Minimum Excursion	Minimum Excursion specifies how much the signal must decrease and then increase before another peak can be declared.
DPX Signal Density	
Density Threshold	Density Threshold specifies the signal density (number of hits per displayed pixel) that the DPX bitmap must exceed to be considered a trigger event.
Minimum Excursion	Minimum Excursion specifies how much the signal density must decrease and increase again before another peak can be declared.
Smoothing (pixels squared)	Smoothing specifies the number of pixels around the marker that are averaged together to reduce "noise" in the readout of signal density. The value of this control is the number of pixels on each side of the square area used for averaging. With Smoothing = 1, no averaging is done and the marker z-axis readout is the hit count (density) of a single pixel. Use this control to characterize how wide or narrow a range of pixels should be averaged to determine the signal density.

- 1. Select Markers > Define Markers to display the Define Markers control panel.
- 2. Select the Define Peaks tab.
- 3. To define the level for Peak Threshold, enter a value in the Peak Threshold number entry box.
- 4. To define the amount the trace must dip, enter a value in the Peak Excursion number entry box.
- 5. Click the close button to remove the Define Markers control panel.

Using the Markers Toolbar

Front Panel: Markers

Application toolbar:

Menu bar: View > Marker Toolbar

Select **Marker Toolbar** to display or hide the Marker Toolbar in the application window. The Marker Toolbar enables you to operate existing markers or define new markers.

Markers Define v MR Frequency 1.900335 GHz To Center Peak 🔹 🖈 🖈 Table X

Enabling a marker or adjusting the position of a marker automatically opens the Markers toolbar.

Description
Opens the Define Markers control panel.
Selected marker readout. This readout shows which marker is selected. The pop-up menu allows you to choose the selected marker, add markers, and turn all markers off.
Marker position controls. For frequency displays, this readout shows the marker position in Hertz. For time displays, this readout shows the marker position in seconds. The position of the selected marker can be changed by selecting the numeric readout and using the knob to adjust the value.
Changes the analyzer's Center Frequency to the frequency of the selected marker. Not selectable for time markers.
Moves the marker to the highest peak on the signal. On displays that scale about zero on the vertical axis (for example, Magnitude Error, EVM, and Frequency vs. Time), the highest peak selected by the Peak button is an "absolute value", therefore, negative peaks are included in the search for the highest peak.
Moves the selected marker to the next peak to the left of the current position.
Moves the selected marker to the next peak to the right of the current position.
Moves the selected marker to the next lower peak value. The peak value here refers to the numeric value of the peak amplitude. Thus, when repeatedly moving the marker, it can move to the right or left depending on the location of the next lower value.
Moves the selected marker to the next higher peak value. The peak value here refers to the numeric value of the peak amplitude. Thus, when repeatedly moving the marker, it can move to the right or left depending on the location of the next higher value.
Displays/hides the marker table from the display.
Removes the Marker Toolbar from the display.

Measuring Noise Using Delta Markers in the Spectrum Display

In the Spectrum display, you can set Markers to dBc/Hz to measure noise on the trace. Markers in this mode operate just as they do in normal mode, but the readouts for the markers are in dBm/Hz and dBc/Hz.

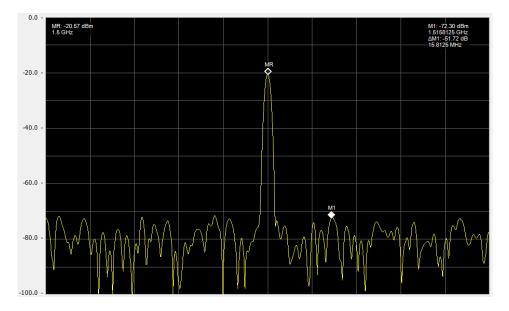
dBm/Hz is the power in milliwatts referenced to a 1 Hz bandwidth. To make this measurement, the analyzer assumes that the measured signal is random noise. It then converts the measured power (made at any RBW) to the power that would be measured had a 1 Hz filter been applied for the measurement.

dBc/Hz represents dBm/Hz referenced to a carrier. Here, it is assumed that the carrier is a CW signal, and its signal level does not change when the RBW is changed, so the Reference Marker measurement on the carrier is unchanged from any other marker measurement. However, the delta marker values are converted to dBm/Hz, and then a difference value, in dBc/Hz, is calculated between each delta measurement and the reference.

Measuring Noise

To measure noise on a Spectrum trace:

- 1. Select Markers > Define to display the Markers control panel.
- 2. Click Add. The first marker defined is always designated the Marker Reference. Subsequently defined markers are Delta Markers for which readouts can be selected for Delta, Power, or Absolute. You can also select and adjust markers by clicking on an existing marker on a trace.
- 3. Click Add again so that there are at least two markers defined.
- 4. Check that **Readouts** is set to Delta and check the **dBc/Hz** box.
- 5. If you have more than one trace defined, use the drop-down list for each marker to set it to the trace on which you want to measure noise.
- 6. Notice that Detection is set to Average for the trace you are using for this measurement.
- 7. Check that the Amplitude units are set to dBm (that is the default). If they are not, click the Analysis) icon, select the **Units** tab, and select **dBm**.
- 8. Click the Close button to remove the control panel.
- 9. Move the markers to the desired locations on the trace.
- **10.** Read the frequency and power level for the selected marker in the upper corners of the display. To display the delta measurement in dBc/Hz, select the delta marker (M1, M2, M3 or M4) by clicking on it or pressing the front-panel Select button until it is selected.



The following image shows the Spectrum display with a Delta Marker.

The following image shows the Spectrum display with Power Markers.

The Mask Test Tool

You can specify pass/fail and mask parameter conditions for the Spectrum, Spurious, DPX Spectrum, Noise Figure, Gain, Frequency Settling Time and Phase Settling Time displays. When these conditions are met, the instrument can perform actions such as stopping acquisitions or saving data.

Mask Test Settings

Menu Bar: Tools > Mask Test

Selecting **Mask Test** displays the Mask Test control panel. These settings define test parameters and specify actions to be performed when the test conditions are met. Checking the **Enable Test** box sets the application to perform the test once the conditions are defined.

Mask Test	Define Actions	
✓ Enable Test	Search in: Spectrum: Trace 1 Test for: is greater than -20.00 dBm	

Setting	Description
Enable Test	Select to perform a test, then set the test conditions.
Define (see page 463)	Specifies which result to test and what to test for.
Actions (see page 469)	Specifies the action to take when the test condition is met.

Define Tab (Mask Test)

The Define tab sets the parameters for tests. From this tab, you specify which result to test and what kind of violation to test for.

The following image shows the Define tab with *is great than* selected. After you select that test, you will enter the desired signal level. The procedure is the same if you select *is less than*.

Mask Test	Define Actions	
✓ Enable Test	Search in: Spectrum: Trace 1 Test for: is greater than -20.00 dBm	

The following image shows the Define tab with *is outside mask* selected. After you select that test, you need to click the Edit limits button and set the desired test limits. The procedure is the same if you select *is inside mask*.

Mask Test	Define Actions	
Enable Test	Search in: Spectrum: Trace 1	
	Test for: Is outside mask Edit limits Load from file	

Setting	Description
Search in	Specifies which result to test.
Test for	Specifies what to test for. You can specify a test based on a signal level ("is greater than", "is less than") or a mask ("is outside mask", "is inside mask"). Options for Spurious and Settling Time are Pass and Fail.

Search In

The possible choices for **Search in** include traces from Spectrum, DPX, Noise Figure, Spurious, and Setting Time displays. The available choices are Trace 1, Trace 2, Trace 3, Math, Spectrogram Trace, Spurious, and Settling Time. The available choices include only results from displays that are currently open.

NOTE. If you select a result that is not the selected trace or result in the target display, you will not see the results of the test. To see the results, select the trace from the drop-down menu in the target measurement

display and check the Show box: • 40.9 dB

Test For

The Test for setting has selections that vary based on which display's results you are testing.

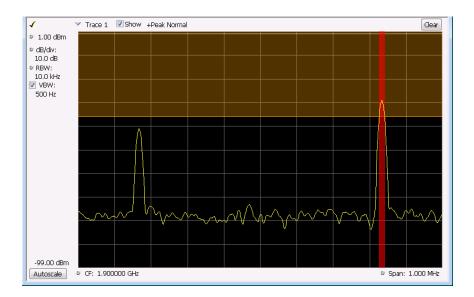
Pass/Fail Tests for Spurious and Settling Time

The Frequency Settling Time, Phase Settling Time measurements, and Spurious measurements test functions provide pass/fail results.

Greater Than/Less Than Tests for Spectrum

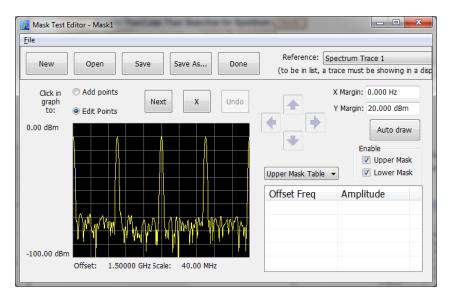
If you select a greater than/less than test, you also specify the level that defines a violation. When you select either **is greater than** or **is less than**, a text entry box appears to the right of the drop-down list. Use the text entry box to specify the signal level you wish to test for. While not as flexible as mask testing, this type of test is quicker to set up.

The following figure shows the results of an **is greater than** test. The vertical red bar highlights results that match the test definition.



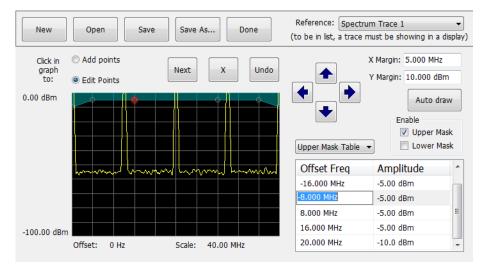
Outside/Inside Mask Tests

If you specify a mask-based test, then you need to edit the mask to specify the levels that define a violation. When you select **is outside mask** or **is inside mask**, an **Edit limits** button is displayed. Click the **Edit limits** button to display the Mask Test Editor window.

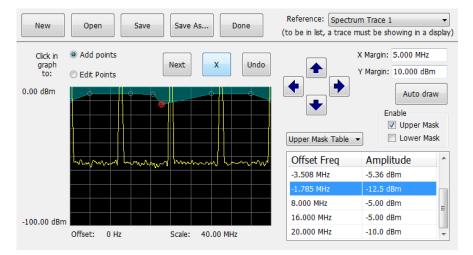


To set up and save mask test limits for a test. Perform the following procedure to set up a test using the mask limits.

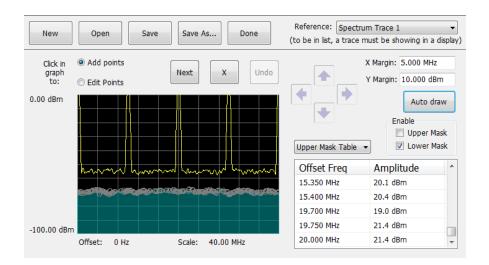
- 1. After choosing the desired **Search in** and **Test for** items, click **Edit limits** to display the Mask Test Editor window.
- 2. Click the New button to create a table. This clears the existing points and loads the default table. You can also click **Open** to open an existing table.
- 3. To edit values, add points, or delete points in a table:
 - **a.** To edit an existing value, double-click on the cell you want to edit and enter the desired value. The active point shows as a red point on the plot.



- **b.** To add a new point, check the box next to the target mask (located below the **Auto draw** button).
- c. Select Add points located below the Open button.
- d. Select the target mask (Upper Mask Table or Lower Mask Table) from the drop-down menu.
- e. Click in the desired location on the plot to add the point.



f. To use the auto draw feature to automatically place points on the chosen mask, enable the desired mask from the drop-down menu and then click the **Auto draw** button.



NOTE. Units may be changed for measurements other than Noise Figure in Setup > Analysis > Units.

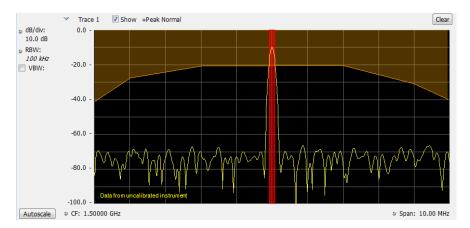
- 4. To delete a point from the table, select the point to be removed, and click the X button.
- 5. To save the mask to a file for later recall, click Save As.
- 6. From the Save As dialog, name the file and save it in the desired location.

NOTE. Masks are saved in XML format with a .msk extension.

7. To dismiss the Mask Test Editor window, click Done.

Mask Test Result Examples

The following figure shows the results of a Spectrum **is outside mask** test with Upper Mask enabled. The vertical red bar highlights results that have exceeded the test limits. The shaded region shows the mask area.



The following figure shows the results of a passing Noise Figure **is outside mask** test with Upper Mask enabled. Markers are also in use.



The following figure shows the results of a failing Noise Figure **is outside mask** test with Lower Mask and Upper Mask enabled. The red area highlights the area of failure, which occurs at the lower mask. Markers are also in use.



Actions Tab

The Actions tab allows you to trigger the application when a signal in the frequency domain violates the mask.

Define Actions				
During Run or Replay	During Run only			
📃 Веер	Save acquisition data	TIQ 🔻	Max files:	100
Stop	Save trace			
	Save picture	PNG 🔻		

Setting	Description
During Run or Replay	Actions specified here will occur in either Run mode or Replay mode.
Stop	The analyzer stops when the test condition is met.
During Run Only	Actions specified here are taken only during Run mode (while acquiring live data).
Save acquisition data	Saves acquisition data to a file when the test condition is met. Use the drop-down list to specify the format of the saved data. The available file formats are: TIQ , CSV, and MAT (see page 515).
Save trace	Saves Trace data to a file when the test condition is met.
Save picture	Saves a screen capture to a file when the test condition is met. Use the drop-down list to specify the format of the saved picture. The available file formats are: <u>PNG, JPG, and</u> <u>BMP (see page 515)</u> . Note that no trace will be saved if the tested trace isn't a saveable trace type. For example, a Spurious trace is not saveable.
Max files	Specifies the number of times a test action stores a file. After this limit is reached, no more files are saved. The instrument will continue to run, but no additional files are saved when test conditions are met.
	Keep in mind when setting this number that picture files are counted as part of the total number of files. For example, if you set Max files to 100, the instrument will save 100 acquisitions if only acquisitions are saved or only pictures are saved. But, if both acquisitions and pictures are saved, then 50 acquisitions and 50 pictures will be saved.

AutoSave File Naming

When one of the AutoSave actions is enabled, the name of the saved file is automatically incremented even if the Automatically generate filenames option (Tools > Options > Save and Export) is not enabled. When the file is saved, it will be saved to C:|<instrument name>Files|.

Analysis Settings

Menu Bar: Setup > Analysis

Application Toolbar: 🏠

The Analysis control panel provides access to settings that are used by all displays. These settings affect only post processing and they do not control hardware settings.

Analysis	Analysis Time Spectrum Time Frequency Units	×
	Analysis Offset: 80.000 ns 📝 Auto Time Zero Reference: Acquisition Start 🔹	
	Analysis Length: 1.000 us	
	Actual: 1.000 us	

Setting	Description
Analysis Time (see page 471)	Specifies the length of time to use in measurements.
Spectrum Time (see page 473)	Specifies whether the Spectrum Analysis display uses the same Analysis Time parameters as all the other displays or if it uses a different Offset and Length.
Frequency (see page 473)	Specifies the measurement frequency (center frequency).
Units (see page 476)	Specifies the Power units for all displays.

Analysis Time Tab

The Analysis Time tab contains parameters that define the portion of the acquisition record that is used for analysis.

Analysis Time Spectrum Time Freq	uency Units		
Analysis Offset: <i>80.000 ns</i>	🔽 Auto	Time Zero Reference:	Acquisition Start 👻
Analysis Length: 1.000 us	🔽 Auto		
Actual: 1.000 us			

Setting	Description	
Analysis Offset	Specifies the location of the first time sample to use in measurements.	
Auto	When enabled, causes the instrument to set the Analysis Offset value based on the requirements of the selected display.	
Analysis Length	Specifies the length of time to use in measurements.	
Auto	When enabled, causes the instrument to set the Analysis Length value based on the requirements of the selected display.	
Time Zero Reference	Specifies the zero point for the analysis time.	
Actual	This is a displayed value, not a setting. It is the Analysis Length (time) being used by the analyzer; this value may not match the Analysis Length requested (in manual mode).	

Analysis Offset

Use analysis offset to specify where measurements begin. Range: 0 to [(end of acquisition) - Analysis Length)]. Resolution: 1 effective sample (or symbol).

Analysis Length

Use the analysis length to specify how long a period of time is analyzed by a measurement. After you enter a value, this box changes to show the actual value in use, which is constrained by Acquisition Time. This setting is not available when Auto is checked. Range: minimum value depends on modulation type to Acquisition Length. Resolution: 1 effective sample (or symbol).

Time Zero Reference

The analysis offset is measured from this point. Choices are: Acquisition Start or Trigger Point.

Parameter	Description
Acquisition Start	Offset is measured from the point at which acquisition begins.
Trigger Point	Offset is measured from the trigger point.

Spectrum Time Tab

Analysis Time Spectrum Time Frequency Unit	5
Spectrum Time Mode	Spectrum Time
Independent	Spectrum Offset: 80.000 ns
Use Analysis Time settings	Spectrum Length: 1.520 ms
	Actual: 1.520 ms

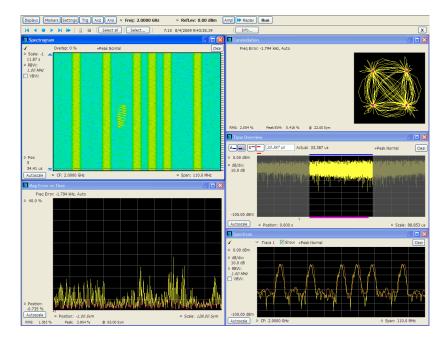
Settings	Description
Spectrum Time Mode	
Independent	Causes the spectrum analysis views to use the settings unique to those displays.
Use Analysis Time settings	Causes the spectrum analysis views to use the settings on the Analysis Time tab.
Spectrum Time (only available w	hen Independent is selected)
Spectrum Offset	Sets the beginning of Spectrum Time with respect to the selected time reference point (selectable in the Analysis Time tab as either Acquisition Start or Trigger).
Spectrum Length	The amount of data, in terms of time, from which spectrum traces are computed.
Auto	When enabled, causes the instrument to set the Spectrum Length value based on the RBW setting.
Actual	This is a displayed value, not a setting. It is the Spectrum Length (time) being used by the analyzer; this value may not match the Spectrum Length requested (in manual mode). The actual spectrum length is always an integer multiple of the time needed to support the RBW value.

Frequency Tab

The Frequency tab specifies two frequency values: the Measurement Frequency and the Spectrum Center Frequency. The Measurement Frequency is the frequency at which most displays take measurements. The Spectrum Center Frequency is the center frequency used by the Spectrum, DPX Spectrum, Spectrogram and Time Overview displays.

Analysis Time Spectrum Time Frequency Units				
Measurement Frequency:	1.500000 GHz			
 Lock Center Frequency of Spectrum displays to Measurement Frequency 				
Spectrum Center Frequency:	1.500000 GHz			

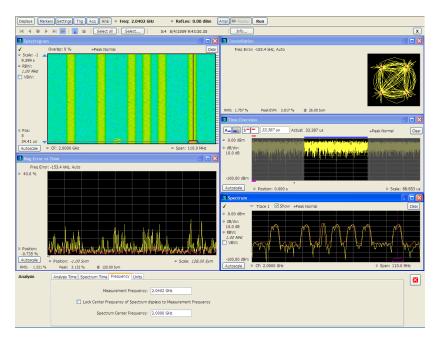
The following screen capture shows a display with both the Measurement Frequency and the Spectrum Center Frequency locked together.



Normally, the Measurement Frequency and the Spectrum Center Frequency are locked together so that both have the same setting. But in some situations, for example, where a signal contains a set of channels, it is useful to unlock the Measurement Frequency from the Spectrum Center Frequency. When the Spectrum Center Frequency is unlocked from the Measurement Frequency, you can adjust the Measurement Frequency so that measurements can be taken at different frequencies without resetting the center frequency. The following screen capture shows the magenta-colored measurement frequency indicator still located at the center frequency.

Displays Marker	rs Settings Trig Acq	Ana Preq: 2.0000 GHz	RefLev: 0.00 dBm	Ampi ≽ Replay	Run			
I4 4 0 F	▶	elect al Select	7:10 8/4/2009 9:43:35.19	Info]			x
Spectrogram			- 🗆 🛛	Constellatio	n		(- 🗆 🖂
o Scale: -1 ▲	overlap: 0 % +Pea	ik Normal	Clear	🖌 🛛 Freq Erro	r: -1.794 kHz, Auto			
9.5015 9.80W: 1.00 MHz VBW:		WIIIA		RMS: 2.054 %	Peak EVM: 5.416 %	© 22.00 Sym		
				🔝 Time Overvi				- 🗆 🗙
⇔ Pos: 5				A 5-	- 33.387 us Acti	ual: 33,387 us	+Peak Normal	Clear
34.41 us 🛫				₽ 0.00 dBm	contracounter loss fotos deservationes	n i <mark>mir plan podrovnih na i pravido na ince</mark>	<mark>P</mark> elistriur/Intention(S	and the part of the local division of the lo
	CF: 2.0000 GHz		 Span: 110.0 MHz 		n an		والأشارانة والاله ورازدار أراري	nahi Maji
Mag Error vs 1			- - ×					1
✓ Freq Error: - ● 40.0 %	-1.794 kHz, Auto			-100.00 dBm				
				Autoscale	₹ Position: 0.000 s		⇒ Scale:	00.052.04
				Spectrum	- Poston, 0.000 s		o state.	- C X
					✓ Trace 1 Show +P	eak Normal		Clear
Position: -0.735 %	A.		Millednesseller	 ○ 0.00 dBm ○ dB/div: 10.0 dB ○ RBW: 1.00 MHz ○ VBW: 	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Ama		Lyry:
	Position: -1.00 Sym		© Scale: 128.00 Sym	-100.00 dBm Autoscale	CF: 2.0000 GHz		Span: 110.0	MUX
RMS: 1.383 % Analysis	Peak: 3.904 % @ Analysis Time Spectrum '	63.00 Sym		Aucuscare			- open. 110.0	
Autoliy515	Lock Cent	Ime Hequency Units Measurement Frequency: 2.0 ter Frequency of Spectrum displate pectrum Center Frequency: 2.0	vs to Measurement Frequency					

The following screen capture shows the measurement frequency indicator located at 2.0402 GHz while the Spectrum Center Frequency is still located at 2.0000 GHz.



You can drag the Measurement Frequency indicator on the screen to set the measurement frequency. Note the base of the Measurement Frequency indicator. The width of the box indicates the widest measurement bandwidth in use among the open displays. You can see how the width of this box changes with the measurement bandwidth by, in this example, adjusting the Measurement BW setting for the Constellation

display (Settings > Freq & BW tab). As you adjust the setting, you will see how the width of the box at the base of the Measurement Frequency Indicator changes.

The Measurement Frequency indicator is useful for interpreting system behavior when MeasFreq is unlocked. If a measurement has a wide bandwidth relative to the spectrum span, and the Measurement Frequency is far from spectrum center, the measurement is likely to fail because its required frequency range exceeds the frequency range of the available data. In such a case, the navigation control will show that the measurement bandwidth extends outside the Spectrum's span.

There are interactions between frequency unlocking and RF & IF Optimization (see the <u>Amplitude control</u> panel (see page 483)). When **Best for multiple displays** is the selected optimization, the instrument is allowed to use its full bandwidth to meet the needs of all open displays. This is the most user-friendly optimization because it decreases the number of **Acq BW too small** errors, but it can increase noise and slightly decrease measurement accuracies. For all other optimization types, the instrument optimizes the acquisition bandwidth for the selected display, improving measurement quality somewhat, but reducing concurrent measurement capability.

There are also interactions with trigger settings. When the Spectrum Center Frequency is unlocked from Measurement Frequency, the RF triggers (Trigger Source = RF Input) can tune to either Spectrum Center Frequency or Measurement Frequency. When a spectrum display is selected, the trigger frequency is the same as the Spectrum Center Frequency. When one of the other displays that uses Measurement Frequency is selected, the trigger is tuned to the Measurement Frequency also. This allows you to trigger on the signal you are measuring. But, there is an exception: when the selected RF & IF Optimization is **Best for multiple displays**, the trigger is always tuned to the Spectrum Center Frequency.

The reason the trigger frequency is affected by Measurement Frequency and RF & IF Optimization, is that these functions control how the acquisition is tuned. The optimization **Best for multiple displays** keeps the acquisition centered about the Spectrum Center Frequency at all times. To accommodate off-center Measurement Frequencies, it just widens the acquisition bandwidth. Other optimizations tune the acquisition frequency to match that of whichever display is currently selected. The RF trigger module receives the same acquisition data as all the measurements, tuned to the center of the current acquisition bandwidth.

Units Tab

The Units tab specifies the global Amplitude units for all the views in the analysis window.



Replay Overview

Replay	Select data records Se	elect DPX Spectra	Acquisition Info	Replay Speed		
DDV Creative -	Select acquisitions	Select	All Se	elect frames		
DPX Spectra 🔻	1: 10/24/20	11 12:4:30.26		1: 10/24/20	011 12:4:30.26	
	Start: 1	10/24/2011 12:4:30.26		Start: 1	10/24/2011 12:4:30.26	
	Stop: 825	10/24/2011 12:4:46.60	:	Stop: 1	10/24/2011 12:4:46.60	
🔲 Show toolbar	825: 10/24/20	11 12:4:46.60		1: 10/24/20	011 12:4:46.60	

Displaying the Replay Control Panel

To display the Replay control panel:

From the menu bar, select **Replay** > **Select data records from history**.

Selecting the Data Type to Replay

Select Data Records Tab

The Select data records tab is used to select which data records to replay. A data record is the smallest unit that can be replayed. Note that what constitutes a data record can vary. If FastFrame is not enabled, a data record consists of a single acquisition. If FastFrame is enabled, each acquisition can contain multiple frames, and a data record consists of a single frame.

Select data records	Acquisition Info Replay Speed
Select acquisiti	ions Select All
1:7/25/201	.1 17:39:29.72
Start: 1	7/25/2011 17:39:29.72
Stop: 304	7/25/2011 17:39:33.79
304 : 7/25/201	1 17:39:33.79

Without FastFrame enabled

Select data records	Acquisition Info Replay Speed	t i i i i i i i i i i i i i i i i i i i			
Select acquisitions Select All Select frames					
1:3/10/201	0 4:47:40.22	1 : 3/10/2010 4:47:40).22		
Start: 1	3/10/2010 4:47:40.22	Start: 1	3/10/2010 4:47:40.22		
Stop: 1	3/10/2010 4:47:40.22	Stop: 10	3/10/2010 4:47:51.74		
1 : 3/10/2010 4:47:40.22		10 : 3/10/2010 4:47:51	74		

With FastFrame enabled

Date and Time Stamps. The line that appears above each Start box (one for acquisitions and one for frames when FastFrame is enabled) is a date stamp that displays the date and time the first record in the current acquisition was acquired. The line that appears below each Stop box is a date stamp that displays the date and time the last record in the current acquisition was acquired.

The line that appears to the right of each Start box displays the date and time the selected acquisition or frame was acquired. The line that appears to the right of each Stop box displays the date and time the selected record or frame in the current acquisition was acquired.

Select All button. Selecting Select All resets the Start and Stop values. The Start value is reset to the first acquisition or frame of the current acquisition. The Stop value is reset to the last acquisition or frame in the current acquisition.

Acquisition Info Tab

Displays information about acquisition settings and sets the number of decimal places used for displaying the time stamp.

Replay Speed Tab

Sets the speed at which data records are replayed.

Select data records	Select DPX Spectra	Acquisition Info	Replay Speed
	Slow		Fast

Replay Menu

The Replay menu provides controls that let you choose how to replay acquisitions. The replay function enables you to, in effect, "rerun" an analysis while applying different measurements to the same set of acquisition data.

Menu item	Description
Acq Data	Select Acq Data to replay acquisitions.
Replay all selected records	Replays the sequence of records specified by Start and Stop on the Select data records tab.
Loop overall selected records	Replays the sequence of records specified by Start and Stop on the Select data records tab continuously.
Replay current record	Replays the currently selected acquisition (or frame).
Replay from selected	Displays a submenu that you use to specify which records are to be replayed.

Description
Replays the first record within the selected set.
Replays the previous record within the selected set.
Replays the next record within the selected set.
Replays the last record within the selected set.
Suspends replay of the data records as soon as the current record's replay action is completed. Press Pause again to begin replay with the next record in the sequence.
Halts the replay of acquisitions. If replay is started after Stop has been selected, replay starts from the first acquisition.
Selects all acquisitions for replay.
Displays the Select data records tab of the Replay control panel. Use the Select data records tab to specify which acquisitions and frames you would like to replay.
Displays or hides the Replay toolbar.

Acq Data

Selecting **Acq Data** selects acquisition data as the source for replay. Selecting Acq Data does not start replay, it only selects the type of acquisition data that will be replayed.

Replay All Selected Records

Selecting **Replay all selected records** replays all the selected data records. The set of selected records may comprise a single record, all records in acquisition history, or a subset of the records in history.

Replay Current Record

Selecting **Replay current record** replays the current data record. You can identify the current acquisition record by looking at the Replay toolbar. The first number to the right of the Select button identifies the current data record. For example, if the number is 2:10, it means the current record is the tenth frame of the second acquisition in history.

Replay from Selected

Select **Replay from selected** to replay records as selected from the submenu. The records replayed can be from the acquisition memory (history) or from a saved acquisition data file that has already been recalled as the current acquisition data.

Pause

Select Pause to suspend playback. Selecting Pause again restarts the replay at the point it was paused.

Stop

Select **Stop** to halt the replay of data. Selecting any Replay action restarts replay of records from the beginning.

Select All

Select Select all to select all data records for replay.

Select Records from History

Selecting **Select records from history** displays the **Select data records** tab of the **Replay** control panel. The Select data records tab allows you to specify which records in the acquisition history will be used when the Replay button is selected.

Replay Toolbar

Displays or hides the Replay toolbar that appears below the main tool bar.

Replay: Acq Data 🔹 🖌 🖌 🍨 🕨 🄛 💭 🛛 🖉 elect All Select... 🚯 🕴 1:20 9/21/2011 11:27:36.27

Replay toolbar

ltem	Description
Replay	
	Replays the first record in the selected set.
•	Replays the previous record in the selected set.

Item	Description
•	Replays the current record in the selected set.
▶.	Replays the next record in the selected set.
M	Replays the last record in the selected set.
₩	Replays all records in the selected set.
C	Replays all records in the selected set continuously until stopped.
li	Pauses replay. Pressing pause suspends replay with the current record. Selecting pause again starts Replay with the next record.
	Stops replay. Starting any replay action after pressing stop starts a new Replay action rather than continuing from the record at which the previous replay action was stopped.
Select All	Pressing Select all selects all records in history for replay. Selecting Select all resets the Start and Stop values on the Select data records tab of the Replay control panel.
Select	Pressing Select displays the Select data records tab of the Replay control panel. The Select data records tab allows you to select records from acquisition history for replay.
1:10 3/10/2010 4:47:51.74	This readout shows information about the data record being replayed. The information displayed shows the acquisition and frame number and time stamp for the current data record.
0	The Info button displays the Acquisition Info tab of the Replay control panel. The Acquisition Info tab displays information about the acquisition data such as acquisition bandwidth, sampling rate and acquisition length. All data records in the acquisition history were acquired with identical parameters. When any of these parameters are changed, all records in history are deleted as soon as the first record acquired under the new parameter values is received.

Amplitude Settings

Menu Bar: Setup > Amplitude

Application Toolbar:

Setting	Description
External Gain/Loss Correction	Specifies whether a correction is applied to the signal to compensate for the use of
(see page 483)	external equipment.

External Gain/Loss Correction Tab

External Gain Value

Use the External Gain Value setting to apply a flat gain/loss correction to the signal. Positive values represent a gain and negative values represent a loss. The range is -50 to +30 dB. Resolution is 0.1 dB.

NOTE. Selecting Preset clears the check box, but it does not change the value.

External Loss Tables

Use an External Loss Table to apply a frequency dependent gain/loss correction to the signal. When an External Loss Table is selected, the analyzer adjusts the signal according to the values in the table. An external loss table allows you to compensate the signal level for variations in cable loss, antenna frequency response or preamp frequency response.

You can create external loss tables from the analyzer application and save them as files. External loss tables are saved as plain text files in CSV (Comma Separated Value) format. The tables have a CSV file extension.

You can change the title for each table. However, note that the title is only a label. It is not tied to the file name of any table you may have loaded or saved.

Creating an External Loss Table

You can create an external loss table with the analyzer application. No external application is required.

To create an external loss table:

1. Click Edit. to display the Table Editor.

🖳 Table Editor - Ext Loss Table 1			
Add Point	Undo	X: Frequency 2.000000 GHz	Y: Loss (Atten) 0.0000000 dB
Frequency Interpolation Linear Log (affects only Trace Correction) 			
New Table Load	Save As	Apply	OK Cancel

- 2. Click New Table to create a table. This clears all entries in the existing table and loads the default table.
- **3.** To edit values in the table:
 - a. To edit an existing value, double-click on the cell you want to edit.
 - b. To add a new point to the table, click on Add Point. Edit the values as required.
 - **c.** Click **Apply** if you want to test your table without closing the editor (the table must be enabled with the check box in the control panel and measurements must already be running).

To specify a frequency multiplier, you can type K, M, or G.

- 4. To delete a point from the table, select the point to be removed, and click Delete.
- 5. Select the Frequency Interpolation method:
 - Select Linear when the frequency scale of the spectrum or spurious measurements are linear.
 - Select Log when the frequency scale of the spectrum is logarithmic.
- 6. When you have entered all the necessary values, click Save As (to save the table in a file) or click OK.
- 7. From the Save As dialog, name the file and save it in the desired location.

External loss tables are saved in CSV (Comma Separated Value) format.

Loading an External Loss Table

To load an external loss table file:

- 1. Click Edit to display the Table Editor.
- 2. Click Load to display the Open dialog box.

- 3. Navigate to the location of the desired file, select it and click Open.
- 4. Click OK.

Continuous Versus Single Sequence

Menu Bar: Run > Single Sequence / Continuous

Selecting Single Sequence sets the acquisition mode so that when you press Run, a single acquisition sequence is performed and the instrument stops once the acquisition sequence is completed. Selecting **Continuous** sets the acquisition mode so that an acquisition sequence is started as soon as you select Continuous and as one acquisition sequence completes, another begins.

Note that an acquisition sequence can require more than one acquisition. For example, in a spectrum view, the trace function might be set to Average 100 acquisitions Thus, a complete acquisition sequence would consist of 100 acquisitions that are averaged together to create the trace that is displayed.

Run

Menu Bar: Run > Run

Selecting **Run** begins a new acquisition/measurement cycle.

Resume

Menu Bar: Run > Resume

Restarts data acquisition, but does not reset accumulated results, such as Average or MaxHold. This allows you to stop acquisitions temporarily, then continue. If the accumulation is already complete, for example, 10 acquisitions or 10 averages have already been completed, each subsequent Resume command will cause one more acquisition to be taken, and its results added to the accumulation. Not available if instrument settings have been changed.

Abort

Menu Bar: Run > Abort

Selecting **Abort** immediately halts the current acquisition/measurement cycle. In-process measurements and acquisitions are not allowed to complete. Visibility and accuracy of results is unspecified after an abort.

Sampling Parameters Tab

The Sampling Parameters tab enables you to set the controls for data acquisition. There are two settings on the Sampling Parameters Tab, the Adjust setting and FastFrame. Depending on the setting chosen for Adjust, two additional parameters can be set. Normally, the best results are achieved by leaving the Adjust control set to All Auto. Manually overriding the automatic settings affects both real-time and swept acquisitions.

Sampling Parameters Advanced FastSave Input Params				
Adjust All Auto (recommended) -	75.00 MS/s 13.3 nsec/Sample	✓ FastFrame		
Acq BW : 60.00 MHz	Capacity: 12.0 ms	Max frames: 10		
Acq Samples: 89233	902 kSamples	Actual: 9		
Acq Length : 1.190 ms	Using: 10.71 ms 803 k	Samples 89.1 % of capacity		

Sampling Control

There are three sampling parameters that interact with each other: Acquisition Bandwidth, Acquisition Length, and Acquisition Samples. Acquisition Bandwidth is the frequency range of the acquisition. Acquisition Length refers to the time over which the acquisition occurs. Acquisition Samples is the number of samples acquired over the acquisition time. The parameters available for Adjust and how the parameters are determined are shown in the following table.

Adjust	User sets		Analyzer calculates
All Auto	N/A	N/A	All values based on the open displays, with the highest priority given to the selected display
Acq BW / Acq Samples	Acq BW	Acq Samples	Acq Length
Acq BW / Acq Length	Acq BW	Acquisition Length	Acq Samples

Acquisition Memory Usage

The center portion of the tab shows how the acquisition memory is used.

Readout	Description	
Samples/s, sec/Sample	Readout of the acquisition sample rate and sample period.	
Capacity	The maximum period of time and number of samples that could be acquired with the current sampling parameters.	
Using	The total amount of acquisition memory that will be used based on the current settings.	

FastFrame

FastFrame is a feature that allows you to segment the acquisition record into a series of frames, or data records. A typical use of FastFrame is to record data samples around signal events of interest, while not wasting memory on irrelevant data between these events. FastFrame is only valid for real-time acquisitions. If any measurement is configured for swept acquisitions, an error message is displayed: Disabled: *FastFrame doesn't support swept settings*.

Setting	Description
FastFrame	Enables FastFrame acquisition mode.
Max Frames	Specifies the maximum number of frames to record in a single acquisition process.

The Actual readout shows the actual number of frames that will be acquired into the acquisition memory. This number changes based on the Acq BW, Acq Samples, and Acq Length values. This number will never be greater than the value set by Max Frames.

Advanced Tab (Acquire)

Provides access to Advanced Acquire settings.

Sampling Parameters Ad	vanced FastSave Input	Params
Dither Control: Aut	to 👻 Dither Status:	On (required by selected RF & IF Optimization)

Setting	Description
Dither	Can be set to Auto or Manual. In Auto mode, each measurement sets Dither as appropriate for the measurement. In Manual mode, the user setting overrides the measurement preference.

Dither

Dither is the process of adding noise to the analog signal prior to the analog-to-digital conversion. The purpose of adding noise is to randomize the quantizing process of the ADC (analog-to-digital converter) so it does not appear as discrete components in locations where the distortion components of the ADC would fall. All ADCs produce quantizing errors that appear as noise (quantizing noise) or as discrete components which are less desirable. Without dither and in the presence of tones that are close to sub-multiples of the sample rate or correlated to the sample rate, all the quantizing energy can fall in the same locations as discrete distortion components. This can increase what appears as spurious tones but they are not related to the normal spurious mechanisms or true distortion. Adding noise can randomize the quantization process so those tones aren't produced.

In general, you should leave the Dither setting on Auto. In the Auto mode, individual measurements will select the best guess dither setting (on or off). In Manual mode, the user setting overrides individual measurements' dither settings enabling the user to determine the best use for the best measurement.

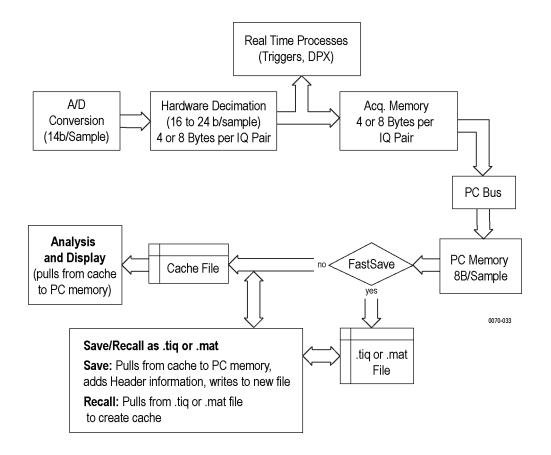
NOTE. If the <u>*RF & IF Optimization*</u> is set to Best for multiple displays, you cannot change the Dither setting.

Dither is not always necessary. The signal itself can be used to randomize quantizing errors. Since the input signal is not under control of the instrument, the use of dither is signal dependent and its use must be determined by the user. Typically, pure tones create the most problems with quantizing errors. Dither should be used for those input types. Many digital modulation types are noise-like, so dither is usually not needed for modulation types such as CDMA, GSM and many others. Dither also uses up a bit of headroom in the ADC, typically 2-3 dB. If the largest dynamic range to the noise floor is needed, that is Signal to Noise Ratio, the dither can probably be turned off. The measurements for Channel Power/ACLR and MCPR automatically turn dither off for just that reason. Signals in the range of -6 dB to -40 dB below the reference level usually show the greatest benefit from having dither present. The user can find the best use by observing the results for the particular input signals while setting dither on or off. There are cases where dither can make things worse. If dither makes an improvement in the measurement, it should be left off.

FastSave

FastSave (also known as Fast Save) is a way to automatically save acquisitions to a file. It is a way to collect data, not to analyze the data. Analyzing the data require recalling the saved acquisition data file.

When making acquisitions and performing analysis, the instrument creates a cache file with a copy of the acquisition that it uses as the source for analysis and displays. To Save a waveform as a .TIQ or .MAT file, the instrument pulls data from the cache, formats the data for the chosen file type, and writes again to the disk with a .TIQ or .MAT extension. Normal operation requires creation of the cache file and reading of a cache file prior to analysis or save functions. These hard-drive read and write cycles can be time consuming for large files. If you need only to save data for later analysis, a mode named FastSave is available.



FastSave mode bypasses cache file creation and writes directly to a file. This eliminates two of three disk read or write operations. Depending on the file size, FastSave reduces the time required for data acquisition up to 65%. Using FastSave means that *only* real-time processes will be used. The instrument triggers and DPX display are not affected. All other measurements are suspended, and an information message (Disabled - FastSave is selected) is displayed in the graph area of each display.

Preparing for a FastSave Acquisition

- 1. Configure the instrument as necessary to capture the signal event you are interested in.
- 2. On the Setup > Acquire > FastSave tab, specify the Base file name.
- 3. Click the ... button to specify the location where the acquisition files will be saved.
- 4. Set the number of files to save by entering a number in the Max files saved per Run box.
- 5. Specify the file format (TIQ or Matlab).

Starting a FastSave Acquisition

To start a FastSave acquisition:

- 1. Select the Acq button to display the Acquire control panel.
- 2. Select the FastSave tab.
- 3. Select the FastSave acquisition data checkbox ton enable FastSave acquisition.
- 4. Start a FastSave acquisition:
 - a. If the instrument is running when you enable FastSave, FastSave acquisitions begin immediately.
 - **b.** If the instrument is paused when you select FastSave, select **Run** to begin FastSave acquisitions.

NOTE. When using FastSave in Single Sequence, it is possible for more than one acquisition to be saved under the following conditions.

- The DPX display is open
- Acquisition length is less than about 50 ms

FastSave can store more than one short acquisition in the time it takes DPX to acquire, process and display one set of DPX spectrums (about 50 milliseconds). Thus, you may find that FastSave creates more than one file under these conditions. To limit FastSave to a single acquisition per process, set **Max files** saved per run to 1 in the FastSave tab (Setup > Acquire > FastSave).

FastSave Status Messages

Once the FastSave acquisition begins, a status messages appears in the graph area. The message that appears depends on whether the instrument was running or paused when FastSave acquisition data was clicked.

- Disabled FastSave is selected: This appears when acquisition is paused. It means that the display update is disabled until FastSave is disabled. FastSave acquisition will not begin until you select **Run**.
- Saving X of XX FastSave is active and saving files. This appears only while FastSave is active.
- **Done saving restart with Stop, then Run .. More -** Displayed when the specified number of files have been saved. FastSave can be restarted by selecting Run to begin a new set of acquisitions.

FastSave Tab

Use FastSave tab is used to configure and initiate FastSave (see page 490) acquisitions.

Sampling Parameters Advanced FastSave	Input Params
 FastSave acquisition data (1 acquisition per file, Analysis disabled except DPX) 	Location: C:\RSA6100A Files
Format: TIQ 🔹	Base file name: Max files saved per Run: SAVED 10

Setting	Description
FastSave acquisition data Enables/disables FastSave acquisitions. If acquisitions are running, selection data checkbox immediately begins saving acquisition. Image: selection of the instrument is paused, FastSave acquisitions will not begin until you selection.	
Format	Specifies the file format of the FastSave acquisition data files. Files can be saved in <u>TIQ</u> or <u>MAT</u> format.
Base file name	Specifies the base name for acquisition data filenames. When acquisition data files are saved, a 24-character timestamp is appended to the base file name. The maximum base file name length cannot exceed 232 characters.
Location	Specifies the directory location where files will be saved. Files can be saved on the local hard drive, a network location or even a USB- connected drive. However, due to the time required to transfer files across a network or by USB, the local hard drive is the only recommended location.
Max files saved per Run	Specifies the number of files to be saved each time a FastSave acquisition is started. The number of files that can be saved is limited only by the storage space available. Each saved acquisition file uses about 3.3 MB of space.

Acquire

Menu Bar: Setup > Acquire

Application Toolbar:

Selecting Acquire displays the Acquire control panel.

The Acquire control panel changes based on whether you are connected to an RSA306 or not.

Acquire (RSA306 not connected)

The Acquire control panel contains the Acquisition Data tab and Playback tab.

Acquire	ACQUISITION Data Playback
Signal Input:	Sample Rate: 56.000 MS/s
RF V	Record Length: 119 Samples

Signal Input. The Signal Input control is not used by SignalVu-PC.

Setting	Description	
Acquisition Data	Displays the sample rate and record length reported by the oscilloscope.	
Playback	Plays saved files that were recorded with the Record feature.	
(requires option SV56)	Playback only plays .r3f file formats.	
	NOTE. The Record tab only displays when connected to an RSA306.	

Acquire (RSA306 connected)

Selecting **Acquire** displays the Acquire control panel. These settings control the hardware acquisition parameters for the RSA306 signal analyzer.

Acquire	IQ Sampling Parameters Frequency Referen	ce Record
Run:	Adjust: All Auto (recommende 💌	56.0 MS/s
	Acq BW: 40.00 MHz	17.9 nsec/Sample
	Acq Length: 1.906 us	Capacity:1 s 56.6 MSamples
	Samples: 107 Samples	Using: 1.91 us, 107 Samples, 0.0 % of capacity

Tab	Description
IQ Sampling Parameters	Sets the controls for real-time acquisition.
Frequency Reference	Specifies the source of the reference frequency.
Record	Records the acquisition data directly to a file.
Playback	Plays the saved files recorded with the Record feature.
(requires option SV56)	Playback only plays .r3f file formats.

Run

Run mode specifies whether the analyzer will stop acquiring data after it completes a measurement sequence.

- **Continuous** In Continuous mode, once the analyzer completes a measurement sequence, it begins another.
- **Single** In Single mode, once the analyzer completes a measurement sequence, it stops.

NOTE. A measurement sequence can require more than one acquisition. If the analyzer is configured to average 100 traces together, the measurement sequence will not be completed until 100 traces have been acquired and averaged.

Triggering

The analyzer has two triggering modes: Free Run and Triggered.

Free Run

In Free Run mode, the instrument initiates acquisitions without considering any trigger conditions. It is a fast and easy way to see the signals. Free Run is usually adequate for the Spectrum display unless you need to specify a particular time at which to collect the data record.

Triggered

In the Triggered mode, the instrument initiates an acquisition when a trigger event is recognized. The conditions that define a trigger event depend on the selected trigger source. There are several source selections available for choosing the signal to monitor for a trigger event. If the RF input is the selected trigger source, you can choose to use power, frequency mask triggering, DPX Density, or Runt as the trigger types. If other inputs are selected as the trigger source, you can select the slope and level of the trigger point. With the Gated source, you also specify the gating signal level.

Power triggering. Power triggering triggers the instrument on time-domain signal transitions. The incoming data is compared to a user-selected level in dBm. You can select the time-domain bandwidth and trigger on the rising or falling edge.

Frequency Edge triggering. Frequency Edge triggering triggers the instrument when the frequency of the input signal changes relative to the instrument center frequency.

Frequency mask triggering. Frequency Mask Triggering allows you to trigger the instrument when a signal in the frequency domain violates the mask. You can draw a mask to define the conditions within the real-time bandwidth that will generate the trigger event. It allows you to trigger on weak signals in the presence of strong signals. This triggering is also useful for capturing intermittent signals.

DPX Density triggering. DPX Density triggering uses characteristics of the DPX display to specify trigger parameters. When using DPX Density triggering, the percentage of time the signal falls within the measurement box is used to define a trigger event. The measurement box is defined by frequency and amplitude values.

Runt triggering. Runt triggering allows you to define a trigger event based on a pulse amplitude that crosses one threshold but fails to cross a second threshold before recrossing the first.

You can define the following event parameters by selecting the respective tab in the Trigger control panel:

- Event source, event type, and event definition.
- Time parameters that define what portion of the data record is used for pretrigger samples and whether to delay the trigger for a set amount of time after the recognized event.
- Advanced parameters define where a trigger occurs within the acquired memory or trigger each segment in the swept acquisition mode.

Save on Trigger

An additional feature of the triggering capability is to save acquisition data when a trigger event occurs. When the analyzer is run in Triggered mode, you can configure the instrument to save acquisition data to a file. You can also set the instrument to save a picture of the screen when the trigger event occurs. See Action Tab (Triggering) (see page 514) for details on configuring Save on trigger.

Trigger Front Panel Status Lights

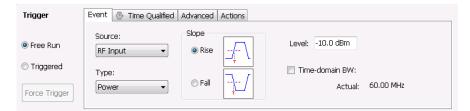
The analyzer has three lights on the front panel that indicate the Trigger status:

- Arm The instrument is collecting pre-trigger data.
- Ready Enough pretrigger data has been collected and the instrument is waiting for the next trigger event.
- Trig'd A trigger even has been received, and the instrument is collecting post-trigger data and transferring the complete data record out of acquisition memory.

Setting Up Triggering

To set up triggering, use the Trigger control panel. To display the Trigger control panel:

Press **Trigger** on the front panel or click **Trig** in the Application toolbar or select **Setup** > **Trigger**.



Using Free Run

To set Triggering to Free Run:

Click the **Free Run** option button.

The signal analyzer will acquire a signal without regard to any triggering conditions.

Using Power Trigger

To trigger acquisitions based on the power of the signal:

- 1. Click the **Triggered** option button.
- 2. Select **RF Input** from the Source drop-down list.
- 3. Select Power from the Type drop-down list.
- 4. For further information on setting the power level parameters, see Event Tab (Triggering). (see page 503)

Using Frequency Edge Triggering

To trigger acquisitions based on input signal frequency changes:

- 1. Click the **Triggered** option button.
- 2. Select **RF Input** from the **Source** drop-down list.
- 3. Select Frequency Edge from the Type drop-down list.
- 4. Set the **Freq Slope** as appropriate. Select **Rise** to trigger when the signal frequency is increasing. Select **Fall** to trigger when the signal frequency is decreasing.
- 5. Set the Freq Level. The Freq Level is the frequency that you want to generate a trigger.
- 6. If appropriate, enable **Power Threshold** and set the value. Use this setting to ensure that only sufficiently large signals, not noise, can generate a trigger.
- 7. If appropriate, enable **Time-domain BW** and set the level. Use this setting to process the trigger input signal before the trigger system analyzes the signal.

For further information on setting the Frequency Edge parameters, see Event Tab (see page 503).

Using Frequency Mask Triggering

To trigger acquisitions based on violations of a user-defined mask:

- 1. Click the Triggered option button.
- 2. Select **RF Input** from the **Source** drop-down list.
- 3. Select Frequency Mask from the Type drop-down list.

For further information on setting the frequency mask parameters, see <u>Event Tab (Triggering) (see page 503)</u> and <u>Mask Editor (see page 499)</u>. If Frequency Mask triggering is installed, you can change the resolution bandwidth of the frequency transform used to compare to the trigger mask. The standard FMT uses a fixed length FFT for frequency transforms.

Using DPX Density Triggering

To trigger acquisitions based on the density of the DPX Bitmap trace:

- 1. Click the Triggered option button.
- 2. Select **RF Input** from the Source drop-down list.
- 3. Select **DPX Density** from the **Type** drop-down list.
- 4. Set the DPX Density parameters as appropriate. You can do this two ways:
 - Entering values for Threshold, Frequency, and Amplitude using the front-panel controls.
 - Select Trigger On This from the Touchscreen Actions menu (right-click in the graph or press and hold on the display for two seconds). Move and size the measurement box that appears to set the values for Frequency and Amplitude.

NOTE. If the Amplitude units (Tools > Analysis > Units) is set to Watts or Volts, you cannot move the measurement box using a mouse or the touchscreen. Set the amplitude units to any unit other than Watts or Volts to move or resize the measurement box.

For further information on setting the power level parameters, see Event Tab (Triggering) (see page 503).

Using Runt Trigger

To trigger acquisition based on a runt signal:

- 1. Click the **Triggered** option button.
- 2. Select **RF Input** from the Source drop-down list.
- 3. Select Runt from the Type drop-down list.
- 4. For further information on setting the power level parameters, see Event Tab (Triggering) (see page 503).

Frequency Mask Trigger

The following topics describe the frequency mask trigger controls:

Event tab (see page 503): explains how to configure frequency mask triggering parameters.

Mask Editor (see page 499): explains how to create and edit frequency masks.

Triggering (see page 495): explains how to initiate frequency mask triggering.

Mask Editor (Frequency Mask Trigger)

The Mask Editor is used to create masks that are used by the Frequency Mask Trigger function. The Frequency Mask Trigger (FMT) function is used to define trigger events to capture signal anomalies based on their frequency and amplitude.

Displaying the Mask Editor

To display the Mask Editor:

- 1. Press Trigger on the front panel or select Trig from the Application toolbar.
- 2. Select the Event tab.
- 3. Set Source to RF Input.
- 4. Set Type to Frequency Mask.
- 5. Select Mask Editor.

Creating a Mask

The simplest way to create a mask is to use the Auto draw function.

To create a new mask using Auto draw:

- 1. Select the trace on which to base the mask from the **Reference trace** drop-down list. (Only traces that are shown can be selected from the drop-down list. To show a trace that isn't currently in the list, open its display and enable the trace of interest.)
- 2. Specify the margins to be applied between the mask and the reference trace. Enter values for the X Margin and the Y Margin.
- 3. Click Auto draw.

The following screen shows a mask created with Auto draw.

New	Open Save	Save As Done	Reference: Spect (to be in list, a trace	rum Trace 1 must be showing in a displ
Click in graph to:	 Add points Edit Points 	Next X Undo		X Margin: 5.000 MHz Y Margin: 10.000 dB
0.00 dBm			<	Auto draw
) @ 0 _ <i>0</i> _ Ø	╢╽┉┉┉┉┉	Offset Freq	Amplitude
				1
	mmmmmm	Marymon	9.722 MHz	-12.73 dBm
	Mannanana	manymum	9.722 MHz 9.828 MHz	-12.73 dBm -34.73 dBm
	Mr. Munory Manner	howww.		
100.00 dBr		- www.www.uw	9.828 MHz	-34.73 dBm

To create a new mask without using Auto draw:

Click the **New** button.

Changing a Mask

A mask is a collection of points specified by their frequency (defined by their offset from the center frequency) and their amplitude. You can change a mask by adding (or removing) points and editing points.

NOTE. When placing points in the frequency mask, keep in mind that in most cases, the Frequency Mask Trigger has a range of 80 dB below Reference Level. However, for values of Reference Level lower than -50 dBm, this range decreases as the RefLevel decreases. The FMT range is also reduced when the Acquisition Bandwidth contains frequencies near 0 Hz. In both these situations, the underlying reason the trigger range is reduced is because the instrument is using various amounts of "digital gain" in addition to hardware gain. You are not prevented from placing mask points outside the usable range of the instrument, but at the time the mask is applied, the instrument adjusts its range. When the mask is adjusted, you can see this in the Spectrum display and the Mask Editor. The mask's shaded fill shows the usable vertical range. Points outside this range are shown, but will not cause a trigger.

Adding Points

To add a point to a mask:

- 1. Click the Add points option button. (Alternatively, you can right-click on the desired point location (or left-click and hold for about a second) and release.)
- 2. Click in the graph area where you want the new point added to the mask.

You can also add a point to the mask while it is in Edit Points mode:

Right-click in the graph area where you wish to add a point to the mask. You can also left-click and hold the button down for one second. You can duplicate this method on the touchscreen by touching the screen for one second.

If you add a point by accident, click Undo. You can click Undo until the Undo button is grayed out.

Editing Points

When you edit a point, you change its offset from the center frequency and/or its amplitude. There are two ways to edit the offset and amplitude of a point on a mask. First, you can drag a point to the desired position. Second, you can double-click on the offset or amplitude value in the table and enter a new value.

To edit a point on a mask:

- 1. Click the Edit Points option button.
- 2. Click on the point you wish to change.
- 3. Change the position of the point using the following methods:
 - **a.** Dragging it with the mouse to the desired position.
 - **b.** Clicking the arrow keys in the Mask Editor window to move the point to the desired position. Use the left/right keys to change the frequency offset. Use the up/down arrow keys to change the amplitude. Once you click an arrow key, you can use the front panel knob for fine adjustments.
- 4. To edit another point, click Next.

You can also edit a point by double-clicking on the value in the table that you want to change and typing in a new value.

Deleting Points

To delete points from the mask:

- 1. Click the Edit Points option button.
- 2. Click on the point to be removed and click the X button to delete the point.

You can also delete a point by clicking on the point in the table that you want to delete and clicking the X button.

If you delete a point by accident, click Undo. You can click Undo until the Undo button is grayed out.

Saving a Mask

To save a mask:

Click the **Save** button.

To save an edited mask under a new name:

Click the **Save As** button.

Opening an Existing Mask

To open an existing mask:

- 1. Click on Open. This displays the Open dialog box.
- 2. Navigate to the location of the mask file.
- 3. Select the desired file and click Open.

Trigger Settings

Menu Bar: Setup > Trigger

Application Toolbar: Trig

Front Panel: Trigger

The Trigger control panel allows you to set the parameters that define trigger events and how the instrument responds to them.

Trigger Modes

There are two trigger modes: Free Run and Triggered.

Mode	Description
Free Run	Acquires and displays the signal without triggering.
Triggered	Acquires a data record after the defined trigger event is recognized.

Trigger Tabs

Use the Trigger tabs to access controls for setting the different trigger parameters.

Tab	Description
Event (see page 503)	Sets parameters that control triggering on the selected trigger source.
Time Qualified (see page 512)	Sets values used to adjust time of acquisition with respect to time of trigger event.
Advanced (see page 513)	Sets controls for triggering in swept acquisitions.
Actions (see page 514)	Sets parameters for Save on trigger function.

Event Tab

The Event tab is used to set the parameters that define trigger events. The parameters that appear on the Event tab change depending on the selected Trigger source and type.

Trigger	Event 🕓 Time Qualified	Advanced Ad	ctions		
 Free Run Triggered Force Trigger 	Source: RF Input • Type: Power •		± − ↓ − ↓	Level: -10.0 dBm Time-domain BW: Actual:	85.00 MHz

Source

Source specifies the source of the signal to be monitored for a trigger event. The choices available are: RF Input, Trig In (front), Trig 2 In (rear), Gated, and Line. The Source drop-down list is always visible on the Event tab.

Туре

Type defines the trigger type as Power, Frequency Edge, Frequency Mask, DPX Density, or Runt. The Type selection is only present when Source is set to RF Input.

- When Type is set to Power, a transition through an adjustable level of the selected source determines a trigger event.
- When Type is set to Frequency Edge, the input signal changing in frequency relative to the center frequency defines a trigger event.
- When Type is set to Frequency Mask, where and how the input signal crosses or fails to cross the edge of the mask defines a trigger event.
- When Type is set to DPX Density, the amount of time a signal is present at a particular point in the DPX Spectrum graph defines a trigger event.
- When Type is set to Runt, a signal that exceeds a specified level and then fails to exceed a second specified level defines a trigger event.

Source = RF input.

Trigger	Event 🕓 Time Qualified	Advanced	Actions		
 Free Run Triggered Force Trigger 	Source: RF Input Type: Power	Slope Rise Rise Fall		Level: -10.0 dBm	85.00 MHz

Event Type	Setting	Description
Power		For the Power setting, if the RF input signal crosses the specified level (in the direction set by Slope), a trigger event occurs. A trigger event does not occur if the power level of the signal simply exceeds the level setting, there must be a power level transient that crosses the specified level.
	Slope	The slope control determines whether the signal analyzer finds the trigger point on the rising or falling edge of the RF input signal.
	Level	The Level setting determines the power level that will be recognized as a trigger event. The Level is indicated in the Amplitude vs Time and Time Overview displays with a dark cyan colored-line.
	Time-domain BW	Time-domain BW is a filter used to process the trigger input signal before the trigger system analyzes the signal. The frequency edge trigger point must lie within the range of time domain bandwidth. This makes the range of the frequency edge trigger = Center Frequency ±(0.5 × Time Domain Bandwidth)
Frequency Edge		For the Frequency Edge setting, if the RF input signal crosses the specified frequency (in the direction set by Freq Slope), a trigger event occurs. For Frequency Edge trigger, the frequency that initiates a trigger event is identified by the Measurement Frequency + Frequency Level. Frequency Level can be either a positive or negative value.
	Freq Slope	The slope control determines whether the analyzer finds the trigger point on the rising (increasing) or the falling (decreasing) edge. This setting is analogous to the Slope control on the Power trigger type.
	Freq Level	The Freq Level setting specifies the difference in frequency between the input signal and the analyzer center frequency required to generate a trigger event. The Freq Level setting is limited to half the real-time bandwidth.
	Power Threshold	Specifies the power level the signal must exceed for a frequency variation to be considered valid.
	Time-domain BW	Time-domain BW is a filter used to process the trigger input signal before the trigger system analyzes the signal.
Frequency Mask		For the Frequency Mask setting, events where the trace crosses the edge of the mask when it should not or when the trace does not cross the edge of the mask when it should define the trigger event. Use Mask Editor (on the Event tab when Type is set to Frequency Mask) to create and modify Frequency Masks.
	Violation	Specifies the type of transition that defines a violation.
	RBW	Specifies the resolution bandwidth.
	Auto	Specifies whether the RBW is adjusted automatically or manually.

Table 10: Trigger types

Event Type	Setting	Description
DPX Density		For DPX Density, the percentage of time the signal falls within the measurement box is used to define a trigger event. The measurement box is defined by frequency and amplitude values.
	Density	Specifies whether a trigger event is defined by the DPX Density value exceeding (Higher) the specified Threshold value or is defined by the DPX Density value falling below (Lower) the specified Threshold value.
	Threshold	Threshold specifies the density value used for determining a trigger event. Density is a measure of how much time the signal is present in a particular region in the DPX Spectrum graph. The range for this value is 0 to 100%.
	Frequency	Specifies the frequency at the center of the measurement box. The +/- value specifies the edges of the measurement box above and below the Frequency setting.
	Amplitude	Specifies the amplitude of the center of the measurement box. The +/- value specifies the edges of the measurement box above and below the Amplitude setting.
Runt		Defines a trigger event based on a pulse amplitude that crosses one threshold but fails to cross a second threshold before recrossing the first.
	Pulse	Specifies whether the runt trigger is defined by a positive-going pulse or a negative-going pulse.
	High level	The High level defines the upper voltage limit (first threshold) of a runt pulse.
	Low level	The Low level defines the lower voltage limit (second threshold) of a runt pulse.
	Time-domain BW	Time-domain BW is a filter used to process the trigger input signal before the trigger system analyzes the signal.

Source = Trig In (front).

Trigger	Event 🕓 Time Qualified	Advanced	Actions	
 Free Run Triggered Force Trigger 	Source: Trig In (front) 🔹	Slope		Level: 1.60 V Input Impedance: 50 Ω use menu Setup > Configure In/Out

Setting	Description	
Slope	The slope control determines whether the analyzer finds the trigger point on the rising or the falling edge of the trigger input signal.	
Level	The Level setting determines the signal amplitude that will be recognized as a trigger event.	

Source = Trig 2 In (rear).

Trigger	Event 🕓 Time Qualified .	Advanced Actions	
 Free Run Triggered Force Trigger 	Source: Trig 2 In (rear)	Slope Slope Fall	Triggers at TTL threshold

Setting	Description			
Slope	The slope control determines whether the analyzer finds the trigger point on the rising or the falling edge of the trigger input signal. The trigger level is automatically set at a TTL level.			

Source = Gated. When the Source is set to gated, the front panel **Trig In** source is monitored for the trigger event and a signal on the rear panel **Gate / Trig 2 In** is used to determine when a trigger event is valid. A transition through the selected Level on the TrigIn signal input (selectable as rising or falling edge) will only be recognized as a trigger event if it occurs while the Trig2 signal is True (selectable as High or Low). Note that only edges are trigger events, not stable signal levels.

Trigger	Event 💿 Time Qualified Advanced Actions
 Free Run Triggered 	Source: Slope Gated Trigger when Trig In (front): ● Rise Level: 1.60 V Imput Impedance: 50 Ω
Force Trigger	while Trig 2 In (rear): High use menu Setup > Configure In/Out

Setting	Description		
Slope	The slope control determines whether the analyzer finds the trigger point on the rising or the falling edge of a signal.		
Level	The Level setting determines the signal amplitude that will be recognized as a trigger event.		
while Trig 2 In (rear)	Specifies whether a High or Low signal at the Trig 2 In input (rear panel) allows a trigger event on the Trig In (front) input to be accepted.		

Source = Line.

Trigger	Event 💿 Time Qualified Advanced Actions
🔿 Free Run	Source:
Triggered	
Force Trigger	

The analyzer triggers off of the AC line supply.

Source = RF Input and Type = Frequency Edge.

Trigger	Event 💿 Time Qualified	Advanced Actions		
	Source:	Freq Slope	Freq Level: 0.00000 H	z Actual: 0.00000 Hz
🔘 Free Run	RF Input 🔹	Rise		Hysteresis: -3.00 MHz
Triggered	Tunci		📝 Power Threshold:	-40.0 dBm
	Type: Frequency Edge 🔻	© Fall	🔲 Time-domain BW:	
Force Trigger		Т	Actual:	85.00 MHz

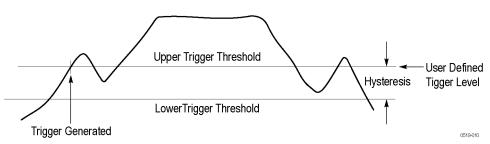
Table 11:

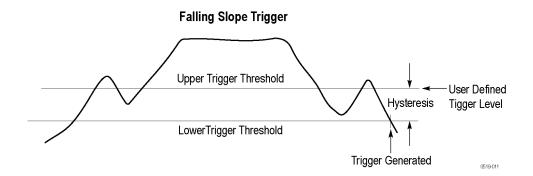
Setting	Description		
Freq Slope	The slope control sets whether the analyzer triggers on the rising (increasing) or the falling (decreasing) edge. This setting is analogous to the Slope control on the Power trigger type.		
Freq LevelThe Freq Level setting specifies the difference in frequency between and the analyzer center frequency required to generate a trigger event Level setting is limited to half the real-time bandwidth. For example, has an 85 MHz real-time bandwidth, the Freq Level is limited to ±42 analyzer has a 25 MHz real-time bandwidth, the Freq Level is limited			
Actual	Readout of the Freq Level being used. This number will be different from the Freq Level setting when Time-domain BW is enabled.		
Hysteresis	Readout of the current hysteresis value.		
Power Threshold	Specifies the power level the signal must exceed for a frequency variation to be considered valid.		
Time-domain BW	Specifies the Time-domain BW. Time-domain BW is a filter used to process the trigger input signal before the trigger system analyzes the signal.		
	The frequency edge trigger point must lie within the range of time domain bandwidth. This makes the range of the frequency edge trigger = Center Frequency ±(0.5 × Time Domain Bandwidth)		
Actual	Readout of the current acquisition bandwidth (see Setup > Acquire > Sampling Parameters). If Time-domain BW is enabled, this readout mirrors the setting for the Time-domain BW.		

Freq Slope

The following figures show how the Freq Slope setting affects the trigger.

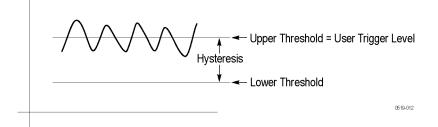
Rising Slope Trigger



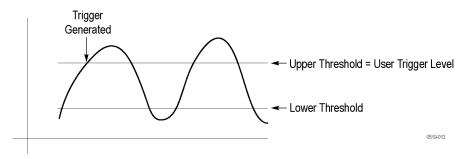


Hysteresis

The following figures show how the hysteresis value affects when a trigger is generated. In the first figure, the signal frequency crosses through the User Trigger Level (Freq Level setting) several times but never generates a trigger because it never crosses the lower hysteresis level followed by crossing the upper hysteresis level.



The following figure shows that a trigger is generated when the signal frequency changes sufficiently to exceed the hysteresis value (the difference between the upper and lower thresholds) and cross the lower threshold followed by crossing the upper threshold.



The hysteresis value is calculated as:

Hysteresis = (0.2 X Full Trigger Level range)/10

This amounts to 0.2 divisions if the full range is set to 10 divisions.

If Time-domain BW = 1 MHz, then full range is 1 MHz, resulting in a hysteresis value of 20 kHz

Frequency edge hysteresis only changes when the acquisition bandwidth or time-domain bandwidth changes. Hysteresis does not change with the vertical scale factor.

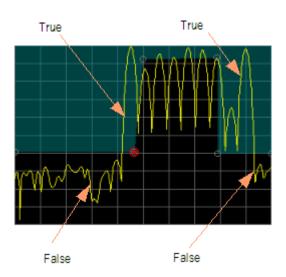
Using a wider acquisition bandwidth allows you to monitor a wider frequency range but it also allows for more noise which requires more hysteresis. To achieve the best results, use the smallest acquisition bandwidth (or time-domain bandwidth) that contains the frequency variations of interest. Using a wide acquisition bandwidth with a small frequency variation can result in the frequency variation not exceeding the hysteresis. This will result in no trigger being generated.

Source = RF Input and Type = Frequency Mask.

Trigger	Event 🕓 Time Qualified	Advanced	Actions		
		-Violation -			
🔘 Free Run	Source:	⊚ т	© T>F	© T>F>T	Mask Editor
Triggered		© F	● F>T	○ F>T>F	Load from file
Force Trigger	Type: Frequency Mask 🔻		True	False	RBW: 500 kHz 🛛 Auto Actual: 500 kHz

Setting	Description	
Violation	These selections define the state or transitions of the signal used to define a trigger event.	
Mask Editor	Displays the Mask Editor so that you can create and edit Frequency Masks.	
Load from file	Invokes the Open dialog for selecting a previously saved frequency mask file.	
RBW	Sets the Resolution Bandwidth value to be used in the spectrum view. The value is italicized when Auto is selected.	
Actual	This is a displayed value, not a setting. It is the RBW being used by the signal analyzer; this value may not match the RBW requested (in manual mode).	

Violation. Violations are state changes (or a sequence of state changes) defined by whether a point on the signal falls within the frequency mask or outside the frequency mask. A True violation occurs if even a single point on the trace falls inside the mask (above the mask's lower edge). Conversely, a False violation occurs if no points on a signal fall inside the mask (all trace points are below the mask's lower edge).



A trigger event is initiated based on the type of violation that occurs and the sequence of violations that occur.

Violation	Description
Т	Only one state is required to initiate a trigger event. The signal has at least one data point inside (above) the mask. The trigger event occurs when the instrument detects the first signal with a point violating the mask. A trigger event could occur on the first acquisition.
F	Only one state change is required to initiate a trigger event. The signal has all data points outside (below) the mask. The trigger event occurs when the instrument has detected the first spectral waveform that lies completely below (outside) the mask. A trigger event could occur on the first acquisition.
T - F (Out)	Two states are required to initiate a trigger event. The signal must be inside the mask and then passes out of the mask. The trigger event occurs when the first non-violating waveform is detected.
F - T (ln)	Two states are required to initiate a trigger event. The signal must be outside the mask and then passes into the mask. The trigger event occurs when the first non-violating waveform is detected.
T - F - T (Out & In)	Three states are required to initiate a trigger event. The signal starts inside the mask and then passes out of the mask. Next, the signal must pass into the mask. The trigger event occurs at the second transition where the signal passes back into the mask.
F - T - F (In & Out)	Three states are required to initiate a trigger event. The signal starts outside the mask and then passes into the mask. Next, the signal must pass back outside the mask. The trigger event occurs at the second transition where the signal passes back out of the mask.

Mask Editor. Launches the <u>Mask Editor (see page 499)</u> that enables you to create and edit Frequency Masks.

Load from File. Enables you to load an existing frequency mask for use with Frequency Mask Trigger.

Source = RF Input and Type = DPX Density. DPX Density triggering analyzes the density of the DPX Bitmap trace to define trigger events. You specify the portion of the DPX Bitmap trace to analyze by

defining a measurement box. The measurement box is the only area of the DPX Spectrum graph that is analyzed for trigger events.

Trigger	Event 🕓 Time Qualified	Advanced Actions				
 Free Run Triggered Force Trigger 	Source: RF Input	Density Higher Lower 	Threshold: Frequency: Amplitude:	10.000 % 1.50000 GHz -20.00 dBm	+/- 2.0000 MHz +/- 5.00 dB	

Setting	Description	
Density	Specifies whether a density value higher or lower than the threshold value defines a trigger event.	
Threshold	Specifies the DPX Density threshold that defines a trigger event. The DPX Density must be higher or lower (specified by the Density selection) than this value to define a trigger event.	
Frequency	Specifies the center of the measurement box on the frequency axis (horizontal).	
+/-	Specifies the width of the measurement box.	
Amplitude	Specifies the enter of the measurement box on the power level (vertical) axis.	
+/-	Specifies the height of the measurement box.	

Source = RF Input and Type = Runt. Runt triggering defines a trigger event based on whether or not a signal transition fails to cross a user-defined level. Two levels are defined for Runt triggering. A Runt signal is one that passes through both levels in one cycle but only passes through one level on the next cycle.

Trigger	Event 🕓 Time Qualified	Advanced Action	1S		
 Free Run Triggered Force Trigger 	Source: RF Input	Pulse Positive Negative		High level: Low level:	-10.00 dBm -30.00 dBm main BW: Actual: 85.00 MHz

Setting	Description	
Positive	Specifies that a second signal transition cycle that fails to exceed the High level will define a trigger event.	
Negative	Specifies that a second signal transition cycle that fails to fall below the Low level will define a trigger event.	
High level	Specifies the High level used to define the trigger event.	
Low level	Specifies the Low level used to define the trigger event.	

Time Qualified Tab

The Time Qualified tab allows you to specify whether triggers are accepted based on timing characteristics. Trigger events that pass the timing qualification result in an acquisition. Trigger events that do not pass the timing qualification are ignored. Time-qualification can be applied to Power, Frequency Mask, Runt and External triggers.

Trigger	Event 🔆 Time Qualified Advanced Actions	
Free Run Triggered Force Trigger	None Shorter Inside Longer Outside	Time 1: 50.000 ms Time 2: 50.000 ms

Setting	Description	
None	No timing qualification is applied to trigger events. Acquisitions occur whenever a trigger event occurs (as specified on the Event tab).	
Shorter	If the length of the trigger event is shorter than the time specified by the Time 1 setting, then the trigger event is accepted and an acquisition is completed.	
Longer	If the length of the trigger event is longer than specified by the Time 1 setting, then the trigger event is accepted and an acquisition is completed.	
Inside	If the length of the trigger event is longer than the time specified by the Time 1 setting and shorter than the time specified by the Time 2 setting, then the trigger event is accepted and an acquisition is completed.	
Outside	If the length of the trigger event is shorter than the time specified by the Time 1 setting or longer than the time specified by the Time 2 setting, then the trigger event is accepted and an acquisition is completed.	
Time 1	Enter the Time 1 reference value here. Range: 20 ns-28 s.	
Time 2	Enter the Time 2 reference value here. Range: 20 ns-28 s.	

The following table shows how the appearance of the Time Qualified tab changes depending on whether time qualified triggering is enabled or not enabled.

Tab appearance	Description
🕒 Time Qualified	When None is selected on the Time Qualified tab, the watch icon is dimmed.
C Time Qualified	When any selection other than None is selected on the Time Qualified tab, the watch icon appears in color.

Minimum off time between trigger events. This readout shows how long the trigger conditions must be absent between the end of one trigger event and the start of the next trigger event to be ensure that the end of the first event is recognized. For example, if Freq Mask is selected and its RBW causes a minimum off time of 500 μ s, and your signal violates the mask for 600 μ s of every 1 ms, (so that the OFF time is

 $400 \ \mu$ s), it will appear to the analyzer that the signal is continuously in violation. Shorter and Inside settings will not produce a trigger in this situation.

Advanced Tab (Triggering)

Menu Bar: Setup > Trigger > Advanced

Application Toolbar: Trig > Advanced

Allows you to set parameters for trigger position and holdoff settings.

Trigger	Event 🕑 Time Qualified Advanced Actions	
🔘 Free Run	Position: 50 % V Auto	Holdoff: 1 s
Triggered Force Trigger	Delay: 0 s	Trigger each segment of Swept acquisitions
Force migger		requires trigger signals across entire Span

Setting	Description
Position	Sets the point along the acquisition record the trigger event should occur.
Auto	Enables the instrument to set the position of the trigger event. To manually specify the position of the trigger event, unselect Auto.
Delay	Sets how long after the trigger event specified by the Position setting, the analyzer should wait before actually initiating the trigger event.
Holdoff	Prevents triggers until there have been no trigger events for at least the specified time. Range: 20 ns-10 s.
Trigger each frequency segment in Swept acquisition mode	Sets the analyzer to wait for a trigger for each acquisition in a swept spectrum or other measurement requiring multiple acquisitions worth of span.

Holdoff

Holdoff on the analyzer does not work exactly like the traditional Holdoff setting on an oscilloscope. On an oscilloscope, once the instrument triggers, the holdoff setting causes the oscilloscope to refuse to accept another trigger until the holdoff time has expired. On the analyzer, once a trigger event is identified, the instrument determines how long it has been since the previous trigger event occurred and if the time since the previous trigger event is greater than the holdoff time, the trigger event is accepted and an acquisition is completed. If the time since the previous trigger event is less than the holdoff time, the latest trigger event is ignored (no acquisition occurs) and the holdoff time count restarts.

The most common reason for using holdoff is ensuring that the instrument triggers on the first pulse in a burst. For this application, the difference between the signal analyzer holdoff and the traditional oscilloscope holdoff has no effect on acquisitions.

The case where the difference can be noticed is when the time between trigger events is always less than the specified holdoff time. An oscilloscope will trigger on the first event after the holdoff time expires,

no matter how short the time has been since the most recent rejected trigger event. In such a situation, the analyzer will not ever trigger because it requires that there are no trigger events during the holdoff time before an accepted trigger event.

Actions Tab (Triggering)

The Actions tab sets parameters for the Save on trigger function. The Save on trigger function allows you to save an acquisition data file and/or a screen capture when a trigger event occurs.

Trigger events are defined on the Event (see page 503) and Time Qualified (see page 512) tabs.

Event 🕓 Time Qualified Advanced	Actions		
Save acq data on Trigger:	TIQ 🔹	✓ Max total files saved per Run:	100
(1 complete acquisition, not valid when swept)			
Save picture on Trigger:	PNG -		
Save picture on migger.			

Action tab settings

Setting	Description
Save acq data on Trigger	Enables the Save on Trigger function. The list box to the right of the Save acq data on Trigger check box specifies the format of the saved file. Acquisition data files can be saved in TIQ (native) format, CSV format, and MAT (MATLAB) format. For descriptions of these file formats, see <u>Data, Settings and Picture</u> File Formats (see page 516).
	When TIQ is the selected file type, a file is saved after a complete acquisition, which can include multiple frames. When CSV or MAT is the selected file type, a separate file is saved for each frame.
	Files are saved in the last location a file was saved. If Automatically increments filename/number is enabled (see <u>Save and Export (see page 28)</u>), files will be saved without user interaction. If Automatically increments filename/number is not enabled, you will be prompted for a filename when a trigger event occurs.
Save picture on Trigger	Enables saving a picture of the display when a trigger event occurs. Files can be saved in PNG, JPG, and BMP format. For descriptions of these file formats, see Data, Settings, and Picture File Formats (see page 516).
Max total files saved per Run	Specifies the number of times a Save on Trigger action stores a file. After this limit is reached, no more files are saved. The instrument will continue to run, but no additional files are saved when a trigger event occurs.
	Keep in mind when setting this number that picture files are counted as part of the total number of files. For example, if you set Max total files to 100, the instrument will save 100 acquisitions if only acquisitions are saved or only pictures are saved. But, if both acquisitions and pictures are saved, then 50 acquisitions and 50 pictures will be saved.

Saving and Recalling Data, Settings, and Pictures

You can save different types of data for later recall and analysis.

Data type	Description	Save as type
Setup files	Saves all of the setup information for all displays, except those settings that are not part of Preset.	Setup (.Setup)
Picture of Selected Display (PNG/JPG/BMP)	Saves a capture of the screen in the specified format. This option is useful for including the graphic in reports or other applications. Marker readouts and other information are included.	Picture (.BMP, .PNG, .JPG)
Results Export files	Saves the trace and numeric data for the selected display. The trace and numeric data are saved as CSV files.	Results export (various)
Measurement Settings	Saves a list of settings relevant to the selected measurement to a text file. This option is useful for including the measurement settings in reports.	Measurement settings export (TXT)
Trace	Saves a trace for later recall into the display from which it was saved.	Selected trace (various)
Data		Acquisition data with setup (TIQ); or Acquisition data export (CSV or MAT)

Saving Files

Saving files follows the same procedure regardless of the type of data being saved. To save setups (including application presets), pictures, results, or acquisition data:

- 1. Select Save As from the File menu to open the Save As dialog box.
- 2. Navigate to the folder where you want to save the setups, or use the default location.
- 3. Enter a file name.
- 4. Select the type of file to save from the Save as type drop-down list.
- 5. Click Save.

Recalling Files

You can recall three types of files: Setup files, Selected Trace, and Acquisition data with setup. Recalling data follows the same procedure regardless of the type of data being recalled.

- 1. Select Recall from the File menu to open the Open dialog box.
- 2. Navigate to the folder containing the file you want to recall.

- **3.** Select the type of file to recall from the **Files of type** drop-down list. This selection determines the files that appear in the Open dialog box.
- 4. Select the file to recall.
- 5. Click Open.

Setup Files

You can set up the instrument as desired and then save the settings in a setup file. This enables you to quickly setup the instrument by recalling previously saved setups.

Exporting Results

Save for further analysis of results in other programs, such as MATLAB or Excel.

Pictures of the Selected Display

You can save pictures of the instrument display for documentation purposes. When saving pictures of the display, you can select from three file types: BMP, JPG, or PNG.

Measurement Settings

You can save a list of settings relevant to the selected display to a file for documentation purposes. The exported file uses tab characters to separate values. The settings included in the file depend on the selected display. The contents of the file are the same as a Results export except it does not include the results.

Saving Acquisition Data with Setup

Save for later analysis with the analyzer. The setup is saved as part of the acquisition data file so you can choose when recalling data whether or not to also recall the associated acquisition and analysis parameters.

Saving Acquisition Data Export in CSV Format

Save for examining results in other programs, such as MATLAB or Excel.

Data, Settings, and Picture File Formats

You can save different types of data for later recall and analysis.

File type	File extension	Description
Setup files	.setup	Setup files enable you to save instrument settings for later recall. Using these files saves setup time and ensures consistent measurements.
Picture	.png/.jpg/.bmp	
Results Export	.CSV	Results files contain the trace points and numeric values that were produced by the selected measurement. The header of a Results file includes key acquisition and analysis settings to aid in the interpretation of the data. The file is saved as a plain text file, but the contents are formatted as CSV (comma-separated values). Results files can be opened from applications such as Microsoft Excel and MATLAB.
Measurement Settings	.txt	Measurement settings files contain a list of settings that describe how the instrument is set up for the selected measurement. The list contains measurement settings (for example, Span), trace settings (for example, whether or not a trace is selected) and global settings (for example, Frequency and Reference Level). The list of settings contained in the file varies depending on which display is selected.
Selected Trace	varies with display	
Acquisition Data with Setup	.tiq	These files contain the acquisition data record and complete instrument setup (in binary format). Use these files to save data for later recall and analysis. When you save an Acquisition Data file, the current Setup is always saved with the file. At the time of recall, you will be asked whether you want to restore only the acquisition data or both data and setup. If the instrument is already set up for a specific measurement, you will probably want to recall only the acquisition data. Recalling both data and setup returns the instrument to the same state it was in at the time you saved the file.
Acquisition Data	.CSV	These files contain IQ sample data before it has been processed by a measurement. The acquisition data points are saved as IQ pairs. Use this format to import the acquisition data into Microsoft Excel for further analysis.
Acquisition Data	.mat	These files contain IQ sample data before it has been processed by a measurement. The acquisition data points are saved as IQ pairs. Use this format to import the acquisition data into MATLAB for further analysis.
Range file	.CSV	These files contain a list of settings that describe how the instrument is set up for the Spurious measurement. The file contains the number of ranges enabled, the start and stop frequencies for each enabled range, the limits for each enabled range, the mask type and more.

Saved File Types

Results Export File Format

The Results Export format contains trace points and/or scalar results produced by the measurement. The file contains general information about the measurement settings at the top of the file and the results data in the second part of the file. Groups of settings or results are headed with [text], as described below.

At the top of the file is the measurement name and the date and time data was acquired.

The first group of settings is [Global Parameters]. These settings include the Measurement Frequency, Acquisition Data, Reference Level and others.

The second group of settings is [Parameters]. These settings are specific parameters which vary depending on the measurement.

The next group is [Trace Parameters], which may not be present, depending on the measurement. Within this group, there are parameters specific to a trace. There will be a Trace Parameters group for each trace shown on the display.

The next group is [Results]. These are scalar results for the measurement.

Next is [Traces]. The Traces group consists of one or more [Trace] groups. There is one Trace group for each trace. Each [Trace] group contains background information about the trace (units, number of points, x scaling, and others depending on the measurement) at the top of the group, followed by the trace points.

Acquisition Data with Setup File (.tiq) Format

The file consists of two parts - the header that is in XML and the data that is in binary format.

Header. The header consists entirely of the DataFile element. This element is broken down into sub-elements.

- 1. DataSetsCollection
- 2. Setup

DataSetsCollection. The DataSetsCollection contains a DataDescription element, a DataSet element, and a ProductSpecific element.

Binary data. Binary data is a sequence of Int32 values, which are IQ pairs (I,Q,I,Q, ...) in binary Little Endian format.

To convert these values to volts, multiply the individual values by the Scaling value in the DataDescription.

The binary data starts at an offset into the file == the "offset" attribute in the DataFile element. This offset number will always start at the 19th character into the file (starting with 1), and will always be 9 characters long.

NOTE. You should not casually modify the XML header, because this will change the offset to the start of the binary data.

Acquisition Data Files (.csv)

The acquisition data files have two sections. At the top of the file is the following information:

- SamplingFrequency The sampling frequency in Hertz.
- NumberSamples The number of IQ samples in the file.
- DateTime When the data was acquired.

- Frequency The center frequency in Hertz.
- AcquisitionBandwidth The acquisition bandwidth Hz.

Following the AcquisitionBandwidth are the data. The data are IQ pairs, in volts.

Groups of settings or results are headed with [some text].

The first thing in the file is the measurement name and the date/time when the acquisition was taken.

The first group [Parameters] are global parameters. Measurement Bandwidth in this group is the measurement bandwidth used by the General Signal Viewing measurements (Spectrum, Amplitude vs. Time, etc). It also includes some source settings, like Acq BW, Dither, Preamp, and RF Attenuation.

The second group [Parameters] are measurement-specific parameters.

Another group which can occur is [Trace Parameters]. Within this group, there will be a set of parameters, one for each trace that is currently shown.

Another group is [Results]. These are scalar results for the measurement.

Another group is [Traces]. It has [Trace] groups under it, one for each trace. Each [Trace] group has some background information about the trace (units, number of points, x scaling, etc), and the trace points themselves.

Acquisition Data Files (.mat)

The acquisition data files saved in MATLAB format contain the following MATLAB variables:

- InputCenter The center frequency in Hertz.
- XDelta The sample period in seconds.
- Y A complex array containing IQ pairs.
- InputZoom The acquisition bandwidth in Hertz.

The MATLAB format used to save acquisition data has the following properties and limitations:

- Files are stored in MATLAB Level 5 format.
- MATLAB Level 5 file size is limited to 2 GB.
- The instrument acquisition memory limit is 1 GB (1.024 Gigabytes). Because of the way acquisition data is processed, 1 GB of acquisition memory requires 2 GB of memory to store. When header information (instrument settings) is added to the acquisition data, the resulting file size is >2 GB.
- If acquisition memory is filled (1 GB), exporting the data to MATLAB format will result in a file that exceeds 2 GB in MATLAB level 5 format. A PC with sufficient memory is required to open the file. If memory is not sufficient, MATLAB will warn the user. To check how much acquisition memory is filled, select Setup > Acquire > Sampling Parameters. When the instrument is stopped, or you are analyzing a recalled data file, you can find the acquisition length under File > Acquisition Data Info.

Printing Screen Shots

You can print screen shots (screen captures) two ways: use File > Print or save a picture file and print the file using a separate graphics program. Printing a screen capture is the same as printing with any windows program. For details on the available file formats for saving a screen capture, refer to <u>Data, Settings, and</u> <u>Picture File Formats (see page 516)</u>. For details on saving a picture to a file, see <u>Saving and Recalling</u> <u>Data, Settings, and Pictures (see page 515)</u>.

To print a screen shot:

- 1. Select File > Print.
- 2. Select File > Print Preview if you wish to review the screen shot before sending it to the printer.
- 3. Select File > Print to print the file to a printer.

Online Help

Menu Bar: Help > User Manual

This menu item displays this help. The help is a standard Windows help system. The Online Help menu item is the only method available to display the help; there are no other links to the help within the software.

Menu Overview

The main menus are:

Menu	Description
File (see page 521)	Select measurements, open and save files, print documents, and preset.
View (see page 524)	Change display size, display the Marker toolbar and Status bar.
Replay (see page 478)	Replay measurements; select which record(s) to play, Replay/Stop/Pause, or enable continuous loop.
Markers (see page 526)	Define markers and search for signal peaks.

File Menu

Command	Description
Recall (see page 521)	The Recall dialog enables you to recall saved data, setups and traces.
Save (see page 522)	Saves a file without asking for a file parameters (based on most recent settings).
Save As (see page 522)	Displays the Save dialog enabling you to specify the parameters of the save operation.
Acquisition data info (see page 478)	Displays the <u>Acquisition Info tab (see page 478)</u> of the Replay control panel. The info on this tab describes such acquisition parameters as acquisition bandwidth, sampling rate, RF attenuation, and acquisition length.
Measurement Data Info (see page 523)	Displays the characteristics of the most recently analyzed record in the display.
Print (see page 523)	Prints the selected display.
Print Preview (see page 524)	Displays a preview of the print output.

Recall

Menu Bar: File > Recall

Application Toolbar: 🗁

Use the Recall command to load previously saved acquisition data, setups or trace data.

To Recall Data or Setups

- 1. Select File > Recall. This displays the **Open** dialog box.
- 2. Select the file type to be recalled and click Open.

Save / Save As

Menu Bar: File > Save / Save As

Use Save / Save As to store acquisition data, setups, and traces. Save is also used to export traces, results and pictures of the display for use in other programs.

Difference Between Save and Save As

Use Save As to specify what kind of data you want to save and where the data should be saved. Use Save to quickly save the same data as you saved the last time you executed a Save, without having to specify the data type and location.

For example, suppose you want to save a picture of a spectrum trace each time you adjust a circuit to document how the adjustments affect the output of the circuit. The first time you want to save a picture of the display, you will need to select Save As. From the Save As dialog box, you specify the type of data you want to save (Picture of Selected Display) and specify the location of the saved file. As long as the <u>Save</u> and <u>Export option (see page 26)</u> is set to automatically name saved files, the next time you want to save a picture of the display, you can just press Save on the front panel and a picture of the selected display will be saved without requiring you to type a file name or the location of the file to be saved.

Data type	Description
Acquisition Data	
Setup	Configuration information detailing instrument settings. Data can be saved in a format readable only by SignalVu-PC, oscilloscopes running SignalVu software, or RSA6100/RSA5100/SPECMON Series instruments.
Selected Trace	Saves the selected trace for later analysis by the analyzer. Data is saved in a format readable only by SignalVu-PC, oscilloscopes running SignalVu software, or RSA6100/RSA5100/SPECMON Series instruments.
Exported Traces and Numeric Results	Save traces and results in a file format that can be used by other programs.
Pictures of the Display	Save screen images in graphic image file formats that can be used in other programs.
Exported Acquisition Data	Save acquisition data records in a file format that can be used by other programs. Acquisition data can be saved in either comma-separated-variable format or MATLAB format.

What Data Types Can Be Saved

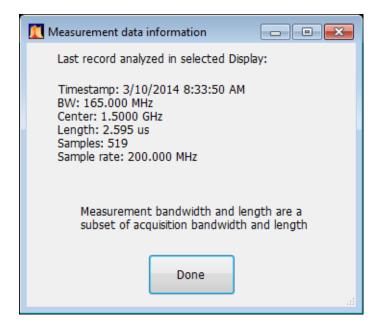
Data, Settings, and Picture File Formats (see page 516).

Option	Setting	Description
Image Format	PNG	Saves exported screen captures in Portable Network Graphics format.
	JPG	Saves exported screen captures in Joint Photographic Experts Group (JPEG) format.
	BMP	Saves exported screen captures in Windows bitmap format.

Options for Saving Pictures of the Display

Measurement Data Info

The Measurement Data Info command in the File menu displays a listing of acquisition-related information about the last data analyzed by the selected measurement. The last data can be from the current acquisition or it could be from a recalled data file.



Print

Menu Bar: File > Print

Print displays the Windows Print dialog box for printing a screen capture of the display. To save ink when printing, use the Colors tab to set the color scheme. See Options Settings (see page 26).

Print Preview

Menu Bar: File > Print Preview

Print Preview shows how a print out will appear when it is printed.

View Menu

The View menu enables you to control the display of items in the application window.

Command	Description
Full Screen (see page 525)	Toggles all views between full-screen size and user-selected size.
Navigator View	Selecting Navigator View adds the Time Overview display to the existing measurement displays to provide a better perspective of the signal.
	When the Navigator View is enabled, the Time Overview display is always located above any other measurement displays and uses the maximum horizontal resolution of the display area, regardless of the Window Tile setting.
Numeric Keypad	When selected, any time you place the cursor within a control or setting that takes an numeric value, you are presented with a dialog box to easily enter a value.
	For instance, placing the cursor in the Frequency setting, displays the following dialog
	Screen. Frequency 1.5 GHz We the arrow buttons to change the value.
	Press the calculator icon to display a keypad that allows you to enter values and suffixes.
Replay Toolbar (see page 480)	Shows or hides the Replay toolbar.
Traces Toolbar	Shows or hides the Traces toolbar.
	The Traces toolbar allows quick access to the trace controls of the selected measurement display. This example is the DPX Spectrum trace toolbar.
	The Traces toolbar can also be controlled from the Basic Controls Toolbar.
Markers Toolbar (see page 460)	Shows or hides the Marker toolbar. Enables you to define Markers and perform Peak searches.
	The Markers toolbar can also be controlled from the Basic Controls Toolbar.

Command	Description			
Basic Controls Toobar	Shows or hides the toolbar containing the basic acquisition settings and controls.			
	Name of selected measurement window			
	 Various controls based on the selected measurement display 			
	Show or hide the Markers toolbar			
	Show or hide the Traces toolbar			
	Show or hide the Settings Control Panel			
	The Basic Controls toolbar allows quick access to controls and settings of the selected measurement display. This example is the DPX Spectrum Basic Controls toolbar.			
Status Bar (see page 525)	Shows or hides the Status bar.			

Full Screen

Menu Bar: View > Full Screen

When unchecked, clicking **Full Screen** resizes the application window to fill the screen. Full Screen mode maximizes the application window, and turns off the application title bar.

When checked, clicking **Full Screen** restores the application window to its previous size. The application title bar is restored.

Status Bar

The Status Bar displays information on specific instrument settings. It contains only status information; it does not display any error information. The Status bar has no controls. It can be hidden.

Elements of the Status Bar

Run Status Indicators Indicator Description

Showing or Hiding the Status Bar

Select View > Status Bar to toggle the display of the Status bar.

Replay Menu

Markers Menu

The Markers menu provides to settings that define and control the location of markers.

Setting	Description
Peak (see page 458)	Moves the selected marker to the highest peak on the trace.
Next Peak >	Moves the selected marker to next peak depending on the setting chosen.
Marker to Center Frequency	Sets center frequency to the frequency of the selected marker.
Define Markers (see page 458)	Displays the Define Marker control panel.

Setup Menu

Command	Description
Displays (see page 31)	Displays the Displays control panel.
Settings (see page 535)	Displays the Settings control panel for the selected display.
Analysis (see page 471)	Displays the Analysis control panel.
Amplitude (see page 483)	Displays the Amplitude control panel.

Presets Menu

The Presets menu provides you access to instrument presets and preset options. Command Description

Tools Menu

Provides access to several utilities for controlling instrument functions.

Command	Description
Mask Test (see page 463)	Enables you to locate and highlight specified signal levels in specified displays.
Options (see page 26)	Displays the Options control panel.

Window Menu

Use the Window menu to arrange how windows are displayed. Displays can be set to appear full screen (one display at a time) or with all (selected) displays visible at once. When all displays are visible at once, you can rearrange the displays by dragging the title bar of a window (deselect Window > Lock Windows to move displays around).

Command	Description
Close View	Closes the selected view.
Cascade	Positions windows in a cascade view (not available when Lock Windows is selected).
Tile Horizontally	Positions widows in a horizontal orientation (top to bottom).
Tile Vertically	Positions widows in a vertical orientation (side by side).
Lock Windows	Locks the windows into their current position, preventing them from being moved. If the windows are locked, the Cascade arrangement is not selectable.
(List of windows)	A numbered list of open windows.

Help Menu

Displays the help.
isplays a PDF version of the help.
-

Error and Information Messages

The following list describes some of the common error and information messages that might appear during instrument operation. Messages that apply specifically to one or more measurements appear in the displays. Messages that pertain globally, such as those about hardware status, are shown in the Status Bar at the bottom of the analyzer application window.

Acq BW too small for current setup

The display needs a wider acquisition bandwidth than what the current data record contains. This can be due to any of the following reasons:

The sampling parameters are being manually controlled.

In the Acquire control panel > Sampling Parameters tab, set the Adjust control to All Auto to allow the software to pick the sample rate and record length that it needs.

• A display other than the one you intended has been selected. The selected display has requested a smaller acquisition bandwidth to achieve a better accuracy or dynamic range for its particular measurement.

Select the display that contains the message. Click Run if the instrument is not already acquiring data.

Acquisitions are not running and the measurement now requests a wider bandwidth than the last acquisition.

Click Run to perform a new acquisition with a wider bandwidth.

• The data is from a recalled TIQ file.

There is no way to increase the acquisition bandwidth for saved IQ data. You must adjust the measurement settings so that less bandwidth is required.

Analysis failure: <description of error>

The instrument is unable to complete a measurement due to difficulty in characterizing the signal. For example, due to either the signal or settings, the instrument may not be able to recognize a pulse so it can compute the pulse measurements.

Try changing settings to improve analysis. For example, when Pulse Trace is displayed, try changing the settings on the Settings > Params.

Analysis failure: Carrier detection failed

The instrument was unable to locate a carrier signal. Try adjusting the Carrier Threshold or Integration BW values, if the measurement has these controls.

Analysis Length was limited

This message appears if the "Results Length", the time over which the measurement computed its results, is less than the Actual Analysis Length reported in the Analysis Time control panel tab and the Time Overview display. The Results Length is indicated by the magenta line below the Time Overview graph. This can occur because the acquisition contained more data samples than a measurement can process (for example, digital demodulation is limited to 80,000 samples) or the measurement had to use some of the first and last samples for pre-measurement processes.

Analysis length too small for current setup

Increase the Analysis Length or decrease the RBW (Spectrum, ACPR, MCPR).

Avg Tx not available in Volts units

The Average Transmitted Power measurement is not defined for Volts.

Can't get acquisition data record

No acquisition record currently exists in memory (run an acquisition or recall a file), or an error has occurred. Repeat the acquisition.

Can't replay data from swept acq

The measurement could not produce results because it is a real-time only measurement but was asked to reanalyze (Replay) an acquisition taken in swept mode.

Can't replay. Live data needed for swept settings

The measurement could not produce results because it was asked to reanalyze (Replay) the acquisition but it is in Swept acquisition mode. Swept-mode measurements cannot analyze recalled data.

CISPR accuracy limited by acq memory. Adjust RBW or freq range

The CISPR function was applied, but the available data did not represent a long enough time to satisfy CISPR requirements. Increasing RBW reduces the amount of time needed for analysis. Reducing frequency range (for example, by reducing Span), decreases sample rate, allowing the available memory to cover a longer time period.

If this data is from a saved file, the error cannot be cleared.

If this data is from a saved file, this error cannot be cleared.

This data was acquired when the input signal contained peaks greater than 6 dB above the Reference Level setting.

If the data is from a file, this error cannot be cleared.

Data from unaligned instrument

The acquisition data was captured when the instrument was not aligned. This message refers to the acquisition data currently being analyzed, but not necessarily to the current status of the instrument. Measurements made on this data might not be accurate.

Disabled: data is from swept acquisition

The display needs to run in real-time mode. The display associated with this message cannot run now because it is not the selected display, and the selected display is performing multiple acquisitions (it is in swept mode).

- Change the settings of the selected display so it is performing real-time acquisitions.
- Select the associated display to make it the selected display. When it is selected, it will force the acquisition parameters to change to meet its own needs.

Frequency exceeds preamp range

This is a warning that signals below the minimum preamp operating frequency are likely to be severely attenuated (this is 100 kHz for option 51, 1 MHz for option 50).

Needs swept acq or larger AcqBW - Acquire data while display is selected

The display is not running because it needs to perform multiple acquisitions (it must be in swept mode) but it is not the selected display. Only the selected display can perform multiple acquisitions.

Select the display showing this message to give it control of acquisitions parameters.

Sometimes, only one display can work and the others will be blank and show errors. This happens when different displays have conflicting demands on the acquisition data record.

Export failure: file not saved

An error occurred while exporting Results. The file was not created.

Export the results again.

Export failure: unable to open results file for export. File not saved.

The Export Results file could not be opened for writing, so the export of results was not completed.

• Verify that there is sufficient free space on hard disk.

Insufficient data for CISPR. Acquire while display is selected

This message appears when a measurement is not the selected measurement and CISPR filters are selected. Set the measurement to be the selected measurement and reacquire the signal.

IQ Processing Error: 8012

This message occurs in GP Digital Modulation displays. The most likely cause for this message is that there are not enough symbols to analyze. This can happen if:

- The Analysis Length is set too short. Increase the Analysis Length on the Analysis Time tab.
- The Analysis Offset has pushed the Analysis Time so far out that the actual Analysis Length is too short, even though the user-requested Analysis Length would have been long enough without the excessive offset. Decrease the Analysis Offset on the Analysis Time tab.
- The input signal is bursted, and the burst does not contain enough symbols.

Needs swept acq or larger Acq BW - Acquire data while display is selected

The display has one of two problems: It is not the selected display, which prevents it from controlling the hardware acquisition parameters, and setting the acquisition mode to Swept; or its settings require a wider data bandwidth.

- Select the display that you are interested in and it will change the acquisition to meet its own needs.
- Increase the acquisition bandwidth manually or by changing the selected display's settings to cause the wider bandwidth.

No Math trace: unmatched trace lengths

A math trace could not produced because the traces selected to generate the math trace do not have the same number of points. This can easily happen if both traces are recalled, but were saved under different "Points" settings. This can also occur if one of the selected traces is a live trace and the other trace is a recalled trace.

- In a Spectrum display, as long as one trace is live, you can change the "Points" setting (Setup > Settings > Freq & Span tab) to match the recalled trace.
- If you are using two recalled traces to generate the Math trace. You must recreate at least one of the traces.

No burst detected

The Burst Detection Mode (see page 441) is On, but no burst was detected in the signal.

• Check that the Threshold setting is properly set.

Not enough samples for current setup

The measurement was not able to run because the combination of analysis length, offset, and measurement bandwidth relative to acquisition bandwidth, were such that not enough samples were available for the measurement to analyze. This can occur when two or more displays are shown and one display requires a wide acquisition bandwidth and another display requires a much narrower bandwidth. The display requiring the much narrower bandwidth must decimate and filter the acquisition record which can result in too few samples left for the measurement.

- Increase the Analysis Length to provide more samples.
- Close any displays you don't currently need.

Not enough samples - try increasing MeasBW

The measurement was not able to run because there are not enough samples available for the measurement to analyze. The Settling Time measurement requires at least 256 samples. This can occur when two or more displays are shown and one display requires a wide acquisition bandwidth and another display requires a much narrower bandwidth. The display requiring the much narrower bandwidth must decimate and filter the acquisition record which can result in too few samples left for the measurement.

- Increase the Analysis Length to provide more samples.
- Close any displays you don't currently need.

No FFT (not all pulses have results)

If a pulse cannot be measured (because its shape is too indistinct or it does not meet the <u>parameters that</u> <u>define a pulse (see page 248)</u>), its results will be "--" for every measurement on that pulse. The instrument cannot compute an FFT.

No pulses found

The instrument was unable to find any complete pulses in the signal.

Make sure the <u>analysis length (see page 471)</u> includes at least one complete pulse cycle, from before one rising edge until after the next rising edge.

Pulse Detection Error

The instrument was unable to detect a pulse.

- The pulse <u>Measurement Filter (see page 248)</u> needs to be smaller. Try reducing the bandwidth and/or selecting the Gaussian filter.
- Detection threshold is not set to the proper level for the signal. Adjust the <u>Power threshold to detect</u> pulses (see page 248).
- The pulse interval is too long for the current settings. Try decreasing the <u>filter bandwidth (see page 248)</u>, as this may reduce the number of data points to a manageable quantity.

RBW conflict. Increase Span or Analysis Length

The measurement is not running because the actual RBW used by the measurement is too large for the current acquisition span. Typically, the analysis length is too short as well.

Either increase the span or increase the Analysis Length.

RBW decreased

The current span or acquisition bandwidth is too small to allow a wider RBW filter.

Increase the span or acquisition bandwidth if the decreased RBW is not acceptable.

RBW increased

The current Spectrum Length (or Analysis Length if Spectrum Length is not Independent) is too small to allow the requested RBW.

Increase the Spectrum Length (or Analysis Length) if the increased RBW is not acceptable.

RBW limited by AcqBW to: XX Hz

The requested RBW is too close to the acquisition BW. Increase the frequency range of the measurement (for example, Span).

RBW too small/large for current Acq BW

If the RBW is set manually, it is possible for the acquisition bandwidth to be incompatible with the RBW setting.

- Change the RBW setting.
- Adjust the Acq BW setting, either directly (Setup > Acquire > Sampling Params: select on of the manual modes) or by adjusting the measurement bandwidth of the selected display (Setup > Acquire > Sampling Params: All Auto).

Recall error: Setup not completely restored

An error occurred while recalling a Setup file. Thus, the current setup may be a combination of settings from the Setup file and the previous Setup.

Recall the setup again.

Recall failure: problem with file or file contents

An error occurred while recalling a Setup, Trace or Data file. This can occur because of a problem opening the file (operating system error) or because of a problem with the contents of the file.

Recall the file again.

Restoring acquisition data

This is a status message displayed while data is being restored from a file.

Save failure: file not saved

An error occurred while saving a Setup or Data file.

Save the file again.

Saving acquisition data

This is a status message displayed while data is being saved to a file.

Selected VBW does not use full Spectrum Length

This message can occur when the Spectrum Length is greater than required for the VBW filter. If you look at the Time Overview display, the Magenta line for Results Length indicates the part of the Spectrum Length that was actually used. The measurement results are correct, but don't include some of the data in the selected Spectrum Length. To clear this message, you can set the Spectrum Length to Auto.

Setup error: <description of error>

When this message appears, it includes text that explains the problem. For example, the ACPR display might show: "Setup error: channels can't overlap". Setup errors are the result of conflicts in instrument settings. These types of errors occur when a user makes manual changes to settings. In the example above, the channel settings in the Channel Power and ACPR display have been set so that the channels overlap in frequency.

Adjust the instrument settings, or change a setting back to Auto, to eliminate the error.

Setup error: Integration BW exceeds Measurement BW

When this message appears, it includes text that explains the problem. Setup errors are the result of conflicts in instrument settings. These types of errors occur when a user makes manual changes to settings.

Adjust the instrument settings, or change a setting back to Auto, to eliminate the error.

Setup error: Measurement time for Freq & Phase results

The <u>Measurement time for Freq & Phase results (see page 250)</u> specifies how far across the pulse top the instrument should wait before measuring the Phase Difference and Frequency Difference for each pulse. If this value is set too large for any of the pulses in the signal, the measurement point ends up on the falling edge or during the pulse off time.

Decrease the Measurement time for Freq & Phase results setting (Settings > Define tab).

Unexpected software error. Please cycle power and try again. If the problem persists, contact your Tektronix Service Center.

An unrecoverable error has occurred, and the instrument application software will shut down.

VBW not applied - Acq BW too small

Increase VBW or measurement bandwidth. Make sure Sampling Parameters are set to Auto.

VBW not applied - Spectrum Length too short

This message occurs when the requested VBW can't be produced because the Spectrum Length is too short.

To clear this problem, set the Spectrum Length to Auto or manually increase the Spectrum Length (see Setup > Analysis > Spectrum Time tab). If Spectrum Length is coupled to Analysis Length, set Analysis Length to Auto or manually increase it (see Setup > Analysis > Analysis Time tab).

Displaying the Windows Event Viewer

When the analyzer generates an error message, information about the error is logged to the Windows Event Viewer.

To display the Windows Event Viewer:

- **1.** Select Start > Control Panel.
- 2. Select Administrative Tools. (If your instrument displays control panels in Category View, select System and Security, and then select Administrative Tools.)
- 3. Double-click Event Viewer.
- 4. From the Event Viewer window, select **Windows Logs**, then select **Application**. This displays a list of all errors that have been reported to the operating system from applications.

Event Viewer (Local)	Application Number of events: 1,467						Actions	
Custom Views Windows Logs Windows Logs Security Security Setup System Forwarded Events Applications and Services Lo Subscriptions	Level Information Information Information Information Information Information Information Information Information	Date and Time 7/27/2011 4:38:07 PM 7/27/2011 4:38:07 PM 7/27/2011 4:36:07 PM 7/27/2011 4:36:17 PM 7/27/2011 4:36:17 PM 7/27/2011 4:01:46 PM 7/27/2011 3:38:02 PM	Source gupdat gupdat gusvc TekRSA Certific Certific Certific	0 0 3 64 65 64	None None None None None	Api	plication Open Saved Log Create Custom View Import Custom View Clear Log Filter Current Log Properties	
	that raises thi can install or	s on for Event ID 0 from sourc s event is not installed on yc repair the component on th	ur local comp e local comput	nnot be fo uter or the ier.	und. Either the compor installation is corrupted		Find Save All Events As Attach a Task To this L View Refresh Help ent 0, gupdatem	
	, Log Name: Source: Event ID: Level: User: OpCode:	iginated on another compu Application gupdatem 0 Information N/A ion: <u>Event Log Online Hel</u>	Logge Task C Keywo Comp	d: i ategory: f rds: (7/27/2011 4:38:07 PM		Event Properties Attach Task To This Ev Save Selected Events Copy Refresh Help	

Errors reported to the Event Viewer from the analyzer application appear under Source as TekRSA.

5. Double-click the last error reported for TekRSA to see details on the most recently reported error. Please note that many items reported as "errors" are simply informational and do not mean that your instrument is impaired. Contact the Tektronix Customer Support Center or Service Center if you are concerned about an error shown in the Event Viewer. Do not send an instrument out for repair based solely on these event reports.

How to Find Out if Software Upgrades are Available

Software upgrades might be available can be downloaded from the Tektronix Web site. To see if a software upgrade is available for your product, use your browser to go to <u>www.tektronix.com/software</u>. Search by the product model number.

To add additional software options or features, you will need an option key from Tektronix. In some instances, you may need to upgrade the product software before adding the new option key. Follow the installation instructions provided with your software option.

Settings

Menu Bar: Setup > Settings

The Settings menu item enables access to control panels that allow you to change settings for the selected display. The control panel that appears when you select **Settings** depends on the selected display. The Settings control panel for the Spectrum display is shown in the following figure.

Spectrum Settings	Freq & Span BW	Traces Scale	Prefs		 	
	Center: 1	.9000 GHz	Span:	85.0 MHz	Max Span	
	Start: 1	8575 GHz				
	Stop: 1	.9425 GHz				
Restore Defaults	Step Size: 5	5.0000 MHz	🔽 Auto			

The control panel for the CCDF display is shown in the following figure.

CCDF Settings	gs Parameters Traces Prefs						
	Measurement Time						
	Single (use Analysis Length)						
	Total Time: 20.000 ms	Span: 85.0 MHz					
Restore Defaults	Continuous						

Settings Control Panels

AM Settings (see page 78)

Amplitude vs Time Settings (see page 60)

Analysis Settings (see page 471)

Audio Spectrum Settings (see page 392)

Audio Summary Settings (see page 394)

CCDF Settings (see page 115)

Channel Power and ACPR Settings

OFDM Channel Response Settings (OFDM (see page 193)) (WLAN (see page 105))

Constellation Settings (see page 407)

EVM vs Time Settings (see page 411)

Eye Diagram Settings (see page 414)

FM Settings (see page 85) Frequency Deviation vs Time Settings (see page 416) Frequency vs Time Settings (see page 62) Magnitude Error Settings (see page 418) MCPR Settings (see page 105) Occupied Bandwidth Settings (see page 112) OFDM Constellation Settings (see page 195) OFDM EVM Settings (see page 196) OFDM Magnitude Error Settings (see page 198) OFDM Phase Error Settings (see page 202) OFDM Power Settings (see page 204) OFDM Summary Settings (see page 206) OFDM Symbol Table Settings (see page 208) Phase Error vs Time Settings (see page 420) Phase vs Time Settings (see page 64) PM Settings (see page 93) Pulse Statistics Settings (see page 247) Pulse Table Settings (see page 242) Pulse Trace Settings (see page 245) RF I Q vs Time Settings (see page 65) Mask Test Limits Settings (see page 463) Settling Time Settings (see page 129) Signal Quality Settings (see page 425) Spectrogram Settings (see page 55) Spectrum Settings (see page 51) Symbol Table Settings (see page 427) Time Overview Settings (see page 45) Trellis Diagram Settings (see page 429)

Accuracy

The closeness of the indicated value to the true value.

ACLR

Adjacent Channel Leakage power Ratio is the ratio of the RRC (Root Raised Cosine) filtered mean power centered on the assigned channel frequency to the RRC filtered mean power centered on an adjacent frequency (defined in 3GPP).

ACPR Measurement

Adjacent Channel Power Ratio (ACPR) is the ratio of the mean power centered on the assigned channel frequency to the mean power centered on an adjacent channel frequency. In the 3GPP specification, it is called ACLR (Adjacent Channel Level Ratio) and both the main channel and adjacent channels are required to be filtered with RRC (Root Raised Cosine) filters.

Acquisition

A series of time-contiguous frames. This is also called a Block.

Analysis Length

The length of time in the Analysis Time.

Analysis Time

The portion of the acquisition record over which one or more measurements are calculated.

ASK

Acronym for Amplitude Shift Keying. The process, or result of a process, in which the amplitude of the carrier is varied in accordance with the state of a digital input signal.

Block

An integer number of time-contiguous frames. See also: Acquisition.

Calibrator

A signal generator producing a specified output used for calibration purposes.

Carrier

The RF signal upon which modulation resides.

Carrier Frequency

The frequency of the CW component of the carrier signal.

Carrier Signal

The electrical signal, typically a sine wave, upon which modulation is impressed.

Carrier-to-Noise Ratio (C/N)

The ratio of carrier signal power to average noise power in a given bandwidth surrounding the carrier; usually expressed in decibels.

CCDF - Complimentary Cumulative Distribution Function

The Complementary Cumulative Distribution Function (CCDF) represents the probability that the peak power above average power of a measured signal exceeds a threshold.

CCDF is a plot of the percent of time that a signal's power value exceeds it average value versus the amount by which it exceeds the average. The CCDF plot has a log of probability on the Y-axis (100% at the top) and dB above average amplitude on the X-axis (0 at the left).

CDMA

Acronym for Code Division Multiple Access.

Center Frequency

The frequency corresponding to the center of a frequency span of the analyzer display.

Check Mark Indicator

The check mark indicator in the upper-left corner of the display indicates the display for which the acquisition hardware is optimized. When you have more than one display open, the display with the check mark indicator has control over the acquisition hardware. To give a display priority over any others, click its title bar.

When *Best for multiple windows* is selected in the Amplitude control panel's RF & IF Optimization control, none of the measurement displays shows a checkmark, as there is not a single optimized measurement.

CISPR

International special committee on radio interference. (Comité international spécial des perturbations radioélectriques)

CW

Acronym for Continuous Wave.

CW Signal

Continuous wave signal - a sine wave.

DANL

Acronym for Displayed Average Noise Level. See Sensitivity (see page 550).

dBfs

A unit to express power level in decibels referenced to full scale. Depending on the context, this is either the full scale of the display screen or the full scale of the analog-to-digital converter (ADC).

dBm

A unit of expressed power level in decibels referenced to 1 milliwatt.

dBmV

A unit to express voltage levels in decibels referenced to 1 millivolt.

dBuV

A unit to express voltage levels in decibels referenced to 1 microvolt.

Decibel

Ten times the logarithm of the ratio of one electrical power to another.

Detection

The process by which a long waveform is decimated (reduced) down to the desired number of trace points, by dividing the waveform into intervals and choosing a single value to represent each interval in the trace.

Display Reference Level

A designated vertical position representing a specified input level. The level may be expressed in dBm, volts, or any other units.

Distortion

Degradation of a signal, often a result of nonlinear operations, resulting in unwanted signal components. Harmonic and intermodulation distortion are common types.

Dynamic Range

The maximum ratio of the levels of two signals simultaneously present at the input which can be measured to a specified accuracy.

EVM

Acronym for Error Vector Magnitude.

Export

Save data to a file in a format other than application-native.

FastFrame

FastFrame segments the acquisition record into a series of frames and then captures acquisitions as single frames. You can then view and measure each frame individually.

FFT

Fast Fourier Transform - a mathematical process to calculate the frequency spectrum of a discrete number of time domain sample points.

Filter

A circuit that separates electrical signals or signal components based on their frequencies.

FM

Acronym for Frequency Modulation.

Frame

A series of time-contiguous samples, long enough in duration and at a sufficient sample rate to produce a spectrum view of a specified span and RBW.

Frequency

A series of time-contiguous samples, long enough in duration and at a sufficient sample rate to produce a spectrum view of a specified span and RBW.

Frequency Band

The continuous range of frequencies extending between two limiting frequencies, expressed in hertz.

Frequency Domain View

The representation of the power of the spectral components of a signal as a function frequency; the spectrum of the signal.

Frequency Drift

Gradual shift or change in displayed frequency over the specified time due to internal changes in the analyzer, where other conditions remain constant. Expressed in hertz per second.

Frequency Range

The range of frequencies over which the performance of the instrument is specified.

Frequency Span

A continuous range of frequencies extending between two frequency limits.

Frequency Settling Time

The time measured from a reference point to when the signal of interest settles to within user-defined tolerance.

GPIB

Acronym for General Purpose Interface Bus, the common name for the communications interface system defined in IEEE Std. 488.

Graticule

The calibrated grid overlaying the display screen of analyzers, oscilloscopes, and other test instruments.

Grayed Out

An on-screen control is "Grayed Out" if it is not adjustable.

I/Q

Acronym for In-phase / Quadrature.

IF

Acronym for Intermediate Frequency.

Import

Bring data into the application from a file of some format other than application-native.

Impulse Response

The Impulse Response trace display shows normalized power on the vertical axis and time on the horizontal axis.

Input Impedance

The impedance at the desired input terminal. Usually expressed in terms of VSWR, return loss, or other related terms for low impedance devices and resistance-capacitance parameters for high impedance devices.

LISN

Acronym for Line Impedance Stabilization Network.

Local Oscillator (LO)

An oscillator which produces the internal signal that is mixed with an incoming signal to produce the IF signal.

Marker

A visually identifiable point on a waveform trace, used to extract a readout of domain and range values represented by that point.

Max Hold

Digitally stored display mode which, at each frequency address, compares the incoming signal level to the stored level and retains the greater level. In this mode, the display indicates the peak level at each frequency after several successive acquisitions.

MCPR (Multiple Carrier Power Ratio)

The ratio of the signal power in the reference channel or group of channel to the power in adjacent channels.

Min Hold

Digitally stored display mode which, at each frequency address, compares the incoming signal level to the stored level and retains the lower level. In this mode, the display indicates the minimum level at each frequency after several successive sweeps.

Modulate

To regulate or vary a characteristic of a signal, typically in order to transmit information.

Modulating Signal

The signal which modulates a carrier. The signal which varies or regulates some characteristic of another signal.

Modulation

The process of varying some characteristic of a signal with a second signal.

Noise

Unwanted random disturbances superimposed on a signal which tend to obscure it.

Noise Bandwidth (NBW)

The exact bandwidth of a filter that is used to calculate the absolute power in dBm/Hz.

Noise Floor

The noise intrinsic to a system that represents the minimum limit at which input signals can be observed; ultimately limited by thermal noise (kTB). The analyzer noise floor appears as a "grassy" baseline in the display, even when no signal is present.

Open (Recall)

Bring data into the application from a file of application-native format.

OQPSK

Acronym for Offset QPSK (Quadrature Phase Shift Keying).

Phase Settling Time

The time measured from a reference point to when the signal of interest settles to within user-defined tolerance.

PM

Acronym for Phase Modulation.

Primary Marker

The marker displayed in the Single Marker mode whose frequency and/or position is changed when tuning with the general purpose knob.

PSK

Acronym for Phase Shift Keying. The process, or result of a process, in which the carrier phase is varied discretely in accordance with a digital code.

QAM

Acronym for Quadrature Amplitude Modulation. The process, or result of a process, in which the amplitude and phase of the carrier are varied concurrently by synthesizing two orthogonal ASK waves (see ASK).

Real-Time Analysis

Measurement technique based on triggering on an RF signal, seamlessly capturing it into memory, and analyzing it in the frequency, time, and modulation domains.

Real-Time Bandwidth

The frequency span over which real-time seamless capture can be performed, which is a function of the digitizer and the IF bandwidth of a Real-Time Signal Analyzer.

Real-Time Seamless Capture

The ability to acquire and store an uninterrupted series of time domain samples that represent the behavior of an RF signal over a long period of time.

Reference Level

The signal level represented by the uppermost graticule line of the analyzer display.

Residual FM (Incidental FM)

Short term displayed frequency instability or jitter due to instability in the analyzer local oscillators. Given in terms of peak-to-peak frequency deviation and expressed in hertz or percent of the displayed frequency.

Residual Response

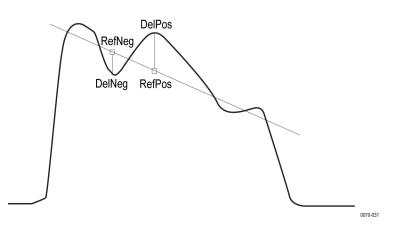
A spurious response in the absence of an input signal. (Noise and zero pip are excluded.)

RBW

The RBW determines how well the analyzer can resolve or separate two or more closely spaced signal components.

Ripple

The Ripple measurement result is displayed in either Watts or Volts. The amplitude units selected on the Setup > Analysis > Units tab determine whether the measurement is presented in Watts or Volts. Volts are shown for linear units (for example, volts or amps); Watts are shown for non-linear units (for example, watts or dBm).



The Ripple measurement, in Watts, is calculated as follows:

 $\% Ripple (Watts) = 100 \times (RatioPos + RatioNeg)$

Where:

$$RatioNeg = \left(\left(\left(\frac{DelNeg}{RefNeg} \right) + 1 \right)^2 \right) - 1$$
$$RatioPos = \left(\left(\left(\frac{DelPos}{RefPos} \right) + 1 \right)^2 \right) - 1$$

- DelPos = Delta Positive in Volts
- RefPos = Reference Positive in Volts
- DelNeg = Delta Negative in Volts (this is a positive value)
- RefNeg = Reference Negative in Volts

The Ripple measurement, in Volts, is calculated as follows:

%Ripple (Volts) = 100 × (RatioPosV + RatioNegV)

Where:

- RatioPosV = DelPos/RefPos
- RatioNegV = DelNeg/RefNeg

Secondary Marker

The "second" marker displayed only in the Delta Marker mode.

Sensitivity

Measure of a analyzer's ability to display minimum level signals, usually expressed as displayed average noise level (DANL (see page 540)).

Shape Factor (Skirt Selectivity)

The ratio of the frequency separation of the two (60 dB/3 dB) down points on the response curve to the static resolution bandwidth.

Signal

As used in this help, the signal refers to the input signal before it is processed. The signal is an input.

Span

Span is the range of frequencies displayed in a spectrum window. Span, start frequency and stop frequency are related by the following equation: Span = (stop frequency) - (start frequency). The settings for center, start and stop frequencies are related to the setting for span; when one parameter is changed, the others are changed automatically.

Span Per Division (Span/Div)

Frequency difference represented by each major horizontal division of the graticule.

Spectrogram

Frequency vs. time vs. amplitude display where the frequency is represented on the x-axis and time on the y-axis. The power level is indicated by variations in color.

Spectrum

The frequency domain representation of a signal showing the power distribution of its spectral component versus frequency.

Spectrum Analysis

The technique or process of determining the frequency content of an RF signal.

Spectrum Analyzer

A device for determining the frequency components of a signal.

Spectrum Time

Analysis Time for spectrum analysis views. Spectrum time can be the same as Analysis Time, but it can be different.

Spur

A spur is a signal peak that exceeds a user-definable threshold (See Spurious > Settings > Ranges) and excursion setting. A spur that also exceeds a limit (either Absolute or Relative) specified on the Settings > Limits tab is considered a violation.

Spurious Response

A response to a analyzer wherein the displayed frequency is not related to the input frequency.

Time Measurement

This is the time in seconds relative to the time reference point in the first acquisition record in the data set.

Time Reference

The point in time during the acquisition record used as the zero point for counting time. The time reference can be set to either the start of the acquisition record or the trigger point.

Trace

As used in this help, trace refers to the displayed signal. The displayed signal can be a processed version of the input signal (for example, it may be averaged.) The trace is a result or output.

Vector Signal Analyzer

Like a spectrum analyzer, a device for determining the frequency components of a signal. However, unlike a standard spectrum analyzer, the vector signal analyzer is optimized for analyzing digitally modulated RF signals.

Vertical Scale Factor, Vertical Display Factor

The number of dB, volts, etc., represented by one vertical division of a spectrum analyzer display screen.

Violation

A violation is a spur that exceeds either an Absolute or Relative limit (depending on the selected mask) specified on the Settings > Limits tab. A spur is a signal peak that exceeds a user-definable threshold (See Spurious > Settings > Ranges) and excursion setting.

Index

Symbols and Numbers

-6dB RBW (MIL) Filter shape Spectrum display BW tab, 71
20 dB bandwidth Bluetooth, 40
20dB Bandwidth display Bluetooth, 371
3-D Spectrogram display, 52
3-D Waterfall Spectrogram/DPXogram, 57

Α

Abort acquisition, 487 Accessories, 3 accuracy, 537 ACLR, 537 LTE, 40 ACPR measurement, 537 Acq Data Replay menu, 478 Acq Data/DPX Spectra, 477 Acquire control panel, 493 acquisition, 537 acquisition data saving, 515 Acquisition data files, 28 Acquisition Info tab, 478 acquisition memory usage, 488 Actions tab Search, 469 Triggering, 514 adaptive equalizer, 436 Adjacent Channel Power Ratio, 33 Advanced Params tab **OFDM** Analysis displays, 210 Advanced Params Tab **GP** Digital Modulation displays, 438 Advanced tab Triggering, 513 Advanced tab (Acquire), 489

Alignments Align Now, 19 Auto button, 19 Off button, 19 +AM, 38 AM display, 38 -AM AM display, 38 AM display, 77 AM measurements, 38 Amplitude control panel, 483 Amplitude vs. Time display, 59 Amplitude vs. Time display Settings, 60 Analysis control panel, 471 analysis length, 537 Analysis Params tab Bluetooth, 379 LTE, 337 P25 Analysis displays, 293 WLAN Analysis displays, 182 analysis time, 537 Analysis Time tab Bluetooth, 380 **GP** Digital Modulation displays, 441 LTE, 338 OFDM Analysis displays, 211 Options control panel, 27 P25 Analysis displays, 293 WLAN Analysis displays, 185 Analysis Time tab (Analysis control panel), 471 APCO P25 measurements, 39 application presets saving, 515 Application presets, 20 Apply ampl corrections, 251 APSK parameters, 439 Arm trigger status light, 496 arranging windows, 527

ASK, 538 Audio BW, 395 setting, 396 audio filters custom, 399 Audio Filters tab Audio Analysis displays, 398 Audio Freq Audio Summary display, 393 Audio Spectrum display, 391 Audio Spectrum settings, 392 Audio Summary settings, 394 Auto button (Alignments dialog), 19 automatically generate filenames, 26 Automatically increment filename/number, 28 Autosave acquisition on Trigger, 513 Average ON Power, 41 Average Transmitted Power, 41 Averaging Audio Analysis displays, 397 Params2 tab, 397

В

Base file name FastSave tab, 493 Basic Controls Toobar, 525 black text settling time measurements, 124 Blackman-Harris 4B Filter Shape Spectrum display BW tab, 71 Blizzard color scheme, 28 block, 538 Bluetooth Analysis Params tab, 379 Analysis Time tab, 380 BT 20dB Bandwidth display, 371 BT InBand Emission, 374

Freq & RBW tab, 388 Frequency Dev vs Time (BT) display, 367 Limits tab, 381 Measurement Params tab, 389 Parameters tab. 386 Power class, 378 Prefs tab, 385 Scale tab, 382 Trace tab, 383 Bluetooth measurements, 40 BT 20dB BW Settings, 373 BT CF Offset and Drift display, 356 settings, 321 **BT** Constellation display, 351 settings, 353 BT Eye Diagram display, 353 settings, 355 BT limits, 358 **BT** Summary display, 358 settings, 363 BT Symbol Table display, 363 settings, 366 Burst detect threshold, 87 **BW** Tab Amplitude vs. Time display, 60 DPXOgram display, 71 Spectrum display, 71

С

C4FM modulation type measurements, 38 C4FM signal quality measurements, 425 calibration, 20 *See also* Alignments calibrator, 538 Carr Freq Err Audio Summary display, 393 carrier, 538 carrier frequency, 538

Carrier frequency detection, 94 Carrier Frequency Error, 38 Carrier frequency offset and drift Bluetooth. 40 Carrier Power Audio Summary display, 393 carrier signal, 538 carrier-to-noise ratio (C/N), 538 CCDF, 33 CCDF - Complimentary **Cumulative Distribution** Function, 539 CCDF display, 114 CDMA, 539 Cell ID detection LTE, 40 center frequency, 539 Channel Power, 33 LTE, 41 **Channel Response** OFDM, 34 WLAN, 35 Channels tab LTE Analysis displays, 324 Channels tab (MCPR), 107 check mark indicator, 539 Check mark indicator, 13 CISPR, 539 **CISPR** Filter shape Spectrum display BW tab, 71 Classic color scheme, 28 configuring Presets, 22 Constellation OFDM, 34 WLAN, 35 Constellation display, 406 displaying a second trace, 444 Constellation display settings, 407 Convergence Equalizer tab, 437 correction tables, 483 creating a mask, 499 creating presets, 23 Creating presets, 20 CW, 539 CW signal, 540

D

DANL. 540 Data file formats, 516 Data properties File menu, 523 Data Range tab OFDM Analysis displays, 211 WLAN Analysis displays, 184 dBfs, 540 dBm, 540 dBmV. 540 dBuV, 540 **De-emphasis** Audio Filters tab, 399 decibel, 540 Default BT limits table, 358 P25 limits table, 280 default settings, restore, 19 Define Markers, 458 Define Peaks tab, 459 Define tab, 463 Pulsed RF displays, 250 Settling Time displays, 130 Delay Triggering, 513 Delta Frequency, 42 Delta Markers, 458 Demod I&Q vs Time display settings, 410 detect AM display, 81 FM display, 88 General Signal Viewing displays, 68 Time Overview, 47 Detect PM display, 96 detection, 541 AM display, 81 FM display, 88 General Signal Viewing displays, 68 Time Overview, 47 Detection PM display, 96

detector AM display, 81 FM display, 88 General Signal Viewing displays, 68 Time Overview, 47 Detector PM display, 96 Deviation, 38 Diff Audio Summary display, 394 Disabled - FastSave is selected, 492 display reference level, 541 Displays arranging, 31 BT CF Offset and Drift, 356 BT Constellation, 351 BT Eye Diagram, 353 BT Summary, 358 BT Symbol Table, 363 Frequency Settling Time, 121 interactions between, 31 LTE ACLR, 314 LTE Channel Spectrum, 317 LTE Constellation, 319 OFDM Channel Response, 191 OFDM Constellation, 194 OFDM EVM, 195 OFDM Mag Error, 199 OFDM Phase Error, 202 OFDM Power, 203 OFDM Spectral Flatness, 197 OFDM Summary, 205 OFDM Symbol Table, 207 P25 Constellation, 273 P25 Eye Diagram, 275 P25 Power, 278 P25 Summary, 280 P25 Symbol Table, 283 Phase Settling Time, 121 selecting, 31 SEM (Spectrum Emission Mask), 137 WLAN Channel Response, 157 WLAN Constellation, 160

WLAN EVM, 162 WLAN Mag Error, 164 WLAN Phase Error, 166 WLAN Power, 168 WLAN Spectral Flatness, 171 WLAN Summary, 173 WLAN Symbol Table, 178 distortion, 541 Dither Control, 489 documentation, 3 Done saving - restart with Stop, then Run, 492 DPX presets, 20 DPX Density Trigger, 497 DPX Spectra/Acq Data, 477 Droop, 41 Droop dB, 41 Duty Factor (%) measurement, 41 Duty Factor (Ratio) measurement, 41 dynamic range, 541

E

Elements of the display, 13 Enable EQ Export Equalizer tab, 437 Enable Equalization Equalizer tab, 437 Equalizer tab **GP** Digital Modulation displays, 436 error message Windows Event Viewer, 533 Error messages, 527 Event tab (Triggering), 503 Event Viewer, 533 EVM, 541 OFDM, 34 WLAN, 35 EVM tab WLAN Analysis displays, 189 EVM vs. Time display, 410 EVM vs. Time Settings, 411 export, 541 Ext Gain/Loss Table tab, 233 External Gain value, 483

External Gain/Loss Correction tab, 483 External Loss Tables, 483 Eye Diagram display settings, 414

F

Fall Time, 41 Fast Save, 490 See also FastSave FastFrame, 541 FastSave configuring, 491 overview, 490 starting, 491 status messages, 492 FastSave acquisition data FastSave tab, 493 FastSave tab, 493 FFT, 542 File formats, 516 File Menu, 521 File types, 516 filter, 542 Filter Parameter GP Digital Modulation displays, 431 Filter Shape Spectrum display BW tab, 71 Find tab **GP** Digital Modulation displays, 441 finding bursts in data GP Digital Modulation displays, 441 Flatness OFDM, 34 WLAN, 35 FlatTop (CW ampl) Filter Shape Spectrum display BW tab, 71 FM, 542 FM display, 83 FM measurements, 38 FMT (Frequency Mask Trigger), 499 Format FastSave tab, 493 frame, 542

Freq & BW tab RF I & Q vs Time display, 66 Freq & BW Tab GP Digital Modulation displays, 435 Freq & RBW tab Bluetooth, 388 Freq & Span tab General Signal Viewing displays, 67 Freq and RBW tab LTE, 335 Freq Deviation, 42 Freq Diff, Phase Diff setting, 252 Freq Error, 38 Freq Estimation tab Pulsed RF displays, 255 Freq Setup tab, 232 Freq, Span & RBW tab Channel Power & ACPR display, MCPR display, 106 **RF** Measurements displays, 149 Freq-domain Linearity setting, 250 frequency, 542 Frequency of local oscillator, 219 frequency band, 542 Frequency Dev vs Time (BT) display Bluetooth, 367 Frequency Dev vs Time (P25) display, 286 Frequency Dev vs. Time (BT) Settings, 371 Frequency Dev vs. Time (P25) Settings, 288 Frequency deviation P25, 39 Frequency Deviation vs. Time settings, 416 frequency domain view, 542 frequency drift, 543 Frequency Edge triggering, 507

Frequency Error, 36 **GP** Digital Modulation displays, 435 Frequency Mask Trigger (FMT), 495 Frequency Offset **GP** Digital Modulation displays, 435 frequency range, 543 Frequency range Bluetooth, 40 frequency settling time, 543 measuring, 126 Frequency Settling Time display, 121 Frequency Settling Time settings, 129 frequency span, 543 Frequency tab, 473 Frequency vs. Time display, 60 Frequency vs. Time Settings, 62 Front panel connectors, 7 Front panel controls, 7 Full Screen, 525

G

Gain and Noise Figure measurements, 218 Gain display, 220 Gain display settings, 221 Gain Imbalance, 423 GPIB, 543 GPIB tab, 26 graticule, 543 Graticule On/Off RF Measurements displays, 154 grayed out, 543

Η

Hanning Filter Shape Spectrum display BW tab, 71 HCPM transmitter logical channel time alignment P25, 40 Help Menu, 527 Hide sensitive readouts, 26 Hide Sensitive readouts, 27 Histogram readout Pulsed RF displays, 258 Holdoff Triggering, 513 HPF Audio Filters tab, 398 Hum & Noise Audio Summary display, 402 hysteresis, 508

I/Q, 544 IF, 544 Ignore Region Params2 tab, 397 import, 544 Impulse Response Amplitude, 42 Impulse Response setting, 251 Impulse Response Time, 42 In-band emission / ACPR Bluetooth, 40 InBand Emission Bluetooth, 374 Information messages, 527 input impedance, 544 Inside Time Qualified tab, 512 Installed options, 4 Intermediate Values tab Uncertainty Calculator Display, 230 Internal attenuator (Internal Settings tab), 483 IQ Origin Offset, 423 IQ vs. time view, 64 is greater than (Test), 464 is greater than mask, 463 is inside mask, 463 is inside mask (Test), 465 is less than (Test), 464 is less than mask, 463 is outside mask, 463 is outside mask (Test), 465

Κ

Kaiser (RBW) Filter Shape Spectrum display BW tab, 71 Keep-out time, 251 Keypad, 524

L

Length, 38 Equalizer tab, 437 Levels tab Pulsed RF displays, 255 Limit lines, 463 Limits BT default, 358 P25 default, 280 Limits tab Bluetooth, 381 P25 Analysis displays, 300 Link to Span, 66 LISN, 544 Local oscillator, 219 local oscillator (LO), 544 Location FastSave tab, 493 Lock Center Frequency of Spectrum displays, 473 Lock Center Frequency of Spectrum displays to Measurement Frequency Frequency tab, 474 Log Audio Spectrum display, 401 Log (Horizontal) Spectrum display, 52 Longer Time Qualified tab, 512 Loop over all selected records Replay menu, 478 LPF Audio Filters tab, 398 LTE Analysis Params tab, 337 Analysis Time tab, 338 Channels tab, 324 Freq and RBW tab, 335 Measurement Params tab, 336

Modulation Params tab, 337 Offsets and Limits Table tab, 329 Parameters tab, 326 Prefs tab, 332 Processing tab, 328 Scale tab. 330 Trace tab, 339 VBW (Channels tab), 325 VBW (Freq & RBW tab), 335 LTE ACLR display, 314 settings, 317 LTE Channel Spectrum display, 317 settings, 319 LTE Constellation display, 319 LTE measurements, 40

M

Mag Error, 424 OFDM, 34 WLAN, 35 Magnitude Error vs. Time display, 416 Magnitude Error vs. Time settings, 418 Main presets, 20 manuals, 3 marker, 545 Marker Noise mode, 461 Marker Properties tab, 458 Marker to Center Frequency, 458 Markers, 460 in the BT Symbol Table, 366 Marker Toolbar, 460 Using Markers, 455 Using Markers in Noise Mode, 461 Markers menu, 526 Markers snap to peaks when dragged, 29 Markers Toolbar, 524 Mask Editor, 463 Mask tab Settling Time displays, 133

Mask Test, 463 is greater than mask, 463 is inside mask, 463 is less than mask, 463 is outside mask, 463 mask testing settling time measurement, 117 MATLAB file format, 516 Max files saved per Run FastSave tab, 493 Max Freq Error, 42 max hold, 545 Max number of pulses Pulse Table display, 248 Max Number of Pulses Params tab, 249 Max Phase Error, 42 Max total files saved per Run, 514 Max trace points, 64 Settling Time displays, 137 MCPR (multiple carrier power ratio), 545 MCPR display, 101 MCPR settings, 105 Meas BW Frequency Settling Time, 130 Meas Frequency Frequency Settling Time, 130 Measurement BW, no filter, 66 Measurement Filter GP Digital Modulation displays, 431 Params tab, 249 Measurement Frequency, 473 Frequency tab, 474 Measurement Length Time Params tab, 132 Measurement Params tab Bluetooth, 389 Channel Power & ACPR display, MCPR display, 107 LTE, 336 Measurement point, 252 Measurement settings export, 515 Measurements, 33 APCO P25, 39

Bluetooth, 40 LTE, 40 Measurements tab, 243 measuring settling time, 126 Menus, 521 MER (RMS), 424 min hold. 545 Min Settled Duration Time Params tab, 132 Mod Distor Audio Summary display, 394 Mode Equalizer tab, 437 modulate, 545 modulating signal, 545 modulation, 546 Modulation characteristics Bluetooth, 40 Modulation fidelity P25, 39 modulation measurements, 405 Modulation measurements, 36 Modulation Params tab **GP** Digital Modulation displays, 431 LTE, 337 **OFDM** Analysis displays, 209 P25 Analysis displays, 290 WLAN Analysis displays, 181 Modulation types supported, 431 moving windows, 527 Multi-Carrier Power Ratio, 33 Multiple Carrier Power Ratio, 105

Ν

Navigator View, 524 Network Connections, 17 nFSK modulation type measurements, 38 nFSK signal quality measurements, 424 No. of Harmonics Params2 tab, 397 No. of Non-Harmonics Params2 tab, 397 noise, 546 Noise Params tab, 235 noise bandwidth (NBW), 546 Noise Figure and Gain measurements, 218 Noise Figure display, 222 Noise Figure display settings, 222 noise floor, 546 Noise markers, 461 Noise measurements, 39 Noise Source tab, 233 Noise Table display, 218 Noise Table settings, 219 Noise Temperature display, 223 Noise Temperature display settings, 224 Non-Harmonic Excursion Params2 tab, 397 Non-Harmonic Threshold Params2 tab, 397 Numeric keypad, 524

0

OBW Level Left/Right, 110 OBW Ref Power, 110 Occupied bandwidth LTE, 41 Occupied Bandwidth, 112 Occupied Bandwidth settings, 112 Occupied BW display, 110 **OFDM Channel Response** display, 191 settings, 193 **OFDM** Constellation display, 194 settings, 195 OFDM EVM display, 195 settings, 196 OFDM Mag Error display, 199 settings, 200 **OFDM Phase Error** display, 202 **OFDM** Power display, 203 settings, 204

OFDM Spectral Flatness display, 197 settings, 198 **OFDM Summary** display, 205 settings, 206 **OFDM Symbol Table** display, 207 settings, 208 Off button (Alignments dialog), 19 Offset & Limits Table tab SEM display, 144 Offset EVM. 424 Offsets and Limits Table tab LTE, 329 online help, 521 open (recall), 546 Operating band unwanted emission LTE. 41 Operating frequency accuracy P25, 39 operating system restore, 29 Optimization Channel Power & ACPR display, MCPR display, 107 Options installed, 4 Options control panel, 26 OQPSK, 546 **OQPSK and SOQPSK modulation** type measurements, 37 Out-of-band spurious emission Bluetooth, 40 Output power Bluetooth, 40 Outside Time Qualified tab, 512 Overlap, 55 Overshoot, 42 Overshoot dB, 42 Overshoot settings, 253 Overview tab, 231

Index

Ρ

P25 presets, 20 P25 Constellation display, 273 settings, 275 P25 Eye Diagram display, 275 settings, 277 P25 limits, 280 P25 measurements, 39 P25 Power vs Time display, 278 settings, 279 P25 Summary display, 280 settings, 283 P25 Symbol Table display, 283 settings, 285 Parameters tab AM display, 79 Bluetooth, 386 CCDF display, 116 FM display, 87 LTE, 326 Occupied BW display, 113 PM display, 94 SEM display, 142 Params tab Noise, 235 Pulsed RF displays, 248 Params1 tab Audio Analysis displays, 395 Params2 tab Audio Analysis displays, 397 Pass /Fail readout SEM display, 139 Pass/Fail tests, 464 Pause Replay menu, 479 +Peak Audio Summary display, 393 -Peak Audio Summary display, 393 Peak Excursion, 458 Peak FSK err, 38

Peak Mag Err, 38 Peak Power, 41 Peak Threshold, 458 Peak/Avg Ratio, 33 Peak-Peak/2 Audio Summary display, 393 Phase Deviation. 42 Phase Error, 424 OFDM, 34 WLAN, 35 Phase Error vs. Time display, 418 Phase Error vs. Time settings, 420 phase settling time, 546 measuring, 126 Phase Settling Time display, 121 Phase Settling Time settings, 125 Phase vs. Time display, 62 Phase vs. Time settings, 64 pictures saving, 515 +PkFM display, 38 PM display, 39 -Pk FM display, 38 PM display, 39 Pk-Pk FM display, 38 PM display, 39 Pk-Pk/2 FM display, 38 PM, 547 PM measurements, 39 Position Triggering, 513 Power OFDM, 34 Power class Bluetooth, 378 Power density Bluetooth, 40 Power Markers, 458 power measurements, 101 Power measurements, 33 Power Threshold to Detect Pulses Params tab, 249 Power vs Time WLAN, 35

Pre-defined Filters Audio Filters tab, 398 Prefs tab, 239 AM display, 83 Bluetooth, 385 FM display, 91 General Signal Viewing Displays, 74 GP Digital Modulation displays, 445 LTE, 332 **OFDM** Analysis displays, 215 Options control panel, 26 P25 Analysis displays, 299 PM display, 99 Pulsed RF displays, 258 **RF** Measurements displays, 154 Settling Time displays, 137 WLAN Analysis displays, 190 presets, 23 Presets, 20 Application, 20 configuring User, 22 DPX, 20 Main, 20 P25, 23 recalling, 22 Standards, 20 User, 20 WLAN, 23 Presets tab Options control panel, 26 primary marker, 547 Print. 523 Print Preview, 524 Processing tab LTE, 328 SEM display, 143 PSK, 547 Pulse measurements, 41 Pulse Statistics display, 245 Pulse Statistics display settings, 247 Pulse Table display, 241 Pulse Table settings, 242

Pulse Trace display, 243 Pulse Trace display settings, 245 Pulse Width, 41 Pulse-Pulse Freq Difference, 42 Pulse-Pulse Phase Difference, 42 pulses how many can be analyzed, 249

Q

QAM, 547 Quadrature Error, 36

R

Range file, 516 RBW, 548 Channel Power & ACPR display, MCPR display, 106 Ready trigger status light, 496 real-time analysis, 547 real-time bandwidth, 547 real-time seamless capture, 548 rear panel connectors, 17 recalling Presets, 22 red text settling time measurements, 124 Ref Audio Summary display, 394 Ref Channel tab SEM display, 144 **Ref level** (Internal Settings tab), 483 **Reference** Filter GP Digital Modulation displays, 431 reference level, 548 Relative power Bluetooth, 40 Repeat, 487 Repetition Interval, 41 Repetition Rate, 41 Replay all selected records Replay menu, 478 Replay control panel, 477

Replay current record Replay menu, 478 Replay from selected Replay menu, 478 Replay menu, 478 Replay Speed tab, 478 Replay toolbar, 480 Replay menu, 479 **Reset Equalization** Equalizer tab, 437 residual FM (incidental FM), 548 residual response, 548 results saving, 515 Resume, 487 RF I & Q vs. Time display, 64 RF I & O vs. Time settings, 65 RF output power P25, 39 Rho, 36 Ripple, 41 Ripple dB, 41 ripple measurement calculation, 548 Ripple settings, 253 Rise Time, 41 RMS Audio Summary display, 393 FM display, 38 PM display, 39 RMS Error Magnitude, 38 RMS FSK Err, 38 RMS Mag Err, 38 RMS Phase Error, 42 Run, 487

S

S/N Audio Summary display, 394 Sampling Parameters Tab, 488 Save acq data on Trigger, 514 Save and Export tab, 26 Options control panel, 28 Save on trigger, 514 Save picture on Trigger, 514 saved file types, 515 saving acquisition data, 515

pictures, 515 presets, 23 results, 515 setups, 515 Saving presets, 20 Saving and Recalling Data, 515 Saving X of XX, 492 Scale tab, 238 AM display, 82 Audio Analysis displays, 400 Bluetooth, 382 FM display, 90 General Signal Viewing displays, 73 **GP** Digital Modulation displays, 445 LTE, 330 **OFDM** Analysis displays, 213 P25 Analysis displays, 296 PM display, 98 Pulsed RF displays, 257 **RF** Measurements displays, 153 SEM display, 147 Settling Time displays, 136 Spectrogram display, 57 Spectrum display, 52 WLAN Analysis displays, 187 Search control panel, 469 Search In, 464 secondary marker, 549 Security tab, 26 Options control panel, 27 Select all Replay menu, 479 Select data records tab, 477 Select records from history Replay menu, 479 SEM display, 137 sensitivity, 550 Set to max BW, 66 Settings, 535 AM display, 78 Audio Spectrum display, 392 Audio Summary display, 394 BT 20dB BW, 373 BT CF Offset and Drift, 321 BT Constellation, 353 BT Eye Diagram, 355 BT Frequency Dev vs. Time, 371 BT Summary, 363 BT Symbol Table, 366 CCDF display, 115 Constellation display, 407 Demod I&Q vs Time display, 410 EVM vs. Time display, 411 Eye Diagram display, 414 FM display, 85 Frequency Deviation vs. Time, 416 Frequency Settling Time, 129 Frequency vs. Time, 62 Gain display, 221 LTE ACLR, 317 LTE Channel Spectrum, 319 Magnitude Error vs. Time, 418 MCPR, 105 Noise Figure display, 222 Noise Table display, 219 Noise Temperature display, 224 Occupied Bandwidth, 112 OFDM Channel Response, 191 OFDM Constellation, 195 OFDM EVM, 196 OFDM Flatness, 198 OFDM Mag Error, 200 OFDM Phase Error, 202 OFDM Power, 204 OFDM Summary, 206 OFDM Symbol Table, 208 Options control panel, 26 P25 Constellation, 275 P25 Eye Diagram, 277 P25 Frequency Dev vs. Time, 288 P25 Power vs Time, 279 P25 Summary, 283 P25 Symbol Table, 285

Phase Error vs. Time, 420 Phase Settling Time, 125 Phase vs. Time, 64 Pulse Statistics display, 247 Pulse Table display, 242 Pulse Trace display, 245 restoring defaults, 19 RF I & Q vs. Time, 65 Signal Quality, 425 Spectrogram display, 55 Spectrum display, 51 Spectrum Emission Mask, 141 Symbol Table display, 427 Time Overview display, 45 Trellis Diagram display, 429 Trigger, 502 Uncertainty Calculator display, 229 WLAN Channel Response, 157 WLAN Constellation, 161 WLAN EVM, 163 WLAN Mag Error, 165 WLAN Phase Error, 167 WLAN Power vs Time, 170 WLAN Spectral Flatness, 172 WLAN Summary, 177 WLAN Symbol Table, 180 Y Factor display, 226 Settings tab, 236 Settled Frequency definition, 116 Settled Phase definition, 117 settling time measuring, 126 Settling Time, 116 definition, 116 Settling Time decimal places Settling Time displays, 137 settling time measurement text color, 124 Setup Menu, 526 setups saving, 515 shape factor (skirt selectivity), 550

Shorter Time Qualified tab, 512 Show graticule General Signal Viewing Displays, 74 Pulsed RF displays, 258 Settling Time displays, 137 Show Marker Readout in Graph General Signal Viewing Displays, 74 Pulsed RF displays, 258 **RF** Measurements displays, 154 Settling Time displays, 137 Show recalled trace, 68 AM display, 80 FM display, 88 PM display, 95 Time Overview display, 47 signal, 550 Signal Power Audio Summary display, 393 Signal Quality display, 420 Signal quality measurements, 423 Signal Quality settings, 425 SINAD Audio Summary display, 393 span, 550 span per division, 550 Span/RBW Ratio Spectrum display BW tab, 71 spectrogram, 550 Spectrogram display, 52 Spectrogram display settings, 55 spectrum, 551 spectrum analysis, 551 spectrum analyzer, 551 Spectrum Center Frequency, 473 Frequency tab, 474 Spectrum display, 49 Spectrum display settings, 51 Spectrum Emission Mask display, 137 settings, 141 Spectrum Monitor Spectrogram, 58 spectrum time, 551 Spectrum Time tab, 473

Spectrums/line, 55 spur, 551 spurious response, 551 Standard Audio Filters tab, 398 Standard Settings button, 430 Standards presets, 20 Standards presets P25, 23 WLAN, 23 Status Bar, 525 Stop Replay menu, 479 Summary WLAN, 35 symbol maps, 446 Symbol Rate, 38 Symbol rate accuracy P25, 39 Symbol Rate Error, 38 Symbol Table WLAN, 35 Symbol Table display, 426 Symbol Table display settings, 427

T

Taps Equalizer tab, 437 Taps/Symbol Equalizer tab, 437 Target Reference Frequency Settling Time, 130 Test For, 464 Test Patterns tab P25 Analysis displays, 295 Test using a mask, 465 THD Audio Summary display, 394 Thunderstorm color scheme, 28 Time, 42 Time & Freq Scale tab Spectrogram display, 57 Time 1 / Time 2 Time Qualified tab, 512 time measurement, 551 Time Overview, 43

Time Overview display settings, 45 Time Params tab Settling Time displays, 132 Time Qualified tab, 512 time reference, 552 time scale status readout. 55 TIQ acquisition data files, 28 TIQ acquisition data files parameters, 27 TNHD Audio Summary display, 394 TOFF LTE, 41 Tolerance (+/-)Frequency Settling Time, 131 Tools Menu, 526 Total AM AM display, 38 Touch Screen, 11 Touch Screen Off. 7 Touch-screen Actions, 11 trace, 552 Trace 2 Constellation display, 444 Trace tab AM display, 80 Bluetooth, 383 FM display, 88 GP Digital Modulation displays, 443 LTE, 339 **OFDM** Analysis displays, 213 P25 Analysis, 296 PM display, 95 Settling Time displays, 133 Time Overview display, 47 WLAN Analysis displays, 186 Traces tab, 237 General Signal Viewing displays, 68 **RF** Measurements display, 150 Spectrogram display, 56 WLAN Channel Response

LAN Channel Ro display, 186

Traces tab - Math Trace General Signal Viewing displays, 71 Traces Toolbar, 524 Transform Window Spectrum display BW tab, 71 Transmitter frequency behavior P25, 40 Transmitter power and encoder attack time P25, 39 Transmitter power and encoder attack time with busy/idle P25. 39 Transmitter throughput delay P25, 40 Trellis Diagram display settings, 429 Trig Meas tab P25 Analysis displays, 298 Trig'd trigger status light, 496 Trigger On This, 497 Trigger settings, 502 Advanced tab, 513 Event tab, 503 trigger status lights, 496 triggering frequency mask trigger, 495 Tutorials YouTube videos, 5

U

Uncertainty Calculator display, 227 Uncertainty Calculator settings, 229 Uncertainty tab Uncertainty Calculator Display, 229 Uniform (None) Filter Shape Spectrum display BW tab, 71 Units tab, 476 Unwanted emissions (ACPR) P25, 39 **User Filters** file format, 452 loading, 451 User presets, 23

User Symbol Map, 440

V

VBW, 52 LTE, 325 **RF** Measurements displays, 149 Spectrum display BW tab, 71 vector signal analyzer, 552 vertical scale factor, vertical display factor, 552 Video tutorials, 5 View Basic Controls Toolbar, 525 Full Screen, 524 Markers Toolbar, 524 Navigator View, 524 Numeric keypad, 524 Replay Toolbar, 524 Status Bar, 525 Traces Toolbar, 524 View Menu, 524 violation, 552 violation (frequency mask trigger), 509

W

watch icon, 512 Waterfall Spectrogram/DPXogram, 57 Window menu, 527 Windows Event Viewer, 533 WLAN presets, 20 video tutorials, 5 WLAN Channel Response display, 157 settings, 157 WLAN Constellation display, 160 settings, 161 WLAN EVM display, 162 settings, 163 WLAN Mag Error display, 164 settings, 165 WLAN Phase Error display, 166 WLAN Power vs Time display, 168

settings, 170 WLAN Spectral Flatness display, 171 settings, 172 WLAN Summary display, 173 settings, 177 WLAN Symbol Table display, 178 settings, 180

Х

x dB BW Ref Power, 110 x dB Level, 113

Υ

Y Factor display, 225 Y Factor display settings, 226 YouTube Tektronix channel, 5