Tektronix®

RSA5100B Series
Real-Time Signal Analyzers
Help

Register now!
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www.tek.com/register

077-0899-07

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- In North America, call 1-800-833-9200.
- Worldwide, visit to *www.tek.com* find contacts in your area.

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Welcome

This Help provides in-depth information on how to use the RSA5100B Series Real-Time Signal Analyzers. For a shorter introduction to the Signal Analyzer, refer to the *RSA5100B 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 *RSA5100B Series Real-Time Signal Analyzer Application Examples Reference*.

About the Tektronix signal analyzer

Product software

The instrument includes the following software:

- **System software**: The RSA5100B Series product software runs on a specially configured version of Windows 10. As with standard Windows 10 installations, you can install other compatible applications, but the installation and use of non-Tektronix software is not supported by Tektronix. 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.

Occasionally, new versions of software for your instrument may become available at our Web site. Visit *www.tektronix.com/software* for information.

Software and hardware upgrades

Tektronix may offer software or hardware upgrade kits for this instrument. Contact your local Tektronix distributor or sales office for more information.

Software upgrades

Tektronix may offer upgrade kits for this software. Contact your local Tektronix distributor or sales office for more information.

Accessories

Standard accessories

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

Quick Start User Manual

- English - Option L0, Tektronix part number 071-3224-XX
- Japanese - Option L5, Tektronix part number 071-3225-XX
- Simplified Chinese - Option L7, Tektronix part number 071-3226-XX
- Russian, Option L10, Tektronix part number 071-3227-XX

Application Examples Reference

- English – Tektronix part number 071-3283-XX
- Japanese - Option L5, Tektronix part number 071-3284-XX
- Simplified Chinese - Option L7, Tektronix part number 071-3285-XX
- Russian, Option L10, Tektronix part number 071-3286-XX

Product Documentation CD-ROM

The Product Documentation CD-ROM contains a collection documentation available for your product, in PDF format. See *Documentation* for a list of the documents included on the CD-ROM.

Note: To check for updates to the instrument documentation, browse to *www.tektronix.com/manuals* 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 optional application licenses (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.

Application licenses can be added to your instrument. For the latest information on available licenses, see the *Tektronix Web site*.

Documentation and support

Documentation

In addition to the instrument Help, the following documents are available. For the most current product documentation, application, and solutions information, visit the Tektronix Web site *www.tektronix.com/downloads*.

- **Quick Start User Manual** (071-3224-XX - English). This manual has information about installing and operating your instrument. This manual is also available in Japanese (071-3225-XX), Simplified Chinese (071-3226-XX), and Russian (071-3227-XX). These manuals are available in both print and a printable PDF file.
- **Application Examples Reference** (071-3283-XX). This manual provides examples of how to solve problems using an RSA5100B Series Signal Analyzer. This manual is also available in Japanese (071-3284-XX), Simplified Chinese (071-3285-XX), and Russian (071-3286-XX). These are available in both print and a printable PDF file.
- **Programmer Manual** (077-00901-XX). This manual provides information to use commands for remotely controlling your instrument. This is available as a printable PDF file.
- **Service Manual** (077-0903-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** (077-0900-XX). This manual includes both the specifications and the performance verification procedures. This is available as a printable PDF file.
- **Declassification and Security Instructions** (077-0902-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 *www.tektronix.com/manuals*. You can find the manuals by searching on the product name.

Where to find more information

You can find all product related documentation on the Tektronix Web site at *www.tek.com/manuals*. Browse *www.tek.com* for additional information related to applications and solutions.

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.

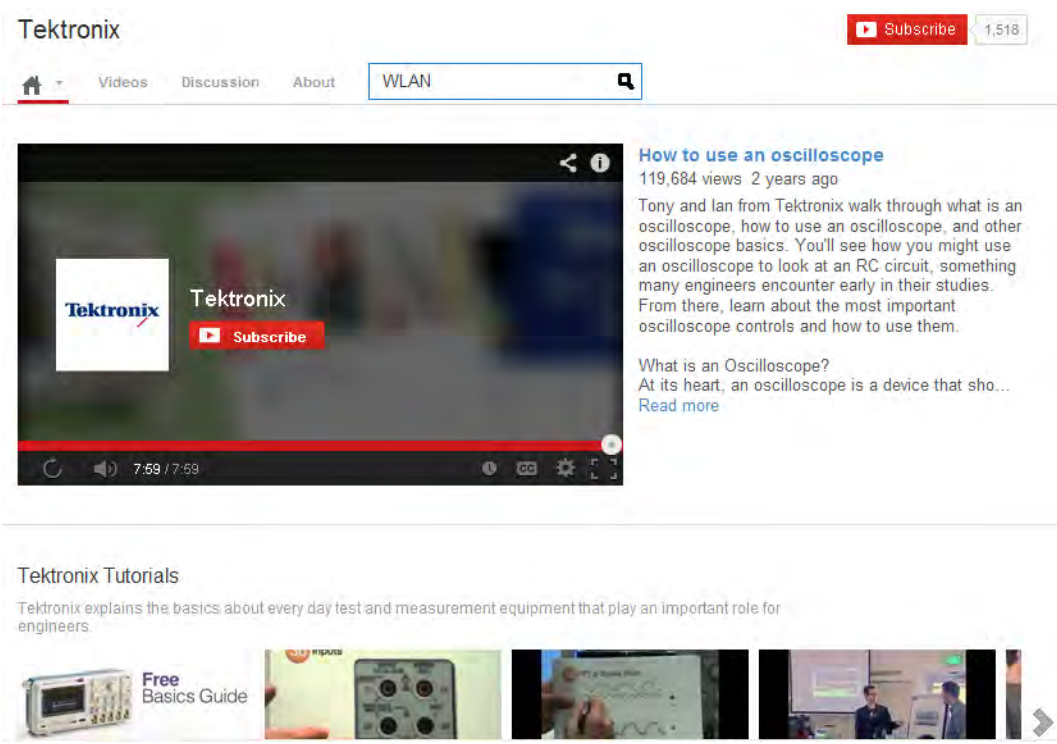
Searching for topics

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.

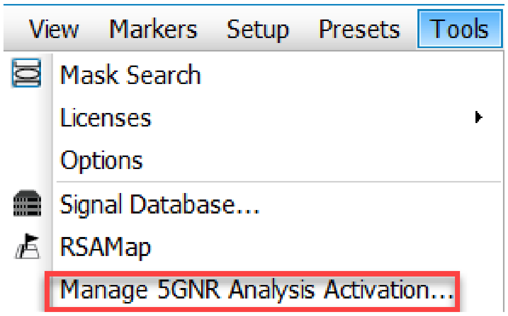


How to manage the 5GNR analysis license

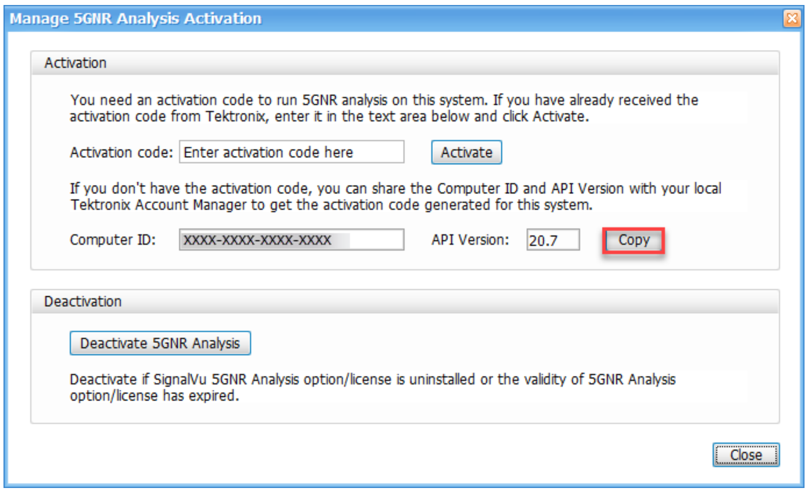
After installing the Tek RSA5100B 5GNR Analysis plugin, it needs to be activated on that instrument/PC/laptop. The activation requires an activation code which is 20 digit alphanumeric characters separated by a hyphen between every four characters. The following topics give procedure to activate or deactivate the 5GNR Analysis.

5GNR Analysis activation

1. Start the Tek RSA5100B application.
2. On the **Tools** menu, click **Manage 5GNR Analysis Activation…**. The **Manage 5GNR Analysis Activation** dialog box appears.

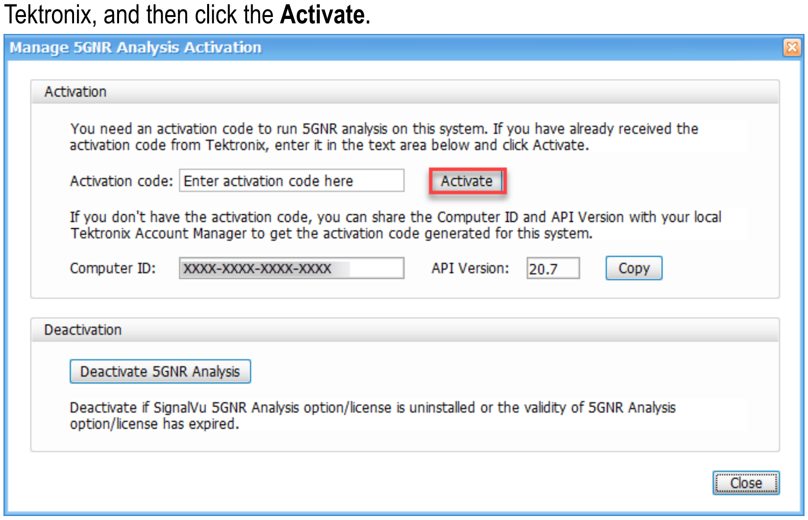


3. If you do not have the activation code, under **Activation**, click **Copy**, and then close the **Manage 5GNR Analysis Activation** dialog box.



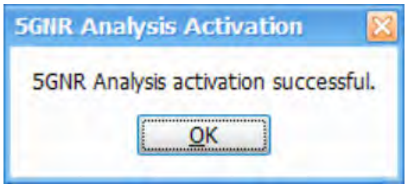
Note: Share the *Computer ID* and *API Version* that you have copied with your local Tektronix account manager to get the activation code generated for this system.

4. If you have the activation code, under **Activation**, in the **Activation code** box, enter the activation code that you received from Tektronix, and then click the **Activate**.



5. If you receive the “5GNR Analysis activation failed. Please enter a valid activation code.” message, click **OK**, and then contact your local Tektronix support or Account Manager to get the correct activation code.

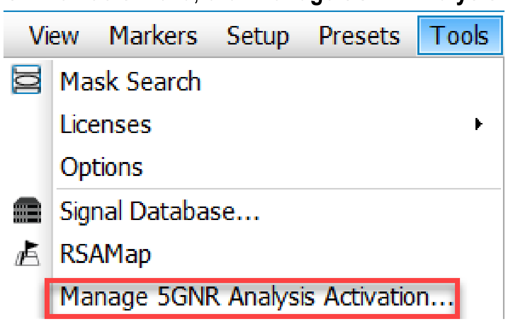
6. If you receive the “5GNR Analysis activation successful” message, click **OK**.



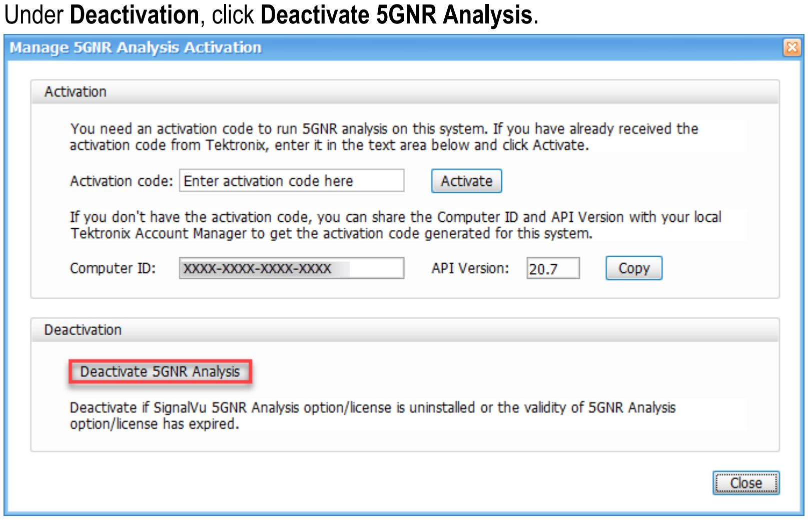
7. Close the **Manage 5GNR Analysis Activation** dialog box and restart the Tek RSA5100B application.

5GNR Analysis de-activation

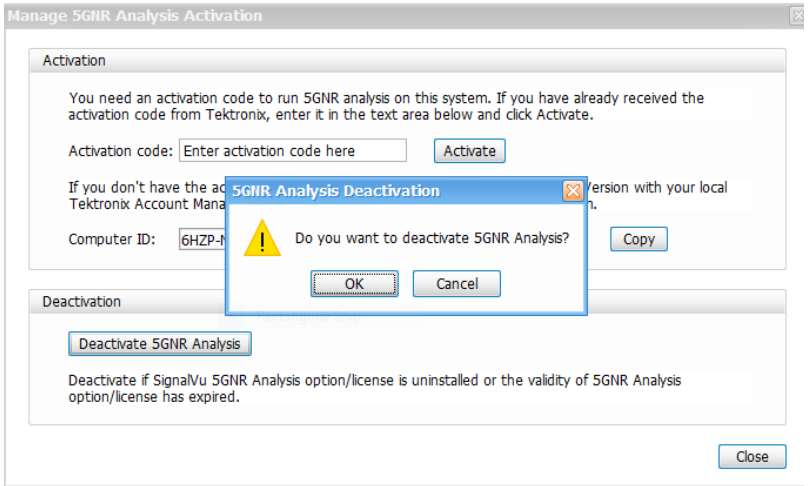
1. Start the Tek RSA5100B application.
2. On the **Tools** menu, click **Manage 5GNR Analysis Activation…**. The **Manage 5GNR Analysis Activation** dialog box appears.



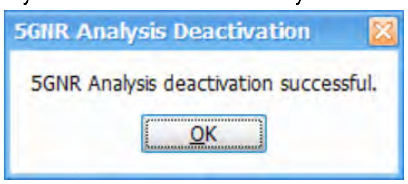
3. Under **Deactivation**, click **Deactivate 5GNR Analysis**.



4. Click **OK** and continue with 5GNR Analysis de-activation.

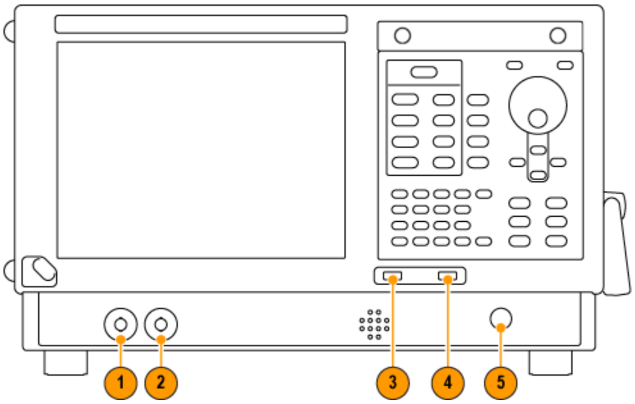


5. If you receive the “5GNR Analysis deactivation successful” message, click **OK**, and then restart the Tek RSA5100B application.



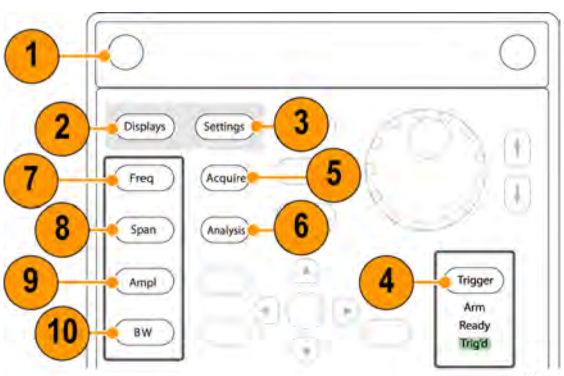
Orientation

Front panel connectors



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

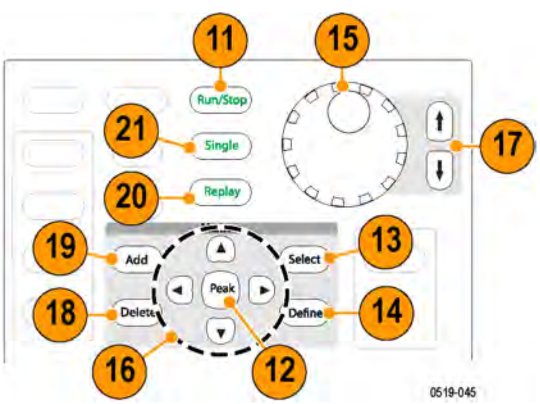
Front-Panel controls



Reference	Item	Function	Menu Equivalent
1	Media	Removable hard disk drive (optional).	

Table continued…

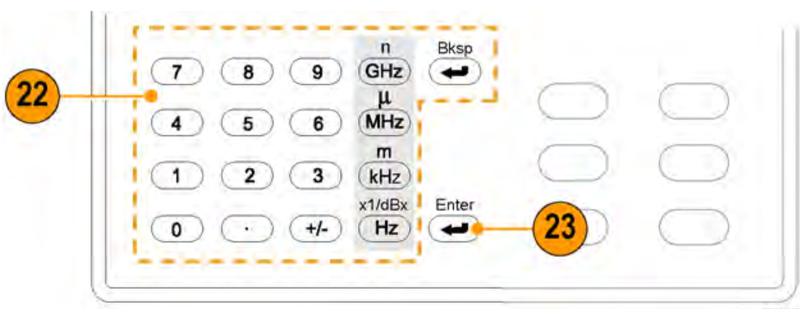
Reference	Item	Function	Menu Equivalent
2	Displays	Opens the Displays dialog box enabling you to select which displays to open.	Setup > Displays
3	Settings	Opens/closes the Settings control panel for the selected display.	Setup > Settings
4	Trigger	Opens/closes the Trigger control panel.	Setup > Trigger
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

Table continued…

Reference	Item	Function	Menu Equivalent
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/decrement 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.

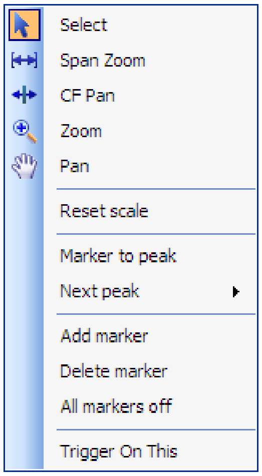
To disable the touch screen, push the front-panel **Touch Screen Off** button. When the touch screen is off, the button is lighted. You can still access the on-screen controls with a mouse or keyboard.

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.

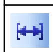
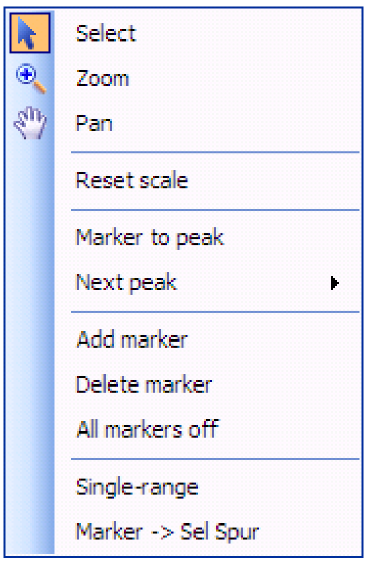
Icon	Menu	Description
	Select	Selects markers and adjusts their position.
	Span Zoom	Zooms the graph area about the selected point. Touch the graph display at a point of interest and drag to increase or decrease the span about the point of interest. Span Zoom adjusts the span control and can affect the 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).
	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.

Table continued…

Icon	Menu	Description
-	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

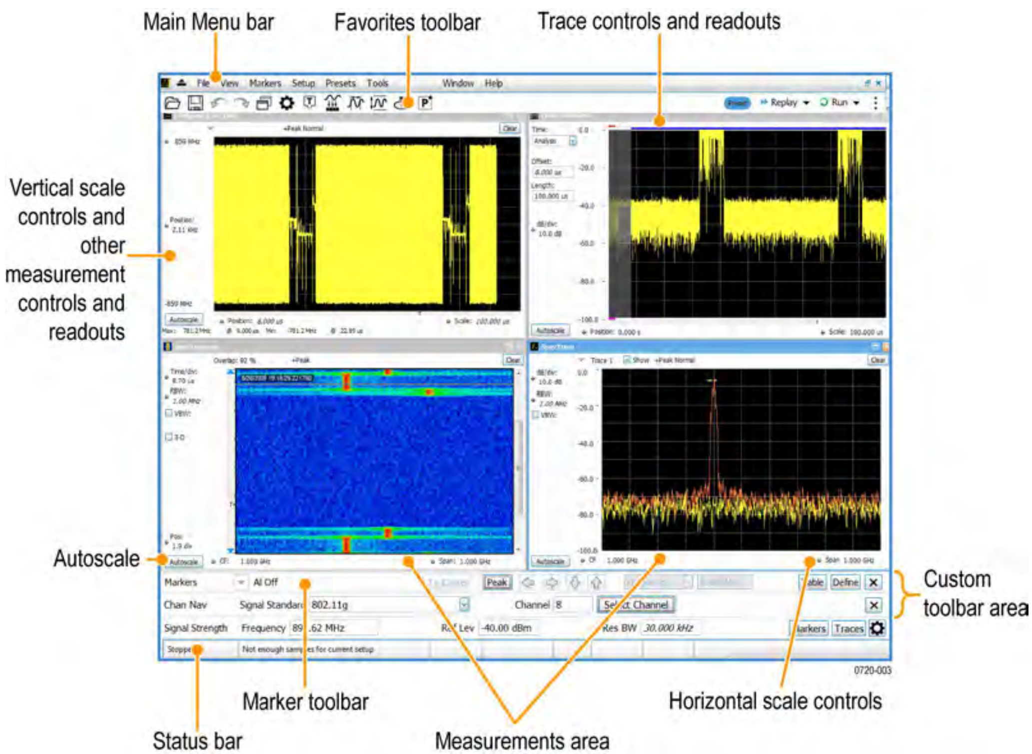
The Touch-screen actions menu in the Spurious display has some minor changes compared to the standard version used in other displays.



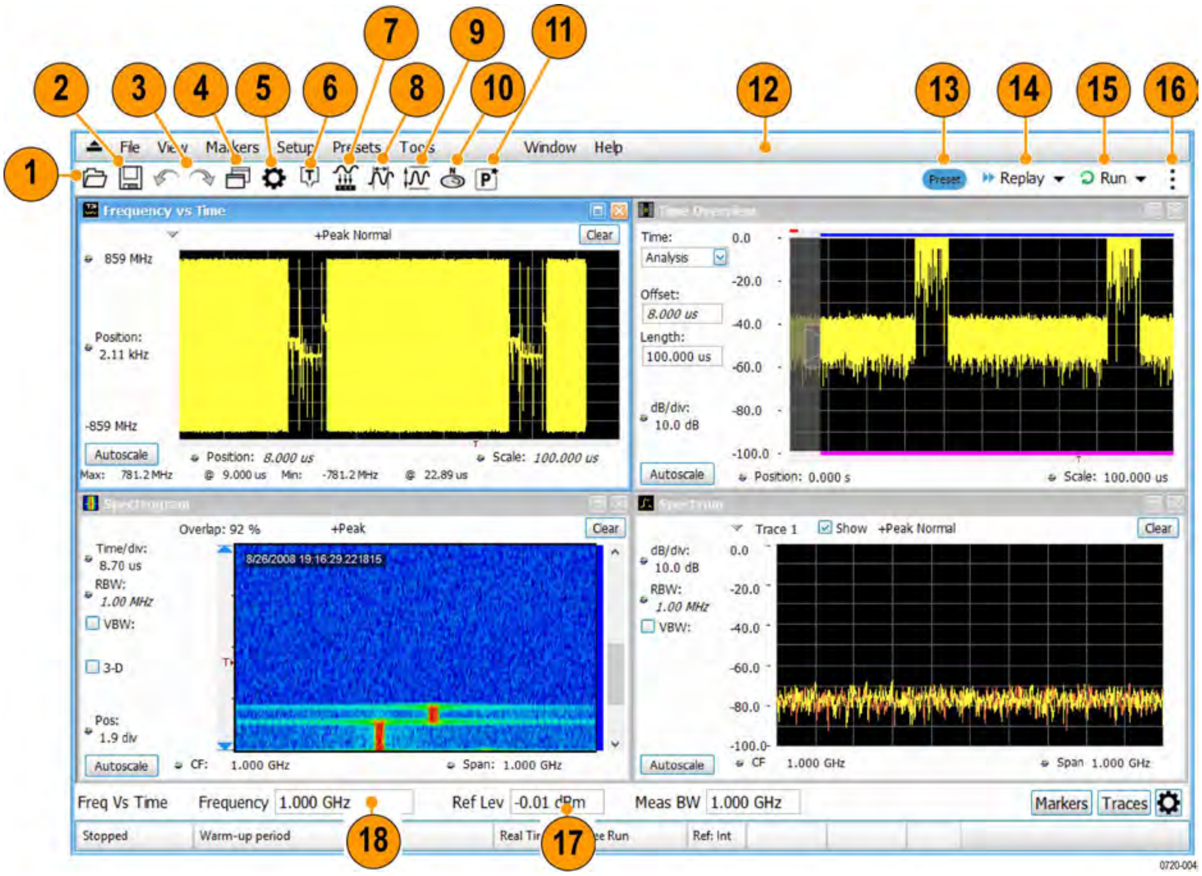
Icon	Menu	Description
-	Single-range	Changes the current multi-range display to a single range display. The displayed range is the range in which you display the touchscreen-actions menu. Selecting Single-range from the menu is equivalent to selecting Single on the Settings > Parameters tab.
-	Multi-range	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

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



Specific elements of the application display window. Specific elements of the display are shown in the following figure. More detailed information is available in the Menus section.



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.
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	Settings	Opens the Settings control panel for the selected display. Each display has its own control panel.
6	Trigger	Opens the Trigger control panel so that you can define the instrument trigger settings.
7	Acquire	Opens the Acquire control panel, which displays the Sample Rate and Record length of the recalled waveform file.
8	Analysis	Opens the Analysis control panel so that you can define the analysis settings such as frequency, analysis time, and units.
9	Amplitude	Opens the Amplitude control panel so that you can define the Reference Level, configure internal attenuation, and specify external gain/loss corrections.
10	GNSS/Antenna	Opens the GNSS/Antenna control panel so that you can configure and activate an external GNSS receiver and antenna.

Table continued…

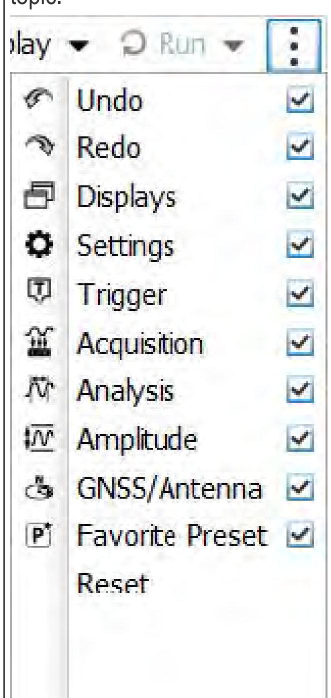
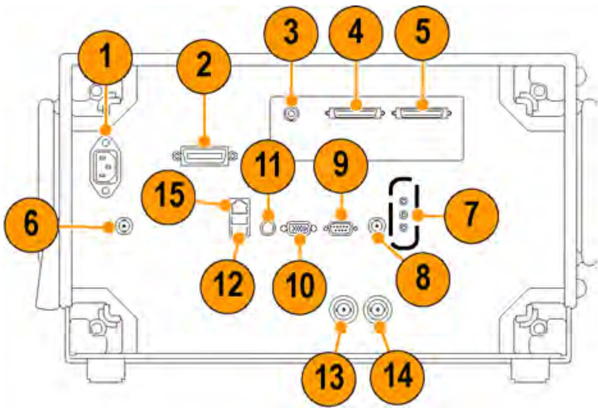
Ref number	Setting	Description
11	Favorite User Presets	Click to select from a list of custom favorite User presets and load the selected preset. For more detailed information, see the Make a User preset a Favorite preset topic.
12	Main menu bar	Located above the Favorites toolbar, it contains access to menus. For detailed information, see the Main Menu (see page 780) topic.
13	Preset	Recalls the Main preset.
14	Replay	Runs a new measurement cycle on the last acquisition data record using any new settings. See the Replay menu topic for more details.
15	Run and Run/Stop toolbar	• Run menu and Run/Stop toolbar Starts and stops data acquisitions and specifies the run conditions. For example, if you select Single in the Run/Stop toolbar (or Run Single in the Run menu), a single measurement cycle is run. If you select Continuous in the Run/Stop toolbar (or Run Continuous in the Run menu), the data acquisition runs until stopped. • Run menu The Run menu also includes Resume and Abort. Resume restarts data acquisition, but does not reset accumulated results, such as Average or MaxHold. This allows you to stop acquisitions temporarily, then continue. Abort immediately halts the current acquisition/measurement cycle. In-process measurements and acquisitions are not allowed to complete. See the Run menu topic for more details.
16	⋮	The Edit Favorites icon allows you access the below menu, which allows you to edit the contents of the Favorites bar. For more information, see the Favorites bar topic. 

Table continued…

Ref number	Setting	Description
17	Reference Level	Displays the reference level. To change the value, click the text and enter a number using a keyboard, or use a mouse scroll wheel.
18	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.

Rear-Panel connectors



Item	Description
1	AC Input, main power connector
2	GPIB
3	Zero Span Analog Output (Option 66)
4,5	Digital I and Q Outputs (Option 65)
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

Table continued…

Item	Description
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.

Operating your instrument

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
- Run alignments only when the **Align** or **Align All** button is pressed (only available for instruments with an HD option installed).

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.

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

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

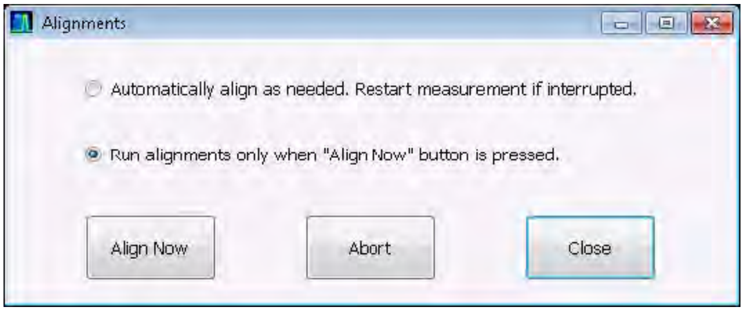
Alignment Status

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.

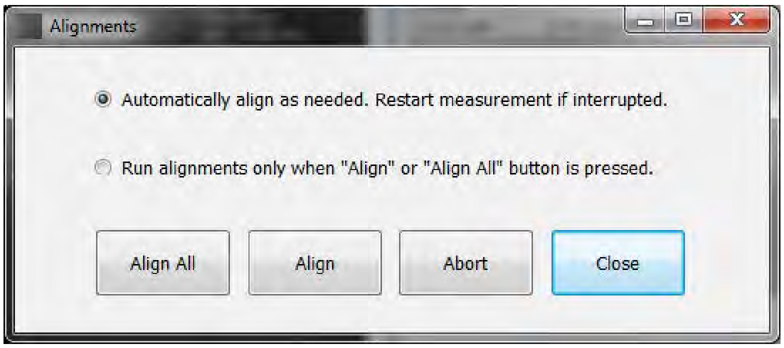
Note: If you must use the instrument before it has completed its 20-minute warm-up period, you should perform an alignment to ensure accurate measurements.

Initiating an Alignment

1. Select **Tools** > **Alignments**.
2. Select the **Align Now** button.
3. Select the desired align button:
   - For instruments without an HD option installed, select the Align Now button.



- For instruments with an HD option installed, you can select one of two alignment buttons. Select Align to run only the alignment procedure necessary to complete an alignment at the current temperature. Select Align All to run all alignment procedures.



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.

Note: While an alignment is running, both the IQ and Zero Span output are disabled.

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.

Alignments for instruments with an HD option. 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.

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**: Selecting a preset from the Preset drop down menu results in one of two actions depending on which item you choose in the **Preset action** list: **Recall selected preset** will immediately execute a preset when it is selected from the Presets menu. **Show list** will display a list of presets subtypes from which you can then select the preset you want to recall." .

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.
Full Spectrum	This Preset sets the instrument to display a Spectrum display with the center frequency set to 1/2 the instrument frequency range and the acquisition bandwidth set to the maximum real-time bandwidth, which depends on the installed option.
DPX	
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.

Table continued…

Presets	Description
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	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	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	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.
LTE	This preset loads a set of LTE displays and a test setup, frame structure, and channel bandwidth to perform LTE tests. The software configures these displays to apply the parameters appropriate for LTE analysis tasks.
5GNR	This preset loads a set of 5GNR displays and a test setup, frame structure, and channel bandwidth to perform 5GNR tests. The software configures these displays to apply the parameters appropriate for 5GNR analysis tasks.
Application	
Time-Frequency Analysis	The Time-Frequency preset configures the instrument with settings suited to analyzing signal behavior over time.
Spectrum Analysis	The Spectrum Analysis application preset provide you with the settings commonly used for general purpose spectrum analysis.
Modulation Analysis	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	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	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.

Table continued…

Presets	Description
Noise Figure	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 (Favorites)	
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.
Other user presets	User presets you create and save will appear in the Preset drop down menu of the User Presets window. Any User preset that you have designated as a Favorite will be marked with an *.

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 > *Preset Options* 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:\RSA5100B 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*.

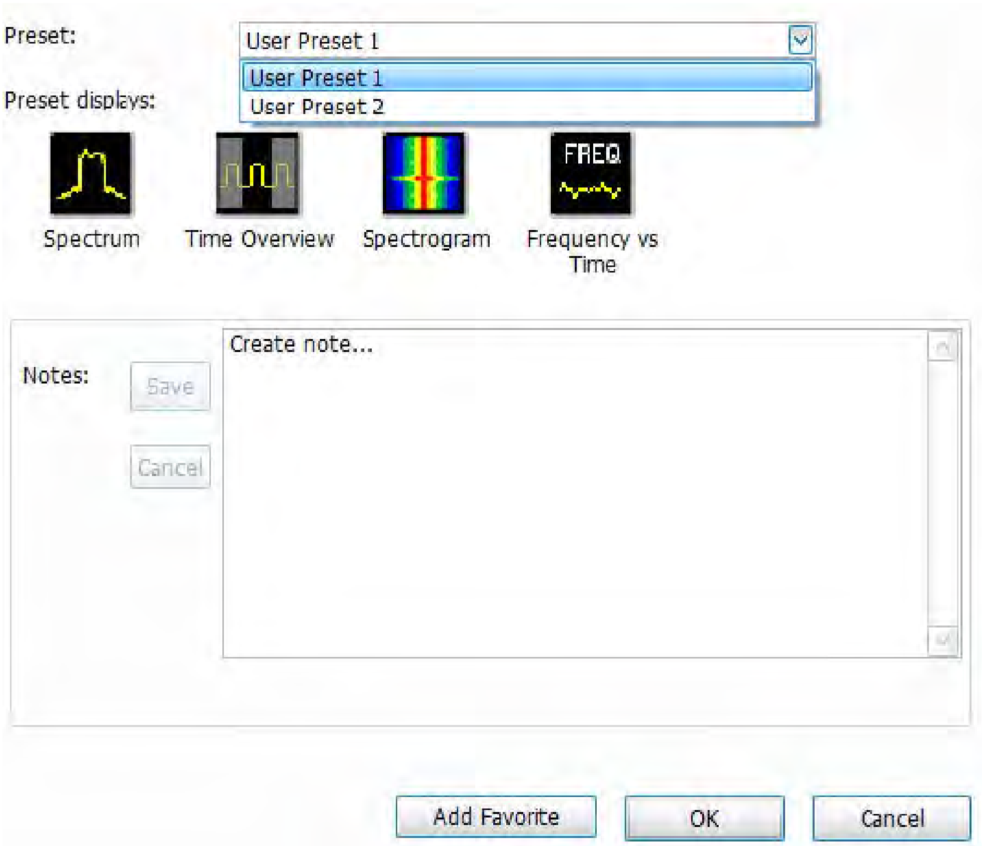
Configuring a User Preset

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.

User (Favorites) Presets

Select the **Presets > User (Favorites)** menu to open the User Presets window. The Presets drop-down list shows the three default user presets provided with the software.



- **User Preset 1:** Sets up the Spectrum, Time Overview, Spectrogram, and Frequency vs Time displays.
- **User Preset 2:** Sets up the Spurious display.

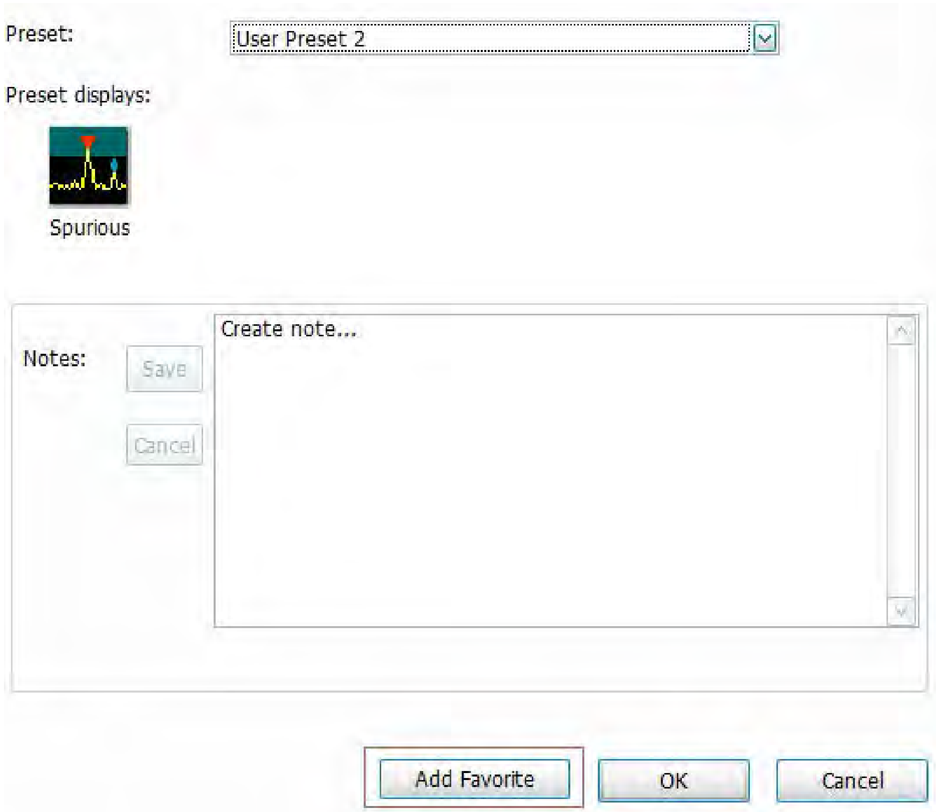
Make a User preset

You can add your own User presets to the list that appears in the User Presets dialog box as follows:

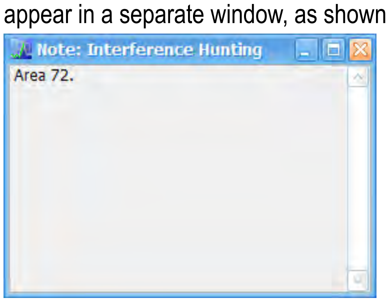
1. Select **Save As** from the **File** menu to open the **Save As** dialog box.
2. Select to save to C:\RSA5100B\User Presets.
3. Enter a file name. The name you give the file will appear in the User Presets dialog box list.
4. Select a .Setup file type from the **Save as type** drop-down list.
5. Click **Save**.

Make a User preset a Favorite preset. You can place one or more User presets on the Favorites bar as a Favorite preset for quick access. Do this as follows:

1. Select **Presets > User** to open the User Presets window.
2. Select the desired preset from the Presets drop-down list.
3. Click the **Add Favorite** button. An * will appear next to the selected preset. You can do this for more than one preset.



4. If desired, add a note for this preset in the Notes field and then click the Save button. Whenever you recall this preset, this note will appear in a separate window, as shown below.

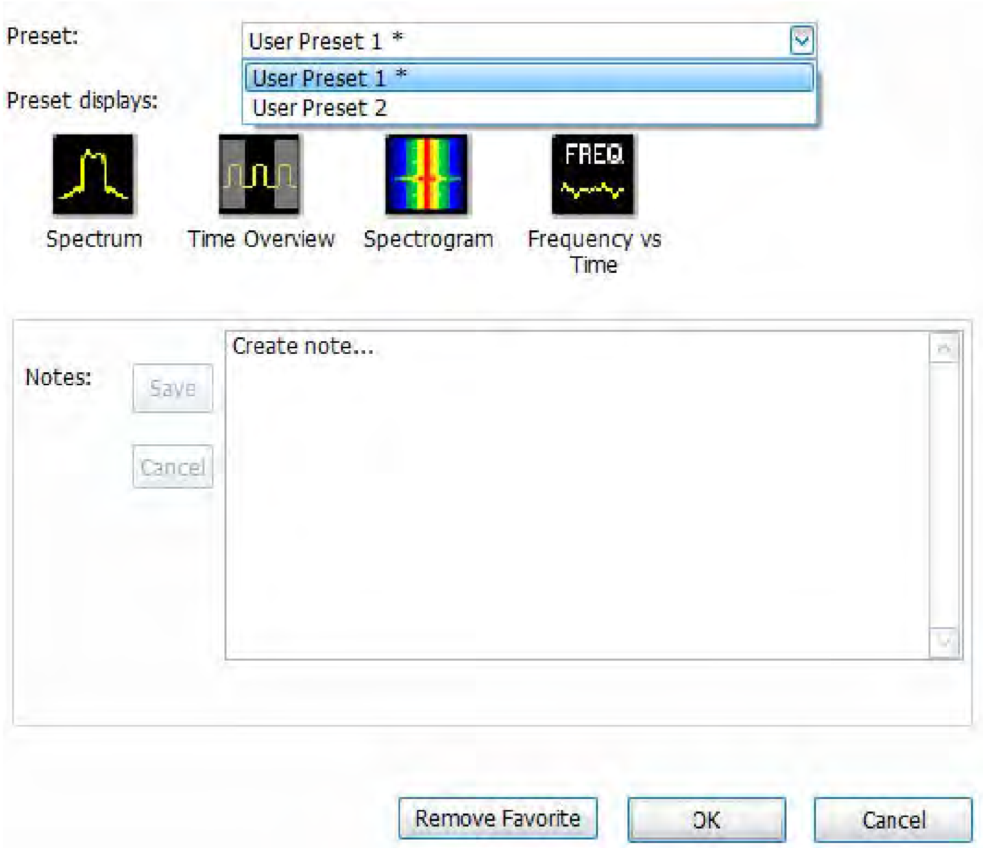


5. Click the **OK** button in the User Presets window.

6. Click on the  icon on the Favorites bar and you will see the recently added Favorite preset listed.

7. When you are ready to recall a Favorite preset, click  and select the preset from the list that appears.

8. To remove a Favorite preset, select it from the User Presets window and click the Remove Favorite button. The * should disappear



from the list.

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 *here*. You can also watch a video tutorial about WLAN Presets at www.youtube.com/user/tektronix. Click *here* 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 *here*.

- **Bluetooth:** The Bluetooth standards specify short range RF signals. The Bluetooth presets allow you to access displays preconfigured for the specific Bluetooth standards you select: Basic Rate, Low Energy, and Enhanced Data Rate (EDR).

  Note: More information is available about Bluetooth standards here.

- **LTE:** The LTE standards ensure that the RF signals meet 3GPP measurements specifications. The LTE presets test setups load pre-configured displays and control setting as suggested by the selected standard to accelerate the test setup of the analyzer.

Note: More information is available about LTE standards and test setups here.

- **5GNR:** The 5GNR standards ensure that the RF signals meet 3GPP measurements specifications. The 5GNR presets test setups load pre-configured displays and control setting as suggested by the selected standard to accelerate the test setup of the analyzer.

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.
- Pulse Cumulative Histogram: Shows a histogram that support statistics over multiple acquisitions. It shows basic pulse measurements and has user definable bins for the cumulated pulses. It provides detailed information about the bins and its content.
- Pulse Cumulative Statistics Table: Shows a statistics table that provides information on Standard Deviation, Average, Max, and Min over different acquisitions.
- Pulse-Ogram: Shows a correlated Amplitude Time vs Time and frequency vs time display, where Y is pulse parameter, X is pulse duration, and Z is number of pulses. It shows you a definable number of stacked pulses in amplitude versus time (reference being the trigger time), as well as in amplitude versus frequency. This display will also show the information as an ‘ogram, where the pulse number is being scanned over time.

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 (25 MHz in a base instrument, 40 MHz in instruments with Option B40, 85 MHz in instruments with Option B85, or 165 MHz in instruments with Option B16x). 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 *Triggering*.

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 μs. 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 µs.

Noise Figure

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

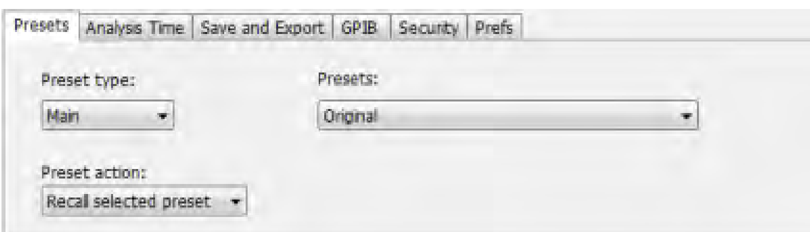
- Gain: This display shows gain versus frequency of the signal. The gain measurement is the ratio of output power to input power in an amplifier or circuit element.
- Noise Figure: This display shows the noise factor in dB. This measurement can help you assess the low level sensitivity of the DUT. Lower 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*.

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.



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* 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 *next peak* 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*.

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 *Time Zero Reference* 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 *next peak* when you drag them. When this setting is deselected, you can drag a marker to any point on the trace.

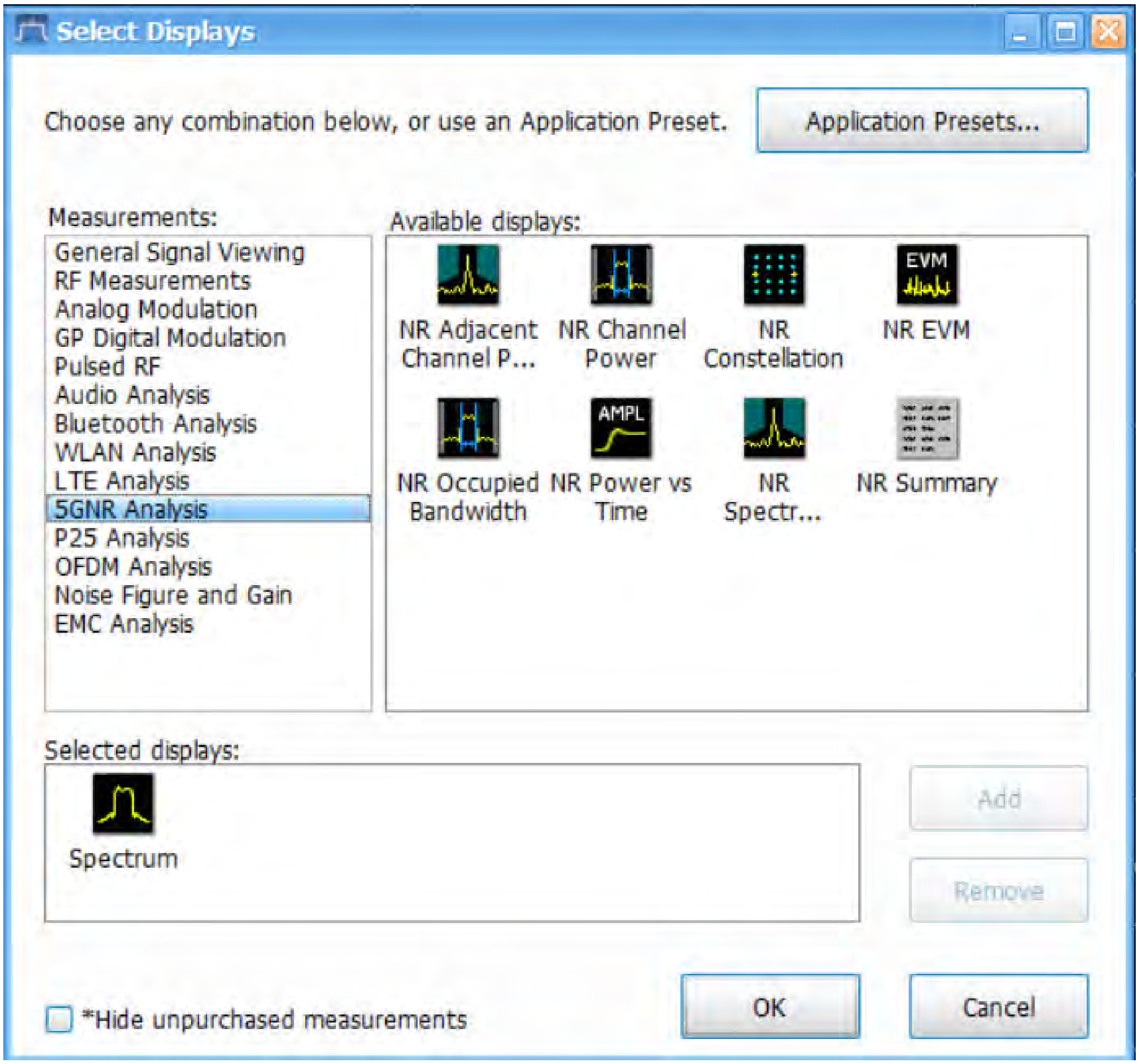
Using the measurement displays

Selecting displays

Menu Bar: Setup > Displays

Favorites toolbar: 

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



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.

Taking measurements

Available measurements

Available automatic measurements include RF power measurements, OFDM analysis, WLAN analysis, APCO P25 analysis, Bluetooth analysis, LTE analysis, 5GNR analysis, EMC Analysis, audio analysis, analog modulation measurements, digital modulation measurements, noise figure and gain measurements, and pulsed RF measurements.

See the specific measurement topic in this document for information about how to take a measurement.

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 *Complementary Cumulative Distribution Function* (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.

OFDM analysis

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	Measure of the signal power leaking from the main channel into adjacent channels.
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.

Table continued…

Measurement	Description
Power	Shows the data symbols' individual subcarrier Power values versus symbol interval (time) and subcarrier (frequency).

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	Measure of the signal power leaking from the main channel into adjacent channels.
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.

Audio measurements

Measurement	Description
Audio Spectrum	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.

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.

Table continued…

Measurement	Description
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 nFSK modulation types

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 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.

Measurements for PM modulation

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.

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.

Table continued…

Measurement	Description
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.
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.

Table continued…

Measurement	Description
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 range are 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.
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.

5GNR Measurements

Measurement	Description
Modulation Accuracy (ModACC)	It measures the deviation of the received symbol relative to the ideal transmitted symbol. The IQ data is processed to identify the OFDM Symbol boundaries and FFT is performed using the various settings under the Modulation Accuracy tab. The subcarrier data is equalized and then data and DMRS are extracted to perform various EVM measurements as per the 3GPP Spec and then used for display in Constellation Display. The Estimation tab provides advanced settings related to IQ Impairments and Frequency Offset estimation and corrections.
Channel Power (CHP)	The measurement is used to verify the maximum carrier output power across the frequency range. It includes the measurement of individual carrier power under carrier aggregation mode. The Integrated Bandwidth type can be chosen between Channel and Signal Bandwidth to include or remove the Guard Bands between carriers respectively.
Adjacent Channel Power (ACP)	It measures the power leakage from the carrier channels into the neighboring frequency channels, commonly referred to as offset channels. The RBW, sweep time, and Spectral Window can be selected from the measurement options tab. By default, 2 offset channels are enabled for measurement.
Spectral Emission Mask (SEM)	It measures the spurious emissions of a transmitter in the immediate frequency bands and compares against the limit chosen in the settings. The RBW settings and the width of the bands can be selected from the measurement options tab. Predefined band settings as per 3GPP are also provided in the options.
Occupied Bandwidth (OBW)	The OBW is the bandwidth containing 99% of the total integrated power of the transmitted spectrum, centered on the assigned channel frequency.
Error Vector Magnitude (EVM)	The EVM vs Symbol or EVM vs Time will give the EVM of OFDM symbols present in the number of symbols considered or the time within a slot.
Power vs Time (PVT)	The PVT measurement measures the time domain power dynamics of the NR signal.

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.

Table continued…

Measurement	Description
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 *Ripple*.
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.
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-Ref Phase Difference	The difference between the frequency of the current pulse and frequency of the previous pulse. The i nstantaneous frequency is measured at a user-adjustable time following the rising edge of each pulse
Pulse-Ref Freq Difference	The difference between the frequency of the current pulse and frequency of the previous pulse. The i nstantaneous 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.

Table continued…

Measurement	Description
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.
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.
Absolute Frequency	The absolute pulse frequency measured at a point specified by the user. The measurement includes carrier frequency as well. The measurement point should be within the pulse width, starting from the 50% point.
Pulse-Pulse Frequency 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.
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.

General signal viewing

Overview

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

- Amplitude vs Time
- DPX Spectrum
- 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.

DPX

DPX primer

With the DPX display (which displays only DPX waveforms saved by RSA5000/RSA6000/SPECMON Series Real-Time Spectrum Analyzers), you can detect and accurately measure transients as brief as 2.7 μs. The instrument computes up to 390,625 spectrums per second of the digitized input signal. Then it displays all these spectrums as a color-graded bitmap that reveals low-amplitude signals beneath stronger signals sharing the same frequency at different times.

The strong signal in the DPX spectrum graph, shown in *Figure 1* on page 61, is a repeating pulse at a fixed frequency. There is also a lower-power CW signal that steps very quickly through the same span. During the pulse's on time, the power of the two signals is additive, resulting in nearly undetectable differences in the pulse envelope shape. But during the time the pulse is off, the sweeping signal is detected and shown in its true form. Both signals are visible in the bitmap because at least one full cycle of their activities occurs within a single DPX display update.

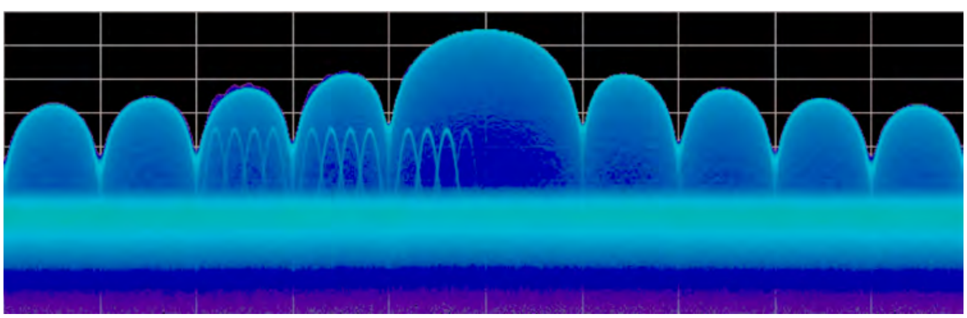


Figure 1: DPX spectrum graph

Compare the display of a *Figure 2* on page 62 and that of a real-time signal analyzer with a *Figure 3* on page 62. The signal captured is a typical WLAN interchange between a nearby PC and a more-distant network access point (AP). The laptop signal is nearly 30 dB stronger than the AP's signal because it is closer to the measuring antenna.

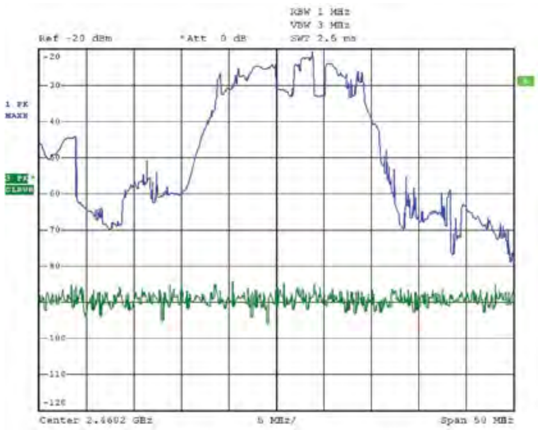


Figure 2: Traditional swept spectrum analyzer

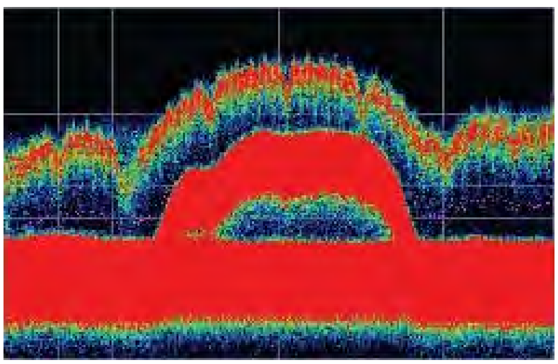


Figure 3: DPX display

The *Figure 2* on page 62 uses line traces that can show only one level for each frequency point, representing the largest, the smallest or the average power. After many sweeps, the Max Hold trace shows a rough envelope of the stronger laptop signal. +Peak detection was selected for the other trace in an attempt to capture the weaker but more frequent AP signal, but the bursts are very brief, so the likelihood of seeing one in any particular sweep is small. It will also take a long time to statistically capture the entire spectrum of a bursted signal due to the architecture of the swept spectrum analysis.

The *Figure 3* on page 62, reveals much more insight on the same signal. Since it is a bitmap image instead of a line trace, you can distinguish many different signals occurring within each update period and/or different version of the same signal varying over time. The heavy band running straight across the lower third of the graph is the noise background when neither the laptop nor the AP is transmitting. The red lump of energy in the middle is the ON shape of the AP signal. Finally, the more delicate spectrum above the others is the laptop transmissions. In the color scheme used for this demonstration (“Temperature”), the hot red color indicates a signal that is much more frequent than signals shown in cooler colors. The laptop signal, in yellow, green and blue, has higher amplitude but doesn't occur nearly as often as the AP transmissions because the laptop was downloading a file when this screen capture was taken.

How DPX Works

This section explains how DPX displays are created. The input RF signal is conditioned and down-converted as usual for a signal analyzer, then digitized. The digitized data is sent through an FPGA that computes very fast spectral transforms, and the resulting frequency-domain waveforms are rasterized to create the bitmaps.

The DPX bitmap that you see on screen is composed of pixels representing x, y, and z values for frequency, amplitude, and Density. A multi-stage process, shown in Figures 4 - 7, creates this bitmap, starting with analog-to-digital conversion of the input signal.

Simplified Flow of Multi-stage Processing from RF Input Through to Spectrum Processing:

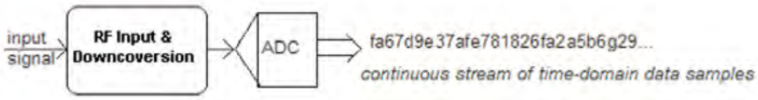


Figure 4: RF signals are downconverted and sampled into a continuous data stream.

Figure 5: Samples are segmented into data records for FFT processing based on the selected resolution bandwidth.

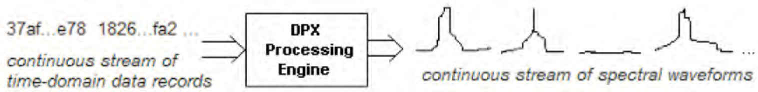


Figure 6: Data records are processed in the DPX transform engine

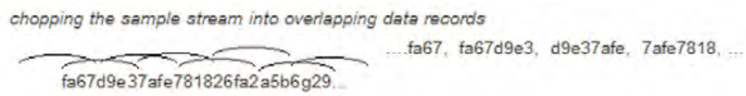


Figure 7: Overlapping the FFTs shortens the minimum event duration required for 100% probability of intercept.

Collecting spectral data. Sampling and digitization is continuous. The digitized data stream is chopped into data records whose length is based on the desired resolution bandwidth (RBW). An additional requirement is placed on FFT length by the desired number of points in a trace. Table 1 shows this relationship and the FFT length is reported in the display if desired. Then the DPX transform engine performs a discrete Fourier transform on each record, continually producing spectral waveforms.

Table 1: Minimum FFT length versus trace length – independent of span and RBW

Trace length (points)	Minimum FFT length
801	1,024
2,401	4,096
4,001	8,192
10,401	16,384

As long as spectral transforms are performed faster than the acquisition data records arrive, the transforms can overlap each other in time, so no events are missed in between. Minimum event length for guaranteed capture depends on the length of the data records being transformed. An event must last through two consecutive data records in order for its amplitude to be accurately measured. Shorter events are detected and visible on screen, but may be attenuated. The DPX Spectrum RBW setting determines the data record length; narrow RBW filters have a longer time constant than wide RBW filters. This longer time constant requires longer FFTs, reducing the transform rate. Additional detail on minimum signal duration is provided in *Guaranteed Capture of Fast Events*.

The spectral waveforms are plotted onto a grid of counting cells called the “bitmap database”. The number held by each database cell is the z-axis count. For simplicity, the small example grid used here in the following grids is 11x10, so our spectral waveforms will each contain 11 points. A waveform contains one (y) amplitude value for each (x) frequency. As waveforms are plotted to the grid, the cells increment their values each time they receive a waveform point.

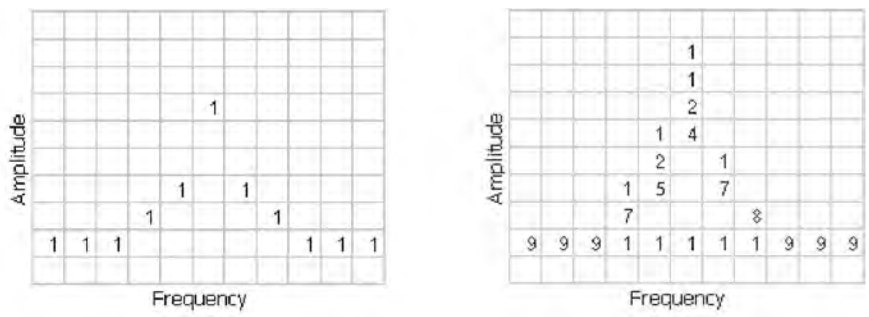


Figure 8: Example 3-D Bitmap Database after 1 (left) and 9 (right) updates. Note that each column contains the same total number of "hits".

The grid on the left shows what the database cells might contain after a single spectrum is plotted into it. Blank cells contain the value zero, meaning that no points from a spectrum have fallen into them yet.

The grid on the right shows values that our simplified database might contain after an additional eight spectral transforms have been performed and their results stored in the cells. One of the nine spectrums happened to be computed as a time during which the signal was absent, as you can see by the string of "1" occurrence counts at the noise floor.

The maximum rate for performing the variable-length frequency transforms that produce those waveforms can be greater than 390,625 per second. Measurement settings that slow this transform rate include narrowing the RBW and increasing the number of points for the line traces available in the DPX display along with the bitmap. Even at their slowest, spectral transforms are performed orders of magnitude faster than a physical display can respond, and also too fast for humans to see, so there's no need to update the screen or measurements at this rate. Instead, the grid collects thousands of waveforms into "frames", each covering about 50 milliseconds (ms). A 50 ms frame contains the counts from up to 14,600 waveforms. After each frame's waveforms have been mapped into the grid, the cell occurrence counts are converted to colors and written to the DPX bitmap, resulting in a bitmap update rate of around 20 per second.

Frame length sets the time resolution for DPX measurements. If the bitmap shows that a -10 dBm signal at 72.3 MHz was present for 10% of one frame's duration (5 ms out of 50 ms), it isn't possible to determine just from the DPX display whether the actual signal contained a single 5 ms pulse, one hundred 50 microsecond (μs) pulses, or something in between. For this information, you need to examine the spectral details of the signal or use another display with finer time resolution, such as Frequency vs. Time or Amplitude vs. Time.

Converting occurrence counts to color. About 20 times per second, the grid values are transferred to the next process step, in which the z-axis values are mapped to pixel colors in the visible bitmap, turning data into information. In this example, warmer colors (red, orange, yellow) indicate more occurrences. The color palette is user-selectable, but for now we will assume the default "temperature" palette.

Number of Occurrences	Color
0	black
1	blue
2	light blue
3	cyan
4	green blue
5	green
6	yellow
7	orange

Table continued…

Number of Occurrences	Color
8	red orange
9	red

The result of coloring the database cells, according to the number of times they were written into by the nine spectrums, one per pixel on the screen, creates the DPX displays.

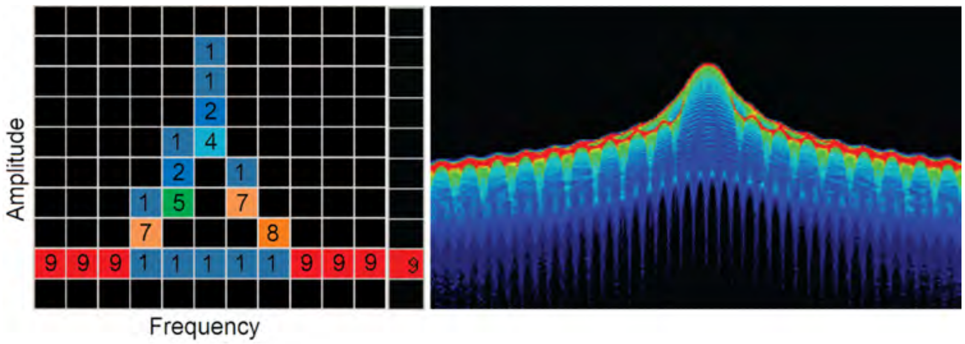


Figure 9: Color-coded low-resolution example (left) and a real DPX display (right).

In addition to the choice of palette, there are z-axis scaling adjustments for Maximum, Minimum, and Curve. Maximum sets the occurrence value that will be mapped to the highest color in the palette. Minimum sets the occurrence value for the lowest color. In the “temperature” palette, the highest color is deep red and the lowest is dark blue. Occurrence values less than the selected Minimum are represented with black pixels, while pixels that exceed the selected Maximum are red in hue but somewhat transparent. Values between Maximum and Minimum are represented by the other colors of the palette.

Adjusting the Minimum above the black default allows you to concentrate most of your color resolution over a small range of medium or higher occurrence rates to visually discriminate between different signals that have nearly equal probability values.

To see why adjustable color scaling is useful compare *Figure 10* on page 65 and *Figure 11* on page 66. On the Scale tab, the Max control is set to 100% in *Figure 10* on page 65. The range of colors now covers the full z-axis range of densities from 0 to 100%. The signals used to create this bitmap are fairly diffused in both frequency and amplitude, so most pixels have low occurrence counts or density values and the upper half of the color palette is unused.

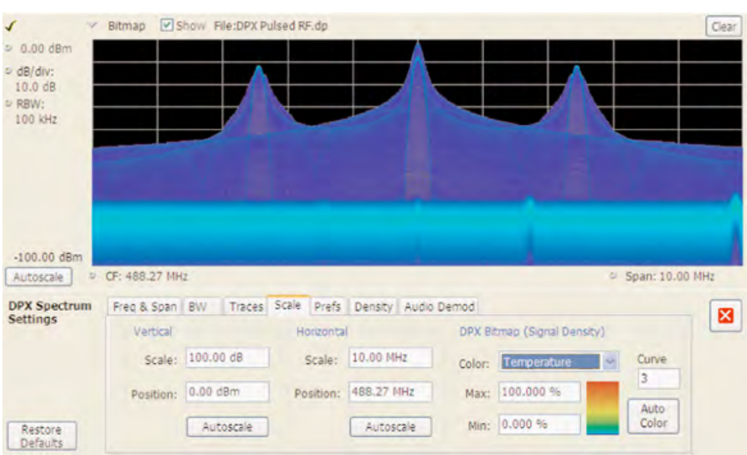


Figure 10: DPX spectrum bitmap with default color scale settings.

When the Auto Color button is selected, the Maximum control's value is set to the highest pixel value in the current bitmap, shown in *Figure 11* on page 66. Now none of the available colors remain unused. The entire palette is mapped to the occurrence values present at the time the button is selected, providing better visual resolution for low densities. Selecting the Autoscale button in the DPX display scales all three axes based on current results.

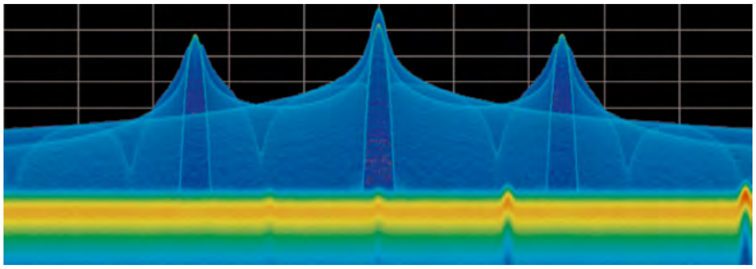


Figure 11: The Auto Color function optimizes the color scale settings.

Color Mapping Curves

The mapping between z-axis values and color does not have to be linear. The Curve control lets you choose the shape of the mapping equation. A Curve setting of 1 selects the straight-line relationship. Higher Curve numbers pull the curve upwards and to the left, concentrating color resolution on lower densities. Settings less than 1 invert the curve, moving the focus of the color range towards higher density values. \Figure 12 on page 66 shows the mapping curves.

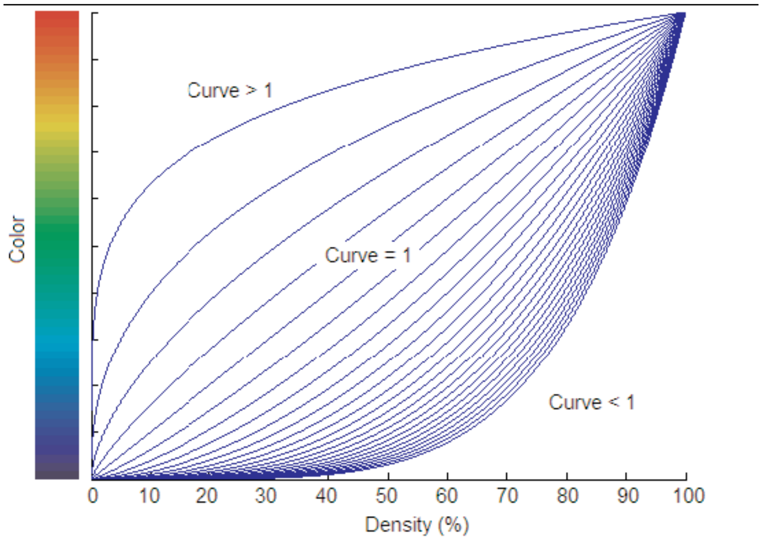


Figure 12: Representative color mapping curves for the "Temperature" palette.

Using the same signal shown in Figure 10 on page 65 and Figure 11 on page 66, the impact of the Curve control can be observed. With the Curve control set to 1 in the Scale tab, shown in Figure 13 on page 66, the mapping between color and density is linear, so the colors spread evenly across the full density range. The color distribution is visible in the colored palette illustration to the left of the Curve control in the Settings panel.

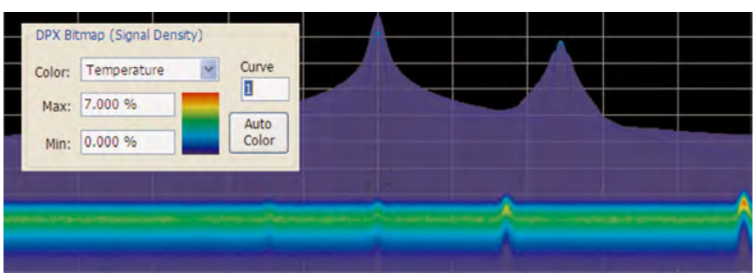


Figure 13: Over a narrow Signal Density range, the color curve is set to 1.

When the Curve control is set to 0.5, as shown in *Figure 14* on page 67, the best color resolution is in the upper half of the density range, and only the dark blues are assigned to densities below 50%. Note the difference in the palette illustration.

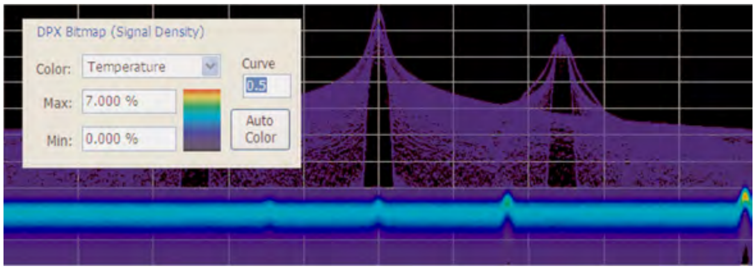


Figure 14: Adjusting to values less than 1, increases the contrast for viewing events in the top half of the selected density range.

In *Figure 15* on page 67, the Curve control is increased to 3. The majority of colors shifts to the lower half of the density scale, but various shades of orange and red are still available for densities above 50%.

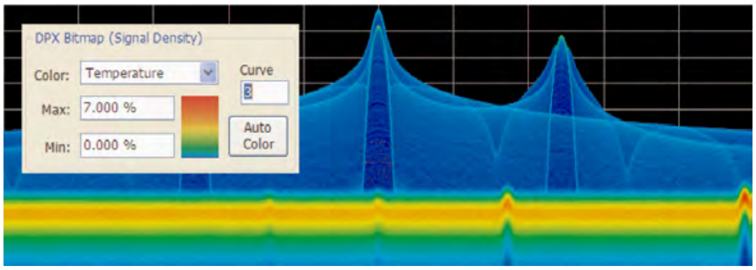


Figure 15: For color curve settings greater than 1, better contrast is provided for events near the low end of the density range.

Swept DPX

DPX Spectrum is not limited in span by its real-time bandwidth. Like the regular Spectrum display, DPX Spectrum steps through multiple real-time frequency segments, building a wide-span display with line traces and the bitmap. See *Figure 16* on page 67.

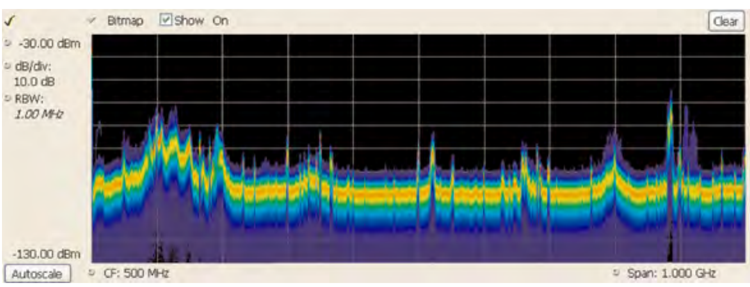


Figure 16: Off-air ambient signals over a 1 GHz span in the swept DPX display.

The analyzer "dwells" in each frequency segment for one or more DPX frames, each containing the results of up to 14,600 spectral transforms. Dwell time is adjustable, so you can monitor each segment of the sweep for up to 100 seconds before moving to the next step. While dwelling in a segment, the probability of intercept for signals within that frequency band is the same as in normal, real-time spans: 100% capture of events as short as 10.3 µsec.

A full pixel bitmap is created for every segment and compressed horizontally to the number of columns needed for displaying the frequency segment. Compression is done by averaging pixel densities of the points being combined together. The final swept bitmap contains a representation of the same pixel bitmap resolution, just like the non-swept bitmaps. Line traces are also created in full for each segment, and then horizontally compressed to the user-selected number of trace points for the full span.

A complex algorithm for determining the number and width of each frequency segment has been implemented. The variables in the equation include user-adjustable control settings like Span, RBW, and number of trace points, RF and IF optimization, and Acquisition BW.

Installed hardware options also can affect the span segmentation. The number of segments ranges from 10 to 50 for each 1 GHz in a sweep.

A helpful piece of information for operators is the actual Acquisition Bandwidth used for capturing each segment. “Acq BW” is shown in the Acquire control panel on the Sampling Parameters tab. Acq BW is typically set automatically by the instrument, based on the needs of all the open displays, but can also be set manually. In either case, the displayed bandwidth is used for every frequency segment in the swept DPX display, though in practice, the displayed portion of the segment is somewhat narrower than the actual Acquisition BW, for performance reasons.

The entire instrument frequency range of many GHz can be covered in a DPX sweep. The Dwell Time control sets the amount of time DPX spends in each segment. This control, circled in *Figure 17* on page 68, can be set between 50 ms and 100 seconds.

Figure 17: During swept DPX operation, the Dwell time control adjusts the observation time of each frequency segment used to construct the composite DPX display.

Guaranteed Capture of Fast Events

The main reason that swept-tuned and step-tuned spectrum analyzers can't provide 100% Probability of Intercept, POI, for a signal that isn't continuously present is that they spend only a short period of time tuned to each segment of their frequency span during each sweep. If something happens in any part of the span other than where it is tuned at that instant, that event will not be detected or displayed. There is also a period of time between sweeps, retrace time, during which the analyzer is not paying attention to the input signal. FFT-based analyzers, including vector signal analyzers, also miss signals during the time between acquisitions. Their POI depends on a combination of factors including span, number of FFT points, acquisition time, memory read/write time, and signal processing speed. Vector analyzers process information sequentially, so when read/write from data and processing is occurring, data is not being acquired.

RSAs, on the other hand, capture data across all frequencies within their real-time span during every acquisition. With Tektronix' exclusive Frequency Mask trigger and DPX Density trigger, POI increases to 100%, insuring capture of any spectral event matching the trigger definition. When operating in free run as a simple signal analyzer, the RSA has a POI similar to other FFT-based analyzers, with gaps between each acquisition. Processing is done concurrent with the acquisitions.

Guaranteed Capture in DPX Real-Time Spans

The DPX display captures any signal that is at least 2.7 microseconds long (with Option 09) and within the real-time bandwidth. This performance is possible because the instrument computes up to 390,625 spectrum transforms per second. The faster the spectrum updates, the shorter the time between acquisitions and the greater the probability that any signal will be detected.

The following table shows the specified minimum signal duration (MSD) for 100% probability of intercept under various combinations of Span and RBW in DPX for a representative signal analyzer. As you can see, MSD is affected by multiple factors.

Table 2: Minimum signal duration for 100% probability of trigger at 100% amplitude

Frequency-Mask and DPX signal processing				Minimum signal duration, 100% probability of intercept, Frequency-Mask and DPX density trigger (µs)			
Span	RBW (kHz)	FFT length	Spectrums/sec	Standard		Opt. 09	
				Full amplitude	-3 dB	Full amplitude	-3 dB
165 MHz	20000	1024	390,625	15.5	15.4	2.7	2.6
	10000	1024	390,625	15.6	15.4	2.8	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	300	2048	195,313	23.4	16.3	13.1	6.1
	100	8192	48,828	44.5	23.4	44.5	23.4
	30	32768	12,207	161.9	91.7	161.9	91.7
85 MHz	10000	1024	390,625	15.6	15.4	2.8	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	500	1024	390,625	20.2	15.9	7.4	3.1
	300	1024	390,625	23.4	16.3	10.6	3.5
	100	4096	97,656	44.5	23.4	34.2	13.2
	30	16384	24,414	121.0	50.7	121.0	50.7
	20	16384	24,414	161.0	55.6	161.0	55.6
40 MHz	5000	1024	390,625	15.8	15.4	3.0	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	300	1024	390,625	23.3	16.3	10.5	3.5
	100	2048	195,313	39.4	18.3	29.1	8.1
	30	4096	97,656	90.4	21.8	90.4	21.8
	20	8192	48,828	140.7	36.3	140.7	36.3
	10	16384	24,414	281.3	72.6	281.3	72.6

Table continued…

Frequency-Mask and DPX signal processing				Minimum signal duration, 100% probability of intercept, Frequency-Mask and DPX density trigger (μs)			
Span	RBW (kHz)	FFT length	Spectrums/sec	Standard		Opt. 09	
				Full amplitude	-3 dB	Full amplitude	-3 dB
25 MHz	3800	1024	390,625	16.0	15.4	3.2	2.6
	1000	1024	390,625	17.7	15.7	4.9	2.9
	300	1024	390,625	23.4	16.3	10.6	3.5
	200	1024	390,625	27.4	16.8	14.6	4.1

To demonstrate the POI in action, a challenging bi-stable signal is used. A CW sinusoid sits at 2.4453 GHz most of the time, but every 1.28 seconds, its frequency changes for about 100 μs before returning to normal. The duty factor of this transient is less than 0.01%.

Figure 18 on page 70 shows a swept analyzer set up for a 5-second sweep of its MaxHold trace. It shows that there is something occurring around the signal. This sweep rate was empirically determined to be the optimum rate for reliable capture of this signal in the shortest time. Faster sweep times can reduce the probability of intercept and result in fewer intersections of the sweep with the signal transient.

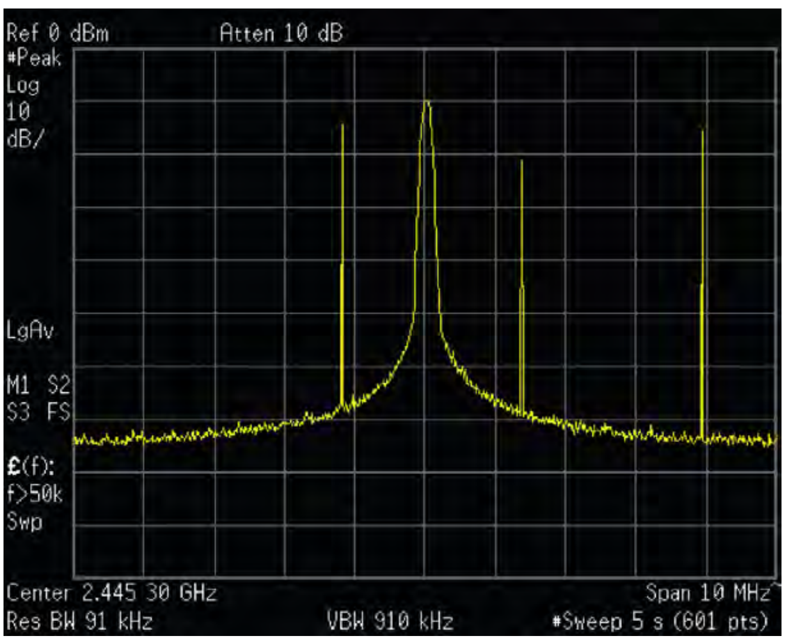


Figure 18: Swept spectrum display of the infrequent transient.

The DPX display shown in *Figure 19* on page 71 shows the exact same event, also captured over a 5 second period. A lot more information can be discovered about the transient. It is obvious at first glance that the signal is hopping by about 3 MHz, with 1.2 MHz of frequency overshoot on transitions

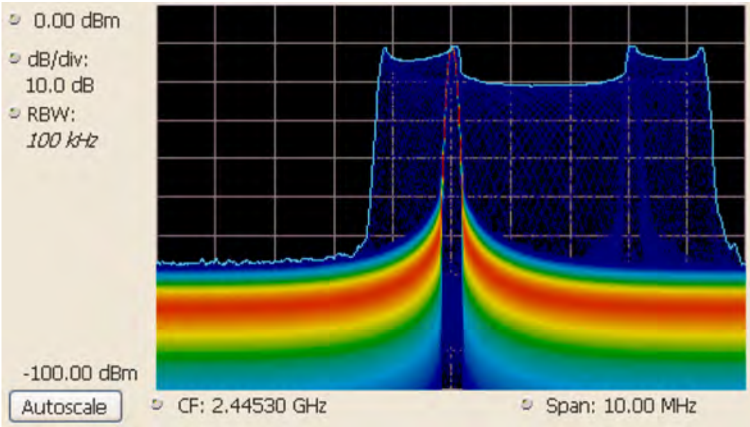


Figure 19: The DPX spectrum display after 5 seconds. The MaxHold trace is cyan.

Guaranteed Capture in DPX Swept Spans

Probability of intercept (POI) for signals within a single segment, while DPX is dwelling in that segment, is the same as for non-swept DPX operation. 100% POI for events as brief as 2.7 microseconds long (with Option 09). But just as in traditional swept analyzers, during the time the acquisition is tuned to any one segment, the analyzer is not monitoring signals in any of the other segments, so probability of capture in segments other than the current one is zero. Because of the wide real-time bandwidth, the number of segments needed to cover the span is much less than for swept analyzers, so the overall probability of intercept is significantly better for DPX sweeps.

Another factor affecting POI is number of trace points. The bitmap is always 801 points wide, but the line traces allow user selection for number of points. 801 is the default and the other choices are 2401, 4001, and 10401. Frequency transforms for traces containing more than 801 points take longer, and this lower waveform update rate increases the minimum signal duration proportionally. This caution applies for swept and non-swept operation. The trace length control is on the Prefs tab in the DPX control panel.

DPX Density Measurements

“Density” is a measure of the amount of time during a defined measurement period during which signals are present within a particular area of the DPX Spectrum bitmap. A clean CW tone gives a 100% reading, while a pulse that is on for one microsecond out of every millisecond reads 0.1%. This section describes how density is computed from hit counts.

If we plot 41 more waveforms into the example grid we used previously (in addition to the nine we already plotted), each column ends with a total of 50 hits. The density for any one cell in a column is its own count value divided by 50 , expressed in percent as shown in *Figure 21* on page 72. The math is very simple: a cell with 24 counts has a 48% density. In practice, instead of batches of 50 waveforms, we collect a frame of thousands of waveforms before each update to the density bitmap.

					4					
					6					
					13					
					18					
				1	3	1				
		1	2	4		4				
1	2	1	43	41	2	38	6	1	2	2
47	46	47	5	4	3	7	43	47	46	47
2	2	1			1		1	2	2	1

Figure 20: Grid showing cell counts after 50 waveforms. For each column, the sum of z-axis values is 50.

0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	12%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	26%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	36%	0%	0%	0%	0%	0%
0%	0%	0%	0%	2%	6%	2%	0%	0%	0%	0%
0%	0%	2%	4%	8%	0%	8%	0%	0%	0%	0%
2%	4%	2%	86%	82%	4%	76%	12%	2%	4%	4%
94%	92%	94%	10%	8%	6%	14%	86%	94%	92%	94%
4%	4%	2%	0%	0%	2%	0%	2%	4%	4%	2%

Figure 21: Grid after converting occurrence counts to percent density values. The sums of the cell density measurements within each column are all 100%.

Measuring Density with Markers

Hit counts are cleared after every frame update, as long as Persistence is not turned on. The density value for any pixel is simply the percent of time it was occupied during the most recent 50 ms frame. Markers can be used to see the Density value for one or more individual points on the screen, enabling measurements of the signal density at any interesting point in the DPX display.

In *Figure 22* on page 72, Wireless LAN signals are analyzed in the presence of a Bluetooth radio signal in the 2.4 GHz ISM band.

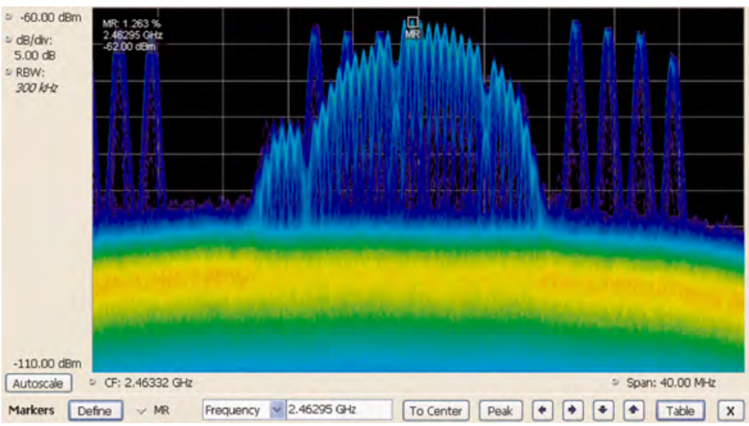


Figure 22: DPX display of WLAN and Bluetooth signals, with a marker on the highest signal.

The “Marker to Peak” function was used to find the peak signal recorded in the display. The marker readout in the upper left corner of *Figure 22* on page 72 shows the Density, Amplitude, and Frequency for the pixel you selected with the marker. By adding additional markers, you can measure the signal density differences between multiple signals of interest.

Marker Peak Search in the DPX Bitmap

Markers on the DPX bitmap can search for peaks, similar to marker peak searching on spectrum line traces. For a human, it is pretty easy to discern “signals” in the bitmap picture. Your brain intuitively identifies strings of contiguous bright pixels. This isn't so easy for a computer. The first thing the RSA must do for any peak search is analyze pixel density values to identify apparent signals. Then it can sift through these density peaks for the amplitude peaks you want to find.

Z-axis density values for the pixels in each column of the bitmap are internally converted into histograms to find density peaks indicating the presence of signals. *Table 3* on page 73 shows the five middle columns from the example grid we used to illustrate density measurements in a previous section (*Figure 21* on page 72). The density values for each pixel in the middle, highlighted column are plotted on the y axis in the bar chart in *Figure 23* on page 73. The bar chart x axis is bitmap row number, numbering from the top of the table.

Table 3: Bitmap section showing density values.

0%	0%	**0%**	0%	0%
0%	0%	**8%**	0%	0%
0%	0%	**12%**	0%	0%
0%	0%	**26%**	0%	0%
0%	0%	**36%**	0%	0%
0%	2%	**6%**	2%	0%
4%	8%	**0%**	8%	0%
86%	82%	**4%**	76%	12%
10%	8%	**6%**	14%	86%
0%	0%	**2%**	0%	2%

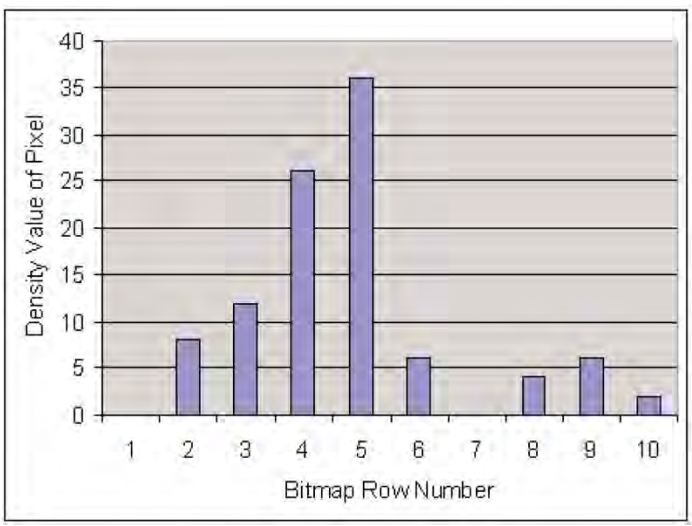


Figure 23: Bar chart of the density values in the bolded column of Table 2.

Assume that Density Threshold is set to 5% and Density Excursion to 5% also. Starting with x=1 in the bar chart, test each bar against the threshold. The threshold criteria is met at x=2. Keep testing until you find a bar that is shorter than the previous bar by at least the Excursion setting. In this case it is x=6. This tells us that a “signal” covers rows 2 through 5. Its density peak is at row 5.

Now you can look for another peak. Continue looking at bars to the right and you will find a density value at row 9 that meets the threshold criteria, but since there are no bars to the right of it that meet the excursion criteria, we can't declare row 9 a signal because it fails to meet the excursion criteria. If row 1 had 1% density, then row 9 would be a density peak.

Once density peaks are found for all columns in the bitmap, we can start looking for the amplitude peaks. When the **Peak** button is selected, the analyzer checks the histograms of every column in the bitmap and finds the density peak with the highest amplitude. The amplitude search has its own versions of Threshold and Excursion settings, but in dBm and dB units. When **Next Peak Down** command is given, the search will scan inside the current column for the next density peak. **Next Peak Right** examines each column to the right of the current marker location to locate density peaks that also meet the amplitude peak criteria.

To demonstrate the value of marker peak search in the DPX bitmap, we will use the time-multiplexed signals showing multiple amplitude levels from an example earlier in this manual. The **Peak** button and its menu equivalent place the active marker on the peak signal in *Figure 24* on page 74. The peak signal is the density peak of highest amplitude in the bitmap.

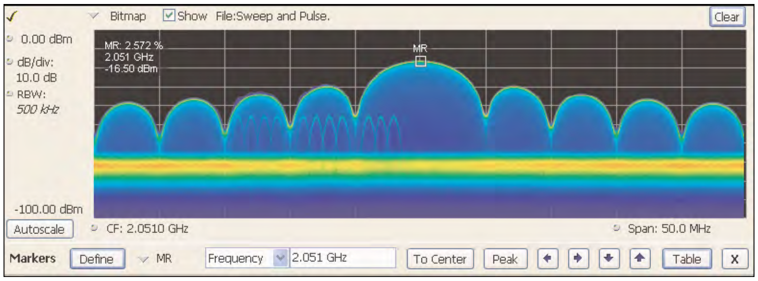


Figure 24: The marker was positioned by selecting the Peak button. Density, frequency, and amplitude measurements at the marker are displayed in the upper left corner of the graph.

The Marker Toolbar, at the bottom of *Figure 24* on page 74, allows easy navigation of peak signals (**Peak Left**, **Peak Right**, **Next Peak Up**, or **Next Peak Down**). Selecting the arrow keys enables the marker to search for amplitude/density peaks at other frequencies, while the **Next Peak Up** and **Next Peak Down** arrows enable the marker to search for other high-density points at the same frequency.

In the Define Peaks tab of the Define Markers control panel, *Figure 25* on page 74, you can adjust the density threshold and excursion controls to modify search behavior. The amplitude threshold and excursion controls also apply to DPX marker searches. Smoothing keeps the marker from finding multiple peaks within the same apparent signal by averaging an adjustable number of pixel densities together, but it does not affect the single-pixel measurement readout displayed by the marker.

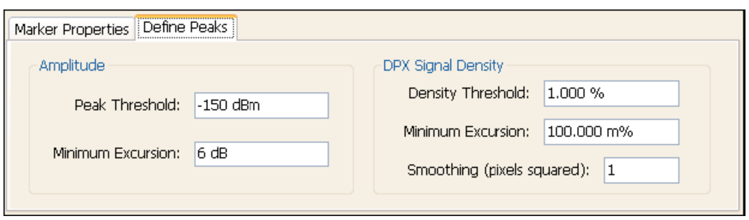


Figure 25: Amplitude and Signal Density controls can be adjusted to define Peak search behavior.

Density Measurements over an Adjustable Area (“The Box”)

The density for a single pixel is its ratio of actual hits vs. possible hits over a defined time period, and markers display these density values. For measuring density over an area larger than one pixel, the DPX display includes a measurement box you can resize and drag around in the DPX display with your mouse or finger.

If you could make the box so narrow that it contained only points within a single column of pixels, the density of this area would be the sum of the included pixels' density values. For example, if the box was three pixels tall and the density values for these pixels were 4, 2, and 7% respectively, the overall density for the three-pixel area would be 13%. Imagine a box one pixel wide and as tall as the graph. Assume that the input signal's amplitude was such that all hits fell at or near the vertical center of the screen. Since 100% of the waveforms written to the bitmap passed through the box, the density for the box is 100%.

$$Density\ of\ an\ area\ =\ \frac{(Sum\ of\ densities\ of\ all\ pixels)}{(Number\ of\ columns)}$$

When you widen the box to cover a broader range of frequencies, software computes the density sum for the included pixels in each column inside the box. The aggregate density value for this box is the average density, calculated by adding the column density sums then dividing by the number of columns. For a 100% result, there must not be any hits above the top edge of the box or below its bottom edge.

In other words, every waveform drawn across the graph entered the box through its left side and exited the box through its right side, with no excursions out the top or bottom. *Figure 25* on page 74 demonstrates this principle on a CW signal. As you can see on the left-hand side, no amplitudes exist above or below the box; the density of the signal is 100%. On the right hand side, there are signals below the box, therefore the density is less than 100%.

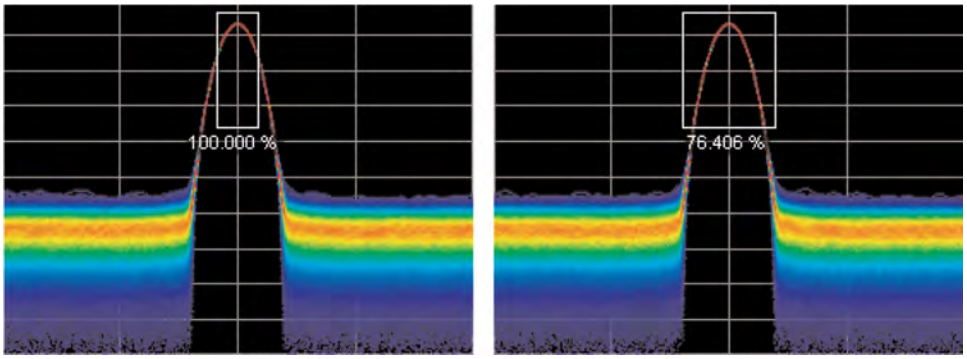


Figure 26: Density of signals defined within an area. Left: Correct measurement of a CW signal. All columns in the box include the signal. Right: Incorrect measurement area. The measurement is accurate, but probably not what you expected. Some columns in the box contain no hits, so they contribute zeros to the calculation of average density.

The density measurement box' vertical size and location are always set in dB and dBm, no matter what units you have selected for measurements. (Amplitude control panel > Units tab.) The box is not draggable when the selected units are linear (such as Amps, Volts, Watts…), though you can still adjust its size and location using the Frequency and Amplitude controls in both the DPX Settings > Density and Trigger > Event tabs. Since the vertical scale is non-linear, a box of constant amplitude changes visual height as it changes vertical position, a disconcerting effect if you are trying to drag it.

Figure 27: DPX Density control panel is used to define the area of interest for DPX density measurements.

A readout will appear somewhere in the graph. If the box is off-screen, the readout will be accompanied by an arrow pointing towards the invisible box. Grab this readout with your mouse or finger and drag the density readout to the area you want to measure.

To adjust the box size, a mouse is the easiest way to drag the sides and corners of the rectangle. For precise settings, use the knob, arrow keys, or keyboard to adjust frequency and amplitude values for the rectangle. These controls are located in the right half of the Density tab in the control panel.

Persistence

Previous sections of this topic have assumed that persistence was not applied to the DPX bitmap. Without persistence, hit counts in the grid are cleared after each frame update. Now we will describe how persistence modifies this behavior, starting with infinite persistence because it is simpler than variable persistence.

Hit counts are not cleared between frames if infinite persistence is enabled. When the instrument is set up for continuous acquisitions, hits keep collecting until you stop acquisitions or click the Clear button above the DPX display. Software keeps track of the total number of waveforms computed during the entire collection period. Density equals the total number of hits to a cell divided by the total number of waveforms.

Variable persistence is trickier. A single-occurrence signal shown in the bitmap does not disappear suddenly upon the next frame update, nor does it linger forever. It fades gradually away. The user sets a time constant for the Dot Persistence control which determines how long it takes for signals to fade. Fading is accomplished by reducing the hit count in every cell, after each frame update, by a factor based on the persistence time constant. The longer the time constant, the less the hit counts are reduced.

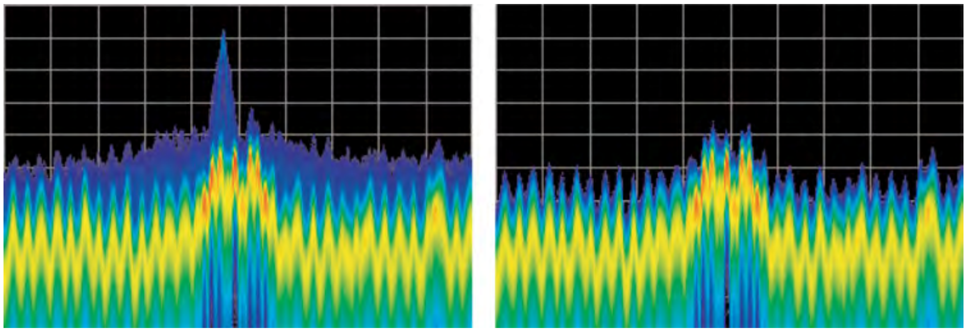


Figure 28: Example of fast transient discovery with and without variable persistence turned on. In the display on the left, with variable persistence of 10 seconds, the occasional sub-second transient that spikes up above the normal signals is held in the display rather than disappearing as soon as the signal goes away. The display on the right, with persistence turned off, requires watching the display continually to see the brief signal.

Not only are single-occurrence signals allowed to remain in the display for awhile by variable persistence, additional hits keep piling on. The result is that cell values are no longer pure hit counts; they include counts due to new hits from waveforms plus proportionally reduced counts from prior frames. As part of translating hit counts into density values, a new software algorithm uses a finite-series equation to discriminate between the effects of persistence and the arrival of new hits. The inflationary effects of persistence on cell counts are removed, so density readings represent the true ratio of actual hits to possible hits over the persistence interval.

The density computation for variable persistence is a very good estimate of true signal density, with errors of less than 0.01%. For exact density measurements, use either no persistence or infinite persistence.

Another subtlety of persistence is its smoothing effect on the density measurement of intermittent signals. Consider a pulse that is on for 10 ms and off for 90 ms of each 100 ms cycle. We'll make the simplifying assumption that the pulse ON time always falls entirely within a single DPX frame update (50 ms). If persistence is not applied, the density measurement is computed on each individual frame. The results will be 20% for each frame containing the ON time and 0% for the other frames. If infinite persistence is enabled, however, the density measurement will settle to 10% after the second frame, and remain at this value for as long as the pulsing continues. With persistence, the density is effectively computed over many frames.

Persistence Effects on Density

Persistence does not alter colors in a density-based bitmap. Its effect is to extend the amount of time over which densities are calculated, leaving signal events visible for the persistence duration.

Before the introduction of density measurements and extra-long hit counters, persistence caused colors to “bloom”, becoming more and more intense over time as the hit counts increased. Longer persistence intervals caused increased blooming, turning crisp signals into fat red stripes. When hit counts are converted to density values, the display is not subject to this effect. As long as the input signals maintain reasonably stable repetition rates and duty ratios, their density values will also remain stable despite ever-increasing hit counts in the underlying grid cells.

If you are accustomed to the original hit-count-based persistence displays, it may seem counter-intuitive that repeating signals in a density-based bitmap will not get brighter and redder over time with infinite persistence. A quick review of the density algorithm explains why: the hit count is divided by the total number of waveforms over the persistence interval. For example, if a signal occupies a pixel 50% of the time over a period of 15 minutes, the density reading will be 50% throughout the entire 15 minutes, though the underlying hit count is steadily increasing.

Z-Axis Resolution

Another factor that can cause color bloom is overflow of the hit counters. If a pixel could only count up to 1000 hits, its density and color values would clip at 100% after just 1000 hits, even if waveform points continue to arrive in the same pixel location. With thousands of waveform points being written to the bitmap, counts add up really fast for highly-repetitive signals. An example of saturation time for one our products is given in the following table. All DPX implementations have maximum hit count values to ensure a minimum time to overflow of greater than 60 minutes.

Table 4: Comparison of DPX z-axis resolution and its effect on saturation.

Hit Count	36-bit custom float (equivalent to 33-bit integer)
Maximum Hit Count	2^{33}
Minimum Time until Overflow (for pixels with 100% density)	8.1 hours

Clipping due to overflow of the counters in one or more cells will not occur until hours have passed, or even days.

One more benefit to having deeper hit counters is better visual resolution of density. RSAs with the highest-performance DPX hardware installed use floating-point numbers to count hits, allowing us to count billions of waveforms while retaining one-hit resolution, providing better than 99 dB of dynamic range for density measurements. Density measurements in µ%, n%, and even f% ranges are quite possible for extremely rare signals captured with infinite persistence.

With straight-line mapping between density and color (Curve setting of 1), resolution is fixed by the number of colors in the palette. For non-linear mappings (Curve settings higher or lower than 1), most of the colors are concentrated at either the low or high end of the density scale, so you can visually discriminate finer differences between density values in that range.

Persistence Adjustments

Dot Persistence can be enabled for the "Bitmap" trace using the Settings control panel. The Persistence can be displayed as Infinite or Variable. For Variable Persistence, you can select the time constant for fading in seconds as shown in *Figure 29* on page 77.

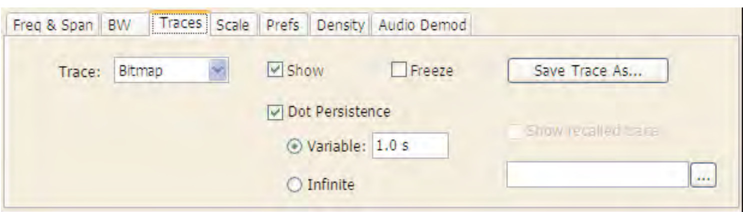


Figure 29: The trace settings control panel allows user control of persistence parameters.

Figure 30 on page 77 demonstrates the observed behavior of variable persistence when a CW signal, represented in the first frame, is turned off. Even if the event was instantaneous and was confined within a single frame, you will observe the color changing to indicate lower and lower density values, until the signal finally disappears entirely.

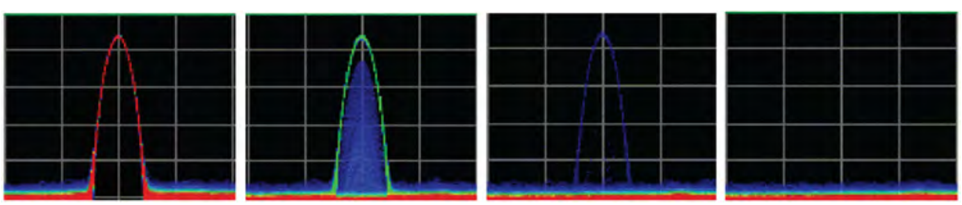


Figure 30: With variable persistence, a brief CW signal captured by DPX remains in the display for an adjustable period of time before fading away.

DPX Density Trigger

The standard DPX display shows you a clear picture of transients and other hard-to-find signals and goes well beyond helping you discover these difficult to find signals by actually triggering on their appearance to capture them into acquisition memory for in-depth analysis. If you can see it in the DPX bitmap, you can trigger on it.

Other trigger methods can detect signals that exceed an amplitude threshold, or even a sophisticated amplitude-vs-frequency mask, but they can't find a signal at a particular frequency if another signal of higher amplitude is sometimes present at that same frequency. The Runt trigger addresses some of these signal-under-signal cases, but not all. As shown in *Figure 31* on page 78, the DPX Density trigger can discriminate signals within a precise amplitude-frequency range without the operator having to know any characteristics of the target signal besides where it might show up in the DPX Spectrum graph.

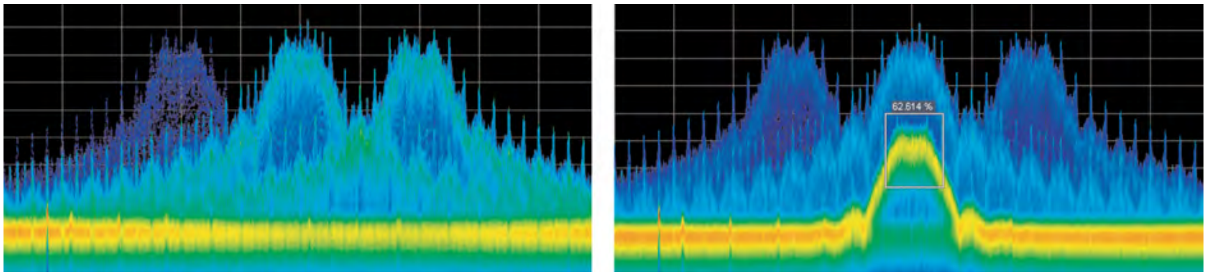


Figure 31: Example of Density Trigger. Left: A free-run DPX display showing pulses with varying frequency. Occasionally, a short pulse in the middle appears for a split instant, but it is hard to capture it with just a Run/Stop button. Right: The triggered DPX displays shows the low-amplitude pulse that was not apparent in the untriggered display. The analyzer was set to trigger whenever the average density in the user-drawn box measured 50% or higher.

The DPX Density trigger uses the same screen-based measurement box as the DPX Density measurement. While the target signal is absent, the density measurement characterizes the “normal” signals within the box. When the target signal finally appears, the density value increases. The trigger system monitors the density measurement and activates a trigger whenever the density value exceeds the adjustable density threshold. The only thinking you have to do is to set this threshold to a level somewhere between the normal density readings and the density due to the trouble-making signal. However, the instrument software can compute the threshold value automatically.

Trigger On This™

The Trigger On This™ function allows you to point and click to set up the DPX Density trigger. By right-clicking on a spot within the DPX display, or pressing and holding your finger on the touchscreen display for about a second, a menu selection will appear. Selecting **Trigger On This** causes a DPX Density box to appear and automatically adjusts the threshold. The DPX display will now only update whenever the automatic threshold is exceeded. Subsequently, if needed for your signal, open the Trigger control panel to adjust the density threshold or the size of the measurement box until the event is reliably captured.

Automatic Threshold Adjustment by Trigger On This™

The trigger density threshold automatically set by Trigger On This is 80% of the measured value. If the signal was present at the moment you selected Trigger On This, the threshold will be 20% less than the signal density, so the next time the signal is present long enough (or present enough times) to exceed the threshold density, it will cause a trigger. If the signal happened to be missing when you selected Trigger On This, the threshold value will be even lower. If you clicked in a part of the display with no signal activity at all, the threshold will be set to zero. Any signal that shows up here will fire the trigger.

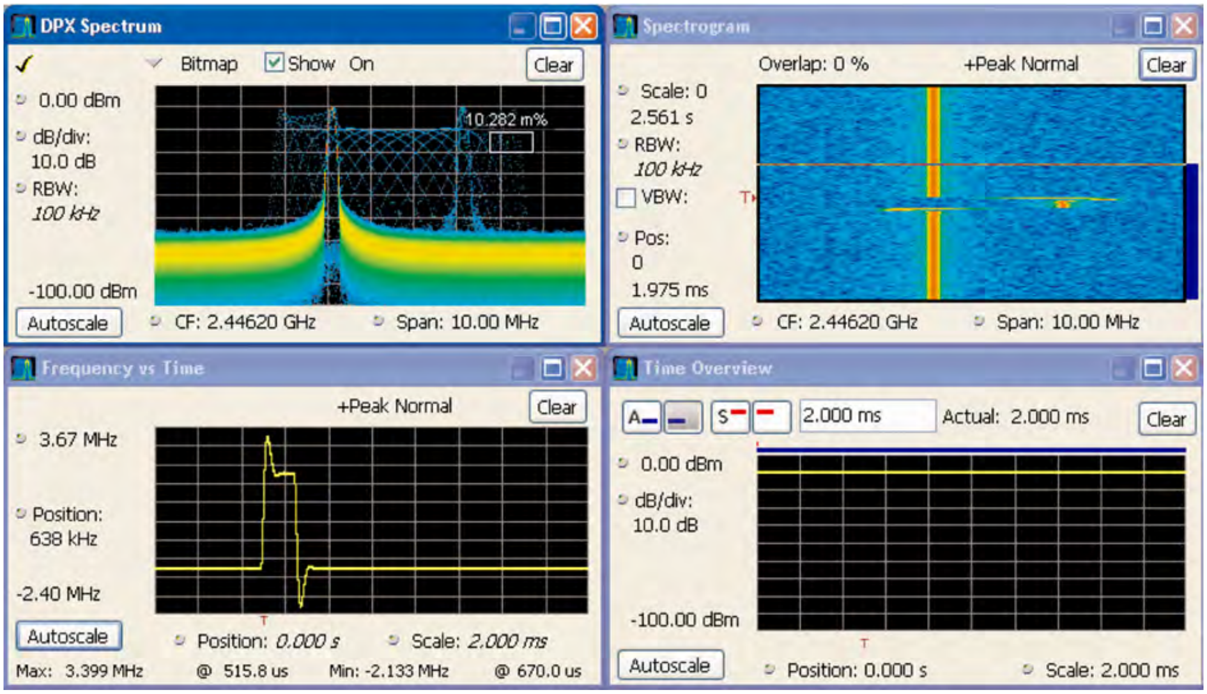


Figure 32: The analyzer triggered when the density in the DPX measurement box exceeded the threshold set by Trigger On This. You can see in the Spectrogram and Frequency-vs-Time displays that the signal event which caused the trigger was a quick frequency hop. The Time Overview shows that the signal amplitude never changed, so a power level trigger would not have worked.

DPX Density Trigger Timing

The time resolution for DPX density measurements is the frame length, around 50 ms. A basic implementation of the DPX Density trigger concept is also frame-based, so a trigger event that occurs anywhere within a frame will not be recognized until the end of the frame. Therefore, the worst case trigger uncertainty is 50 ms.

DPX Density trigger doesn't always have to wait until the end of a frame before firing. For the common configuration of triggering when the measured density is higher than the threshold, the density measurement in the trigger can be computed many times within each frame and it can fire the trigger as soon as the threshold is exceeded.

Consider the case where the threshold is zero. As soon as a single waveform causes a hit within the measurement box, we know that the density is greater than zero. It takes a little longer to test for a 5 or 10% density, and even more time for thresholds at or near 100%.

The DPX Density trigger can also be set to fire when the measured density is below the threshold value. This is useful when you suspect that your signal is missing some of the time. For a signal that is supposed to be CW, you can set the trigger controls to acquire when the density measurement of the signal peak drops below 100%. When using the “lower than” form of the DPX Density trigger, the time resolution is one frame because of the following logic: We can't be sure the actual density is less than, say, 15% until at least 85% of the full test time has elapsed. In order to keep things simple and fast in the trigger module, the RSA just waits until the end of each 50 ms frame to do the “lower than” comparisons.

Persistence and DPX Density Trigger

The smoothing effect of persistence on density measurements can help in determining a good threshold value. With persistence turned off, an infrequent signal's density reading jumps between higher and lower values as it turns on and off, and it can be hard to read these flashing numbers. By turning persistence on, you instruct the instrument to average the density over a longer time period. This density result is somewhere between the ON and OFF density values - the very definition of a good trigger threshold.

Unlike the DPX Density measurement, the DPX Density trigger is not affected in any way by persistence. Density calculations in the trigger system are made with hit count data received from each individual DPX frame, before any persistence is applied. Even when the density measurement reading in the display is averaged over many frames due to persistence, the trigger is computing density for each frame and comparing these quick snapshots against the threshold setting.

DPX display overview

The DPX display enables you to see how traces change over time and thus displays signal events that cannot be seen on a swept spectrum analyzer. A DPX Spectrum indicates how traces change in two ways. First, it uses color shading to show how consistent the shape of a trace is. Second, it uses persistence to hold signals on the screen so you can see them longer.

DPX display

The DPX display works by using a two-dimensional array to represent points on the display. Each time a trace writes to a point on the display, a counter in the array is incremented. A color is assigned to each point in the display based on the value of its counter. Thus, as acquisitions occur over time, a colored waveform, the Bitmap, develops on the display that shows how frequently each display point has been written to.

An important feature of the DPX display is dot persistence. Dot persistence sets how long a point on the display will be visible. You can set the Dot Persistence to be Variable or Infinite. In variable persistence mode, you specify a decay period that limits how long a point will be displayed. In infinite persistence mode, once a point in the display has been written to, it will remain visible indefinitely.

The DPX display can plot the trace in the following views:

- Spectrum – This view plots power on the vertical axis versus frequency on the horizontal axis. This display is similar to a standard Spectrum display.
- Zero Span – This view plots power on the vertical axis versus time on the horizontal axis. This display shows how the power level at the center frequency changes with time.
- Frequency - This view plots frequency on the vertical axis versus time on the horizontal axis. This displays how frequency changes over time, where the center frequency is displayed at the center of the vertical axis.
- Phase - This view plots phase on the vertical axis versus time on the horizontal axis. This displays how phase changes over time, where the zero degree phase position is displayed at the center of the vertical axis.
- DPXogram - This view is a spectrogram version (time plotted along the vertical axis versus frequency on the horizontal axis) of the DPX Spectrum trace. DPX spectrogram creates the spectrogram in real time, and does not require an acquisition to be transferred into memory and analyzed. Because of this real time processing, there are no gaps in the spectral lines, even for monitoring periods that can last for several days.

  The DPXogram has the following limitations:

  - DPXogram cannot sweep a range greater than the maximum real-time bandwidth. When the instrument is sweeping, the DPXogram display shows the *Disabled - data is from swept acquisition* message.
  - No overlap, however, DPXogram can display multiple Spectrums/line.
  - The DPXogram monitors in real time and can be used as a monitor while triggers are occurring. It cannot be set to display only triggered lines.
- Split - This view consists of two DPX views. A DPXogram view appears on the top half of the display and a DPX Spectrum view appears on the bottom half of the display.

To display a DPX view:

1. Select **Freq** and use the front panel knob or number keys to set the measurement frequency.
2. Select the **Displays** button or **Setup** > **Displays**. This displays the **Select Displays** dialog box.
3. From the **Measurements** box, select **General Signal Viewing**.
4. Select **DPX** from the **Available displays** box.
5. Click the **Add** button. This will add the DPX icon to the Selected Displays box (and remove it from the Available displays box).
6. Click the **OK** button. This displays the DPX Spectrum view.
7. Select the desired view from the drop-down list on the left side of the graph.

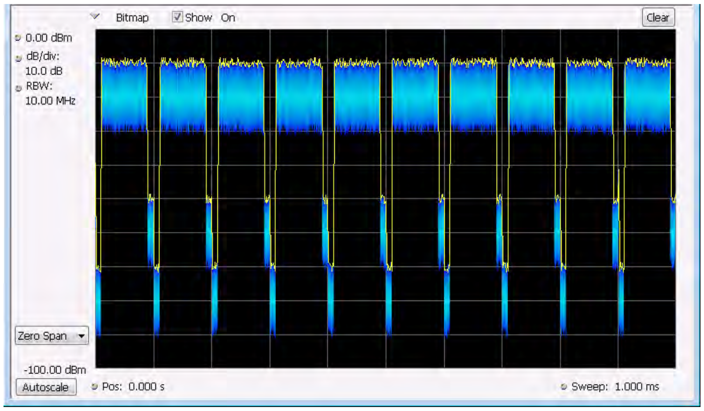


Figure 33: DPX Zero Span view

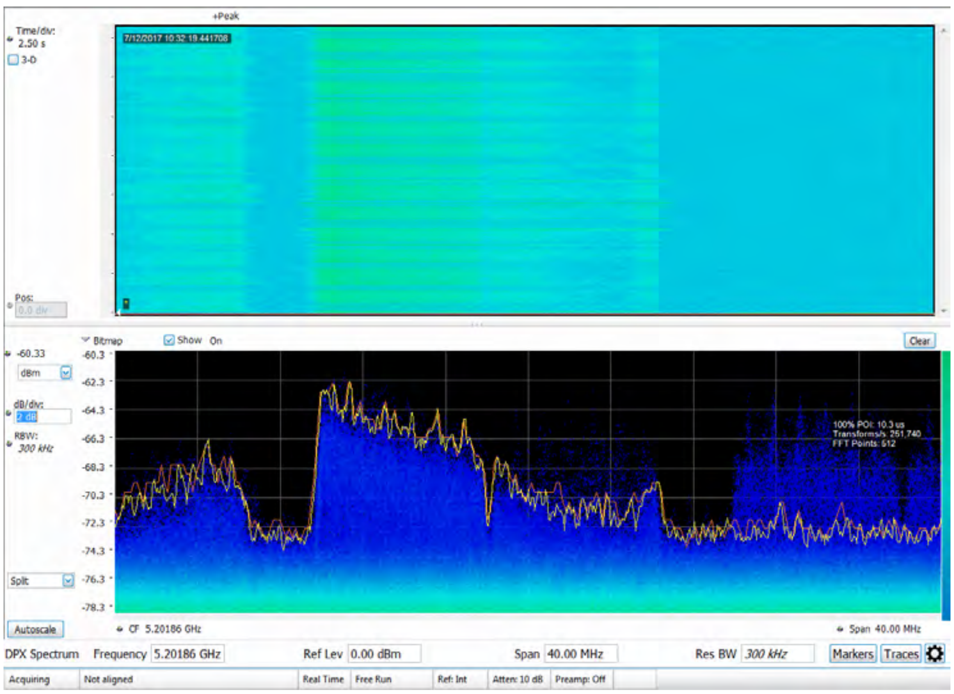
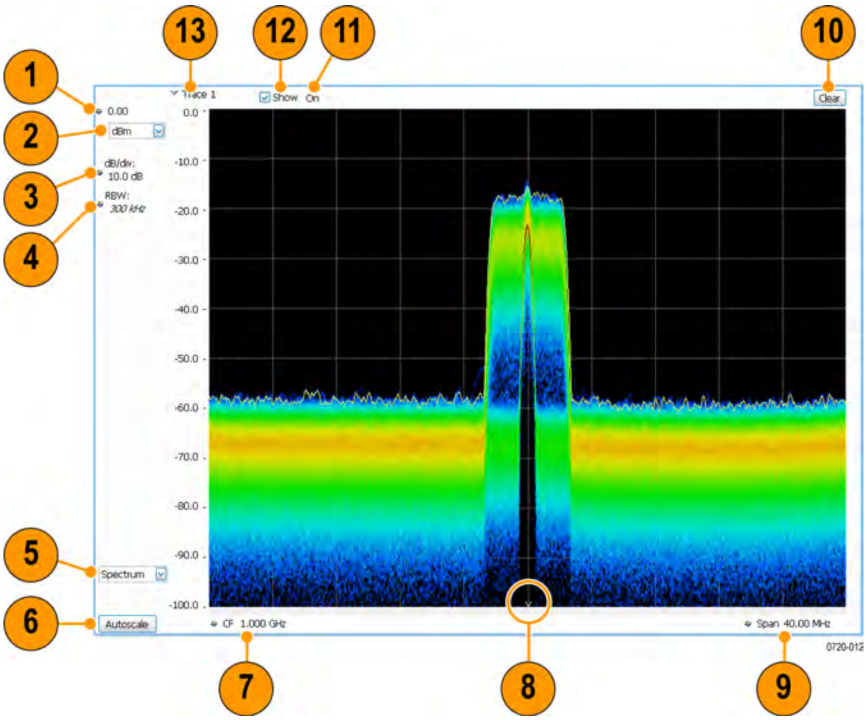


Figure 34: DPX Split View

Elements of the DPX display

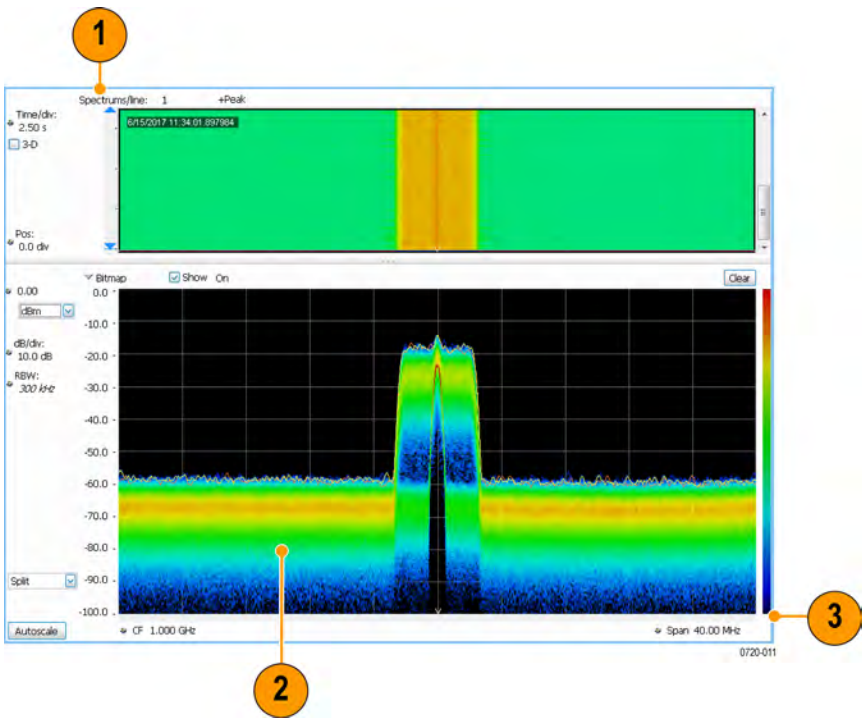


Item	Display element	Description
1	Vert Position	Sets the top of graph value. This is only a visual control for panning the graph. The Reference Level is adjusted in the Toolbar and the Ampl control panel. By default, Vert Position = Ref Level.
2	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the Amplitude selection in the Units tab of Analysis control panel.
3	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.
4	RBW	Sets the resolution bandwidth. Note that when the RBW is set to Auto, its value is italicized.
5	DPX view	Selects the DPX view. Choices are Spectrum, DPXogram, and Split.
6	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen.
7	CF	Adjusts the analyzer center frequency.
8	CF indicator	Indicates the center frequency.
9	Span/Scale	Span - Adjusts frequency range of the measurement. Scale - If Horizontal scale has been manually adjusted in Settings > Scale, then this control adjusts the visual graph scaling without affecting the Span.
10	Clear	Erases the bitmap and traces in the graph and restarts multi-trace functions (Avg, Hold).

Table continued…

Item	Display element	Description
11	Function	Readout of the Detection and Function selections for the selected trace.
12	Show	Controls whether the selected Trace is visible or not. When trace is Off, the box is not checked.
13	Trace	Selects a trace. Touching here pops up a context menu listing the available traces, whether they are enabled or not. If you select a trace that is not currently enabled, it will be made enabled.

Additional elements of the DPXogram split display



This display is only available when a compatible real time spectrum analyzer is connected.

Item	Display element	Description
1	Spectrums/line	Appears only when the display is stopped. Readout of the number of spectrum lines represented by each line of the DPXOgram display. This value changes when the Time/div or Time resolution settings are changed. Line time depends on RBW and FFT processing.
2	DPXogram trace	The selected line in the DPXogram graph can be shown in the DPX Spectrum graph of the Split view. The most recent DPXogram line, usually at the bottom of the graph, is selected by default. If any markers are on, the selected marker determines the selected line.

Table continued…

Item	Display element	Description
3	Color scale	Legend at the right side of the DPX Spectrum display. This element illustrates the relationship between the colors in the DPXogram plot and the amplitude axis of the DPX Spectrum plot. This scale changes with Color (DPXogram) palette selection and Max and Min settings on the Ampl Scale tab.

Time Resolution of DPXogram Display

Due to the large amount of data produced by the DPX hardware during acquisitions, a compressed version of the plot is shown while running. This plot is limited to 500 lines, with each line having 267 points. However, a much longer record, with higher frequency resolution is being collected. As soon as the instrument is stopped, this underlying data is shown, replacing the temporary version. There are 50 lines in each vertical division of the 2-D DPXogram plot, so the time resolution of the graph is Time/div divided by 50. However, you can set the instrument to collect multiple spectra per line, allowing you to zoom in later on this high-time-resolution data.

$$Time\ Resolution\ =\ \frac{10\ \times\ Time/Division}{500}$$

When the DPXogram display is stopped, the analyzer can display the full resolution of the captured data. The Time Resolution readout applies only when the DPXogram is running.

Effects of Changing Time Resolution. The Time Resolution control affects acquisition parameters for the DPX hardware. This means that if you change the Time Resolution value while the instrument is stopped, the new value applies to the NEXT acquisition, and might not represent the results currently shown in the display.

Time resolution can be changed either directly, by manually adjusting the Time Resolution control, or automatically, by changing the Time/div control. Auto is the default, yielding one spectrum per line in the display. When the Time Resolution is decreased below its auto value, multiple spectra are collected to create each line in the DPXogram graph. Once you stop the instrument, you can decrease the Time/div value or use Zoom to see increased time resolution.

If the time resolution is set to a very small number while the Time/div is set to a large value, you might notice that there is a limit to the number of spectra that can be collected. This limit depends on the number of trace points selected. For 801-point spectra, 60,000 underlying spectra can be collected. The number of 2401-point spectra collected is 20,000, and for 4001-point spectra the number is 12,000. When the limit is reached, the oldest spectra are discarded as newer spectra are captured.

Touchscreen Actions on Markers in the Graph Area

Action	Description
Mouse click within 1/2 div. of a marker	Selects the marker and updates the marker display to show the selected marker's values.
Touch marker to select and then use knob, or arrow keys	Adjust the setting associated with the Marker.
Touch and drag a marker	Changes marker position to the "drop point". You can use Tools > Options > Prefs to change whether markers jump from one peak to the next while dragging or move smoothly along the trace.

Available Traces for Display – Standard Instrument

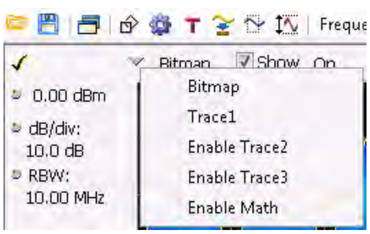
Five traces can be shown in the DPX display– one bitmap and four line traces. The default traces are Bitmap and +Peak detection. The other three traces are –Peak detection, average detection, and math.

Trace	Description
Bitmap	Displays the density of acquired data. The number of data points acquired at each pixel (representing a particular amplitude level at a specific frequency at a point in time) is indicated by color.
+Peak detected	Line trace. Displays the maximum values acquired in each update. Normal and Hold functions are available for this trace.
–Peak detected	Line trace. Displays the minimum values acquired in each update. Normal and Hold functions are available for this trace.
Average detected	Line trace. Displays the average of all the values acquired in each update. Normal and Hold functions are available for this trace.
Math Trace	Line trace. Displays the difference between two traces. The two traces used are set in the Traces tab of the Settings panel.

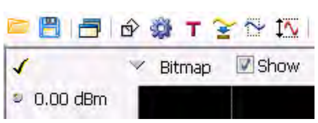
Determining Which Trace Types Are Displayed

You can see the status of all the traces by selecting the Trace drop-down list. Traces that are not displayed are preceded by "Enable". In the following figure, you can tell that the Bitmap and -Peak Trace traces are displayed but the +Peak, Average, and Math Traces are not displayed.

Selecting **Enable -Peak Trace** from the Trace list displays the -Peak detected values trace.



You can see whether a trace is enabled by looking at its **Show** check box. The "selected trace" is selected in the Trace list. The Show check box is checked when the selected trace is enabled. To the right of the show box are readouts for detection of the selected trace (+Pk, Avg (VRMS),) and its function (Hold, Normal,). You can enable/disable the selected trace by checking or unchecking **Show**.



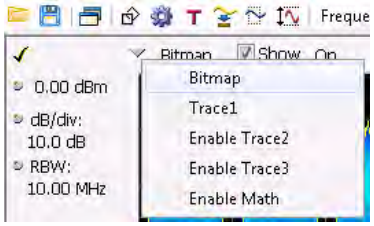
Selecting Traces for Display – Standard Instrument

To select a trace for display:

1. Use the Settings control panel:
   - Select **Setup** > **Settings** or click the **Settings** button.
   - Select the **Traces** tab.
   - Select the trace from the drop-down menu.

- Select the **Show** check box.

2. Select a trace from the Trace drop-down list.



Specifying How +Peak, –Peak, and Average Traces Are Displayed

You control how the +Peak, –Peak and Average (Avg (VRMS)) traces are displayed from the Traces tab of the Settings control panel. From the Traces tab, you can also specify whether these traces display results from single updates or results collected over multiple updates.

To change how the traces are displayed:

1. Select **Setup** > **Settings** or click the **Settings** button.
2. Select the **Traces** tab.
3. Select the trace type from the drop-down list.
4. If you select +Peak Trace or -Peak Trace, use the **Function** drop-down list to select either **Normal** or **Hold**.
   a. Select **Normal** to set the trace to display the maximum/minimum values acquired in each individual update.
   b. Select **Hold** to set the trace to display the maximum/minimum values acquired over time. The trace values are updated only if they exceed the existing values.
5. If you select Avg (VRMS) or Avg (of logs), use the **Function** drop-down list to select either **Normal**, **Average (VRMS)**, or **Avg (of logs)**.
   a. Select Normal to set the trace to display the average values acquired in each update.
   b. Select Average (VRMS) or Avg (of logs) to set the trace to display an average of the average values. Use the Count box to enter the number of times the trace is averaged.

Available Traces for Display

Five traces can be shown in the DPX Spectrum, Zero Span, Frequency, and Phase displays– one bitmap and four line traces. The default traces are Bitmap and Trace 1. The other three traces are 2, 3, and Math. Line traces 1, 2, and 3 have user-selectable Detection and Function settings. The final line trace is Math, allowing you to subtract one line trace from another.

For the DPXogram display, only one trace is available – the DPXogram trace.

For the Split display, you can display the Bitmap trace, Trace 1, Trace 2, Trace 3, Math trace, and Ogram Line (the selected line from the DPXogram display) on the DPX Spectrum portion of the display.

Selecting Traces for Display

This is done almost the same as with the standard instrument, except that the choices available for Trace are different. Instead of +Pk, –Pk, and Avg traces, you select Trace 1, 2, and 3 and independently set the Detection method for each of these traces to +Pk, -Pk, Avg (VRMS), or Avg (of logs).

Reference. *Changing the DPX Spectrum Display Settings*

DPX settings

Menu Bar: Setup > Settings

Front Panel / Application Toolbar: Settings

The measurement settings for the DPX display are shown in the following table.

Settings tab	Description
Freq & Span	Sets frequency and span parameters for the DPX display. This tab appears for the Spectrum and DPXogram displays.
Params	Sets sweep time and scroll settings. This tab appears only for the DPX Zero Span, DPX Frequency and DPX Phase displays.
Freq & BW	The Freq & BW tab specifies frequency and bandwidth parameters for the DPX Zero Span, DPX Frequency, and DPX Phase views.
BW	Sets Resolution Bandwidth.
Traces Tab	Allows you to select the number and types of traces to display and their functions.
Traces Tab	Allows you to select the number and types of traces to display and their functions.
Horiz & Vert Scale Tab	Sets the vertical and horizontal scale parameters for all the DPX views. (Available only when Spectrum view is active.)
Bitmap Scale Tab	Sets the DPX Bitmap display parameters.
Amplitude Scale Tab	The Amplitude Scale tab allows you to change the vertical scale and offset, enable the 3-D Waterfall display, and set the color scheme used for the DPXogram trace.
Time & Freq Scale Tab	The Time and Freq Scale tab allows you to change the vertical and horizontal scale settings, number of points in the trace, and Time resolution.
Prefs	Specifies whether certain display elements are visible.
Density	Specifies location and size for the DPX Density measurement box. (Spectrum display only.)
Audio Demod	Enables and sets parameters for audio demodulation function.

Params tab - DPX zero span DPX frequency and DPX phase views

The Params tab sets the sweep time for the DPX Zero Span, Frequency and Phase views. Use the Params tab to set the scroll mode settings for the DPX Zero Span, Frequency and Phase views. In Scroll mode, points of the trace are plotted as they occur, as opposed to normal mode where the trace is plotted after an acquisition is completed.

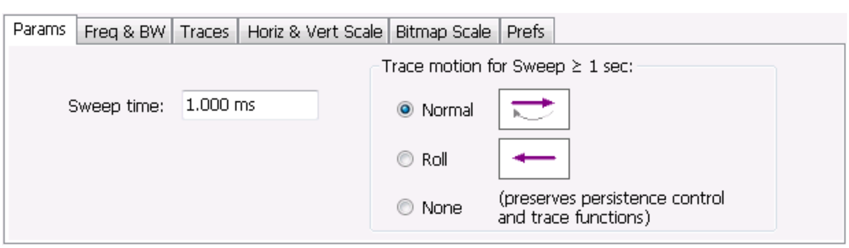


Table 5: Params tab settings Zero Span, Frequency and Phase views

Setting	Description
Sweep time	Sets the time period for the measurement. By default, the Horizontal Scale is equal to Sweep time and the sweep covers 10 divisions. When the graph is zoomed in, the sweep time extends beyond the left and/or right edges of the graph. Range: 100 ns – 2000 s. Default: 1 ms.
Trace motion for Sweep ≥ 1 sec	Specifies how the trace is displayed when the sweep time is equal to or greater than 1 second.
Normal	Select Normal to scroll the position at which data points are added to the trace. In this mode, a caret (^) moves below the graph to indicate the latest position.
Roll	Select Roll to scroll the trace as points are added at the right side of the graph. When Roll is selected, the trace moves to the left as points are added to the trace at the right side of the graph.
None	Select None to display the trace without motion.

Freq and BW tab - DPX zero span DPX frequency and DPX phase views

The Freq & BW tab specifies frequency parameters for some of the DPX display views.

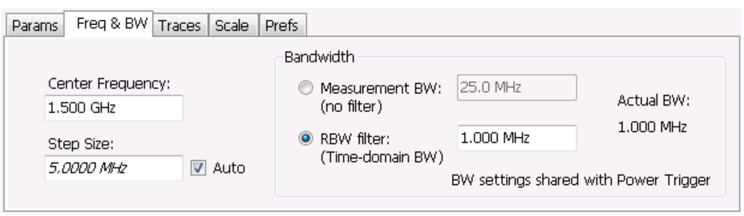


Table 6: Freq & BW tab settings for the bitmap trace

Setting	Description
Center Frequency	Sets the frequency at the center of the measurement bandwidth.
Step Size	Sets the increment size when changing the Frequency using the knob or mouse wheel. Arrow keys have an increment 10 times this setting.
Auto	When Auto is enabled, the step size is adjusted automatically based on Spectrum's span setting.
Measurement BW, no filter	This setting allows you to override the automatic bandwidth calculation and directly enter a bandwidth value without the time-domain filter. 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.
RBW (Time-domain BW) filter	RBW (Time-domain BW) is a filter used to process the input signal before the system analyzes the signal. The filter value determines the acquisition bandwidth that the view requires. Range: 1 HZ to 60 MHz.
Actual BW	Shows the actual bandwidth being used for the display.

Traces tab

The Traces tab allows you to set the display characteristics of displayed traces in the DPX display. The Traces tab settings vary depending on the DPX display view enabled (Spectrum, DPXogram, or Split).

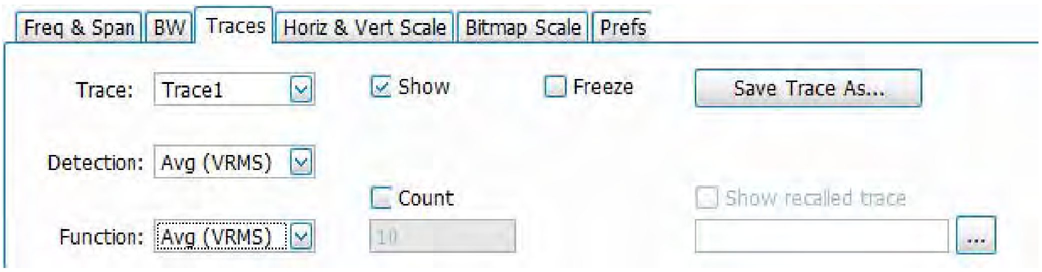


Figure 35: Traces tab with Trace1 and average selected

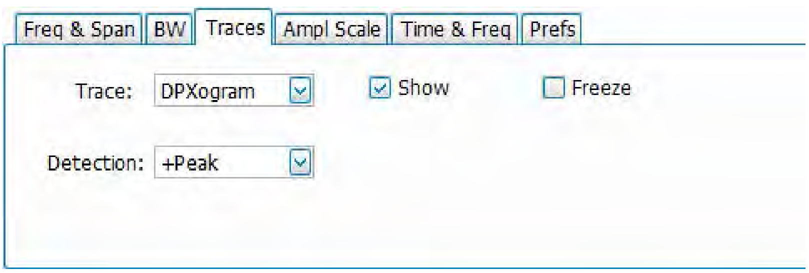


Figure 36: Traces tab with DPXOgram selected

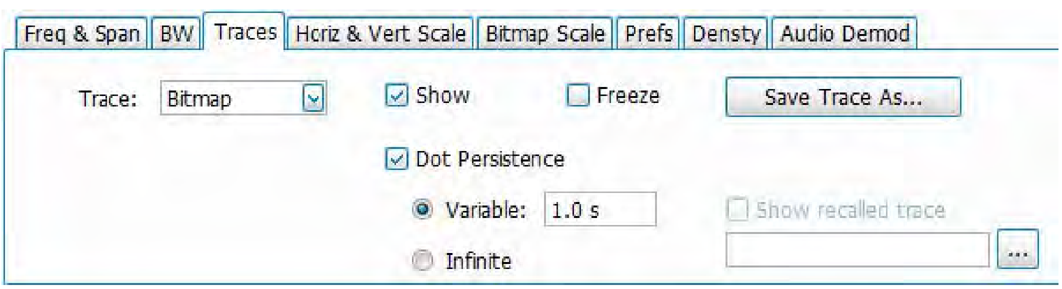


Figure 37: Traces tab with Bitmap selected

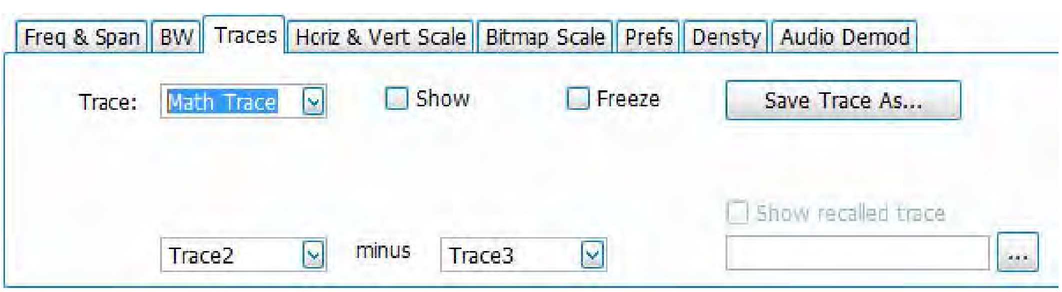


Figure 38: Traces tab with Math Trace selected

Setting	Description
Trace drop-down list	Selects which trace to configure. The available traces are Bitmap, Trace 1, Trace 2, Trace 3, and Math.

Table continued…

Setting	Description
Show	Specifies whether or not the trace shown in the Trace setting is displayed
Freeze	Halts updates to the selected trace.
Detection	Sets the Detection method used for the trace. Available detection methods are +Peak, -Peak, and Avg (VRMS).
Function	Selects the trace processing method. Available settings are: Normal, Average, and Hold.
Count	Sets the number of traces averaged to generate the displayed trace. (Present only when Function is set to Average.)
Dot Persistence (Available only when Bitmap is selected)	Allows a dot to remain visible if it is not updated with new data. Choices for this setting are Variable and Infinite.
Variable	The Variable dot persistence setting controls how long a point in the display is visible before fading. Range: 100 ms – 60 s. Resolution 0.1.
Infinite	The Infinite dot persistence setting prevents a point in the display from fading (not available for the DPXogram trace).
Trace minus Trace (Available only when Math Trace is selected)	The Math trace 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.
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.

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 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.

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

Dot Persistence

Dot Persistence is the characteristic of the DPX display that determines how long a pixel in the display remains visible.

To set the Persistence:

1. Select **Setup** > **Settings**.
2. Select the **Traces** tab.
3. Select **Dot Persistence**.
4. Select either **Infinite** or **Variable**.
5. If you select Variable, enter a value in the text box. The Variable persistence value can be set from 0.05 to 100 seconds.

DPX Trace Processing

The +Peak, -Peak, and Average traces can be processed to display in different ways. The Function setting controls trace processing.

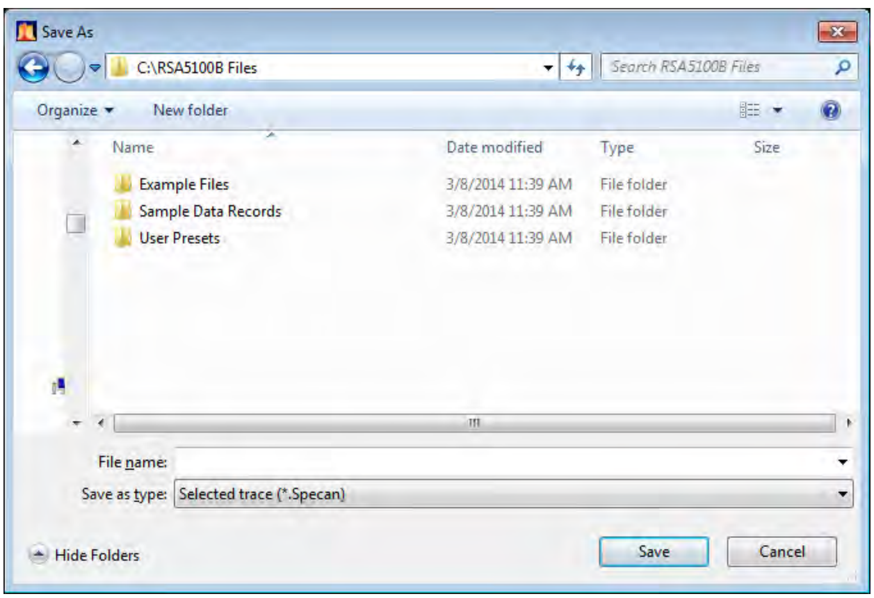
- **Hold** - Displays the value in the trace record for each display point. Each new trace display point is compared to the previous maximum value and the greater value is retained for display and subsequent comparisons. Available for traces using +Peak or -Peak detection.
- **Normal** - Displays the trace record for each display point without additional processing. Available for all detection selections.
- **Average** - Default setting for the 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 **Count** setting specifies how many traces are averaged. Available for traces using Average detection.

  Trace averaging uses the exponential method. If Count = 10, the newest trace's contribution to the averaged trace is 10%. When Count is not checked, the algorithm assumes the maximum number of traces contributing to the average is 2^{32}.

Saving Traces

To save a trace for later analysis:

1. Select the **Save Trace As** button. This displays the Save As dialog box.



2. Type a name for the saved trace and click **Save**.

Recalling Traces

You can recall a previously saved trace for comparison to a live trace. First, specify a trace for recall and second, enable Show Recalled Trace.

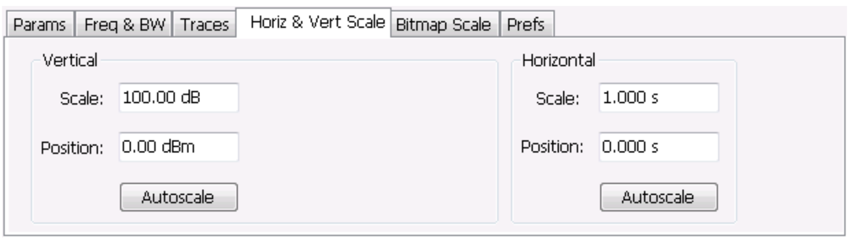
To select a trace for recall:

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 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).

Horiz and vert scale tab

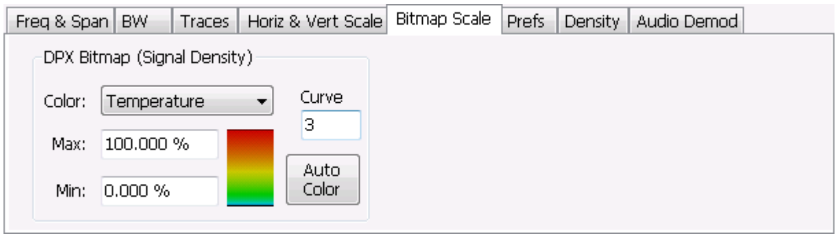
The Horiz & Vert Scale tab allows you to change the vertical scale settings used for the Bitmap trace. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency.



Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale.
Offset	Adjusts the Reference Level away from the top of the trace display.
Reset Scale	Sets Scale to its default value and Offset to zero. Disabled when Units (Setup > Analysis > Units) is set to Watts or Volts.
Autoscale	Resets the scale of the vertical axis to contain the complete trace. Disabled when Units (Setup > Analysis > Units) is set to Watts or Volts.
Horizontal	Controls the horizontal position and scale of the trace display.
Scale	Changes the horizontal scale.
Position	Adjusts the horizontal position of the signal. This does not change the center frequency.
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.

Bitmap scale tab

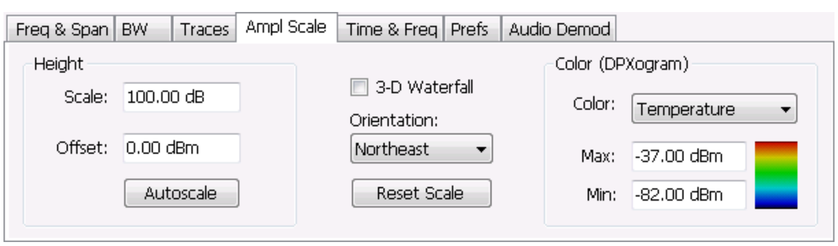
The Bitmap Scale tab allows you to set the color scheme used for the Bitmap trace. Changing the DPX bitmap Color, Max and Min scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency.



Setting	Description
DPX Bitmap (Signal Density)	Controls the appearance and scale of the DPX Bitmap trace.
Color	Allows you to select the color palette used for the DPX Bitmap trace.
Max	Sets the hit density represented by the top of the color scale. "Clipping" occurs for densities greater than this value. Range: 1p% - 100%; Default: 100%.
Min	Sets the hit density represented by the bottom of the color range. Range: 0 - 80%; Default: 0.
Curve	Adjusts how colors are mapped to the signal density. The mapping can be linear (Curve = 1), or it can be set to concentrate the resolution on the lower level of the range (Curve > 1) or the mapping can be set to show the best resolution on the upper range of density or hit count (Curve < 1).
Auto Color	Adjusts the Max and Min settings to display the broadest range of colors.

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 DPXogram trace.



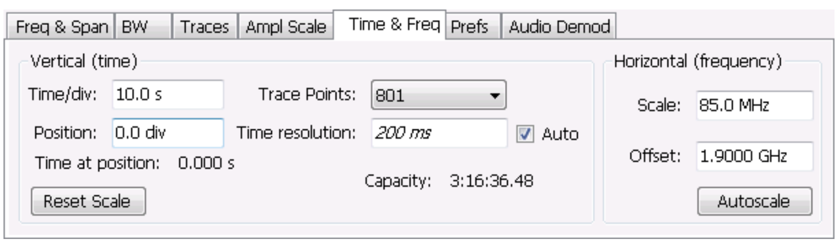
Setting	Description
Height	Height controls apply only to the 3-D Waterfall display.
Scale	Changes the vertical scale for trace Amplitude in the graph (not the vertical scale for Time).
Position	Specifies the level displayed at the bottom edge of the graph. (Bottom front edge in the 3-D view).
Autoscale	Adjusts the vertical position bottom for linear units like Amps and Volts. Adjust the vertical position top for log units like dBm. dBm is the default.

Table continued…

Setting	Description
3-D Waterfall	Displays the DPXogram 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 (DPXogram)	
Color	Displays a drop-down list that allows you to set the color scheme used for the DPXogram trace.
Max	Sets the power level represented by the top of the color scale.
Min	Sets the power level represented by the bottom of the color scale.

Time and freq scale tab

The Time and Freq Scale tab allows you to change the vertical and horizontal scale settings, set the time resolution and number of trace points of the DPXogram display.



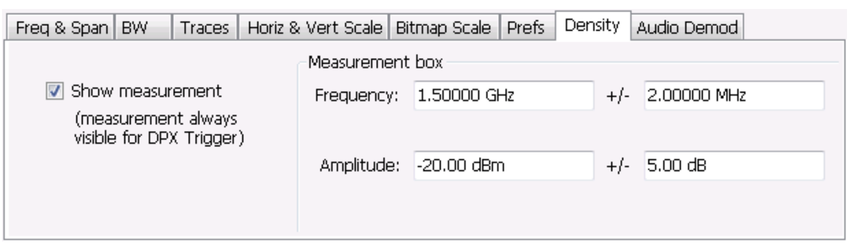
Setting	Description
Vertical (time)	
Time/div	For most Spectrogram applications. Primary time scale control is Time/div. Time scale can be zoomed in or out when acquisitions are stopped.
Position	The position of the DPXOgram record at the bottom of the display. Position cannot be changed while acquisitions are active, and is reset to zero when acquisitions are started again.
Time at position	Displays the time of the DPXogram line shown at the bottom of the graph. This time is relative to the Time Zero Reference of the current acquisition. If Position is set to a negative value, the Time at position readout will be blanked.
Reset Scale	Sets the Time/div and Position settings to their default values.
Trace Points	Sets the number of trace points computed for each DPXogram line. These are the points used for marker measurements and for results export.

Table continued…

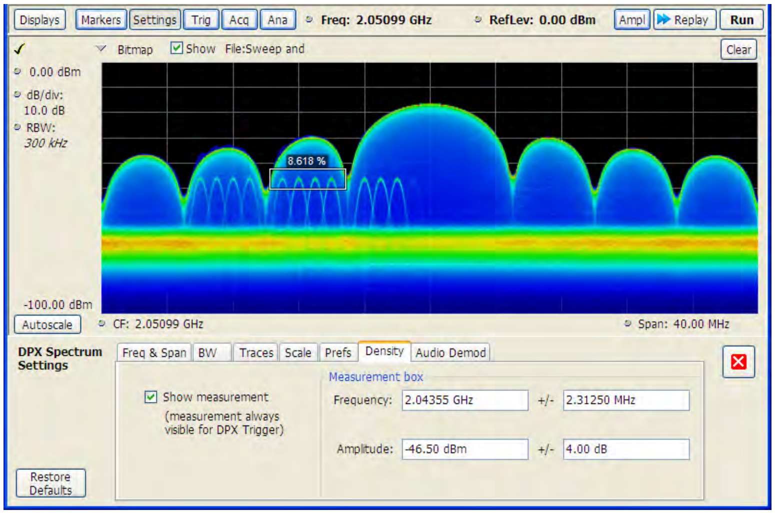
Setting	Description
Time resolution	Specifies the length of time represented by each line in the graph. Line time depends on RBW and FFT processing.
Auto	Sets the time represented by each line in the graph to be adjusted by the analyzer checked) or manually (when unchecked). When Auto is enabled, Time Resolution change based on Time/div.
Capacity	Readout of the total length of time that can be captured. This readout is provided so that you can see how changing the Trace Points and Time resolution affects the amount of data that can be captured. Capacity is represented in the format dd:hh:mm:ss.
Horizontal (frequency)	
Scale	Sets the displayed frequency range of the graph. This control affects only visual scaling, and does not change the acquisition or analysis parameters.
Position	Sets the frequency displayed at the center of the graph. Changing this value does not change the Frequency setting.
Autoscale	Sets the frequency scale to the Spectrogram Span value.

Density tab

The Density tab specifies the parameters of the measurement box used for measuring average signal density of an area in the bitmap. The measurement box is also used by DPX Density triggering.



To measure the average signal density over a rectangular portion of the DPX bitmap, you can adjust the size and location of the measurement area using these controls, or by dragging the measurement box in the graph. You move the box by dragging the readout. You adjust the size of the box by dragging the corners or edges.

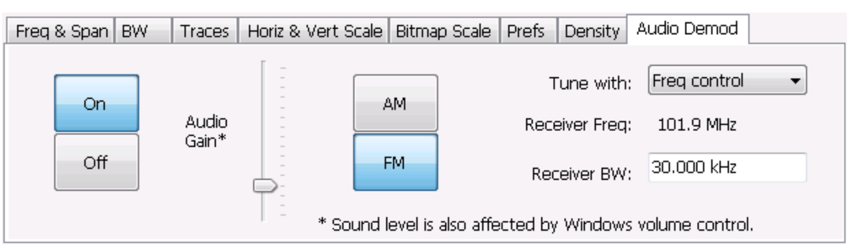


Setting	Description
Show Measurement	Shows or hides the measurement box in the graph when Triggering is not set to DPX Density. If Triggering is set to DPX Density, the measurement box is always visible.
Frequency	Specifies the frequency at the center of the measurement box. The +/- value specifies the width of the measurement box.
Amplitude	Specifies the amplitude of the center of the measurement box. The +/- value specifies the height of the measurement box.

Audio demod tab

Audio demodulation can help you identify unknown radio signals. You control the audio demodulation function with the Audio Demod tab. You access the Audio Demod tab from the Settings control panel of the DPX display.

Note: Audio Demodulation is available only in real-time acquisition mode (not swept acquisition), and the Trigger mode must be set to Free Run (not Triggered).



Setting	Description
On/Off	Enables/disables audio demodulation.
Audio Gain	Adjusts the volume of the demodulated audio.
AM	Selects Amplitude Modulation as the demodulation method.

Table continued…

Setting	Description
FM	Selects Frequency Modulation as the demodulation method.
Tune with	Specifies how the frequency to be demodulated is specified. You can select markers or the frequency control.
Receiver Freq	Readout of the frequency to be demodulated.
Receiver BW	Adjusts the equivalent receiver bandwidth for the audio demodulation. The range of values is 1 kHz to 500 kHz.

AM / FM

Note that these buttons select the demodulation method; they do not specify a frequency band.

Tune with

The choices for this setting are: one of the markers (MR, M1, M2, M3, M4) or the Frequency control (either the front-panel knob or the Freq control in the application).

To use a marker to specify the frequency to be demodulated:

1. Select **Markers** > **Define Markers** to display the Define Markers control panel.
2. Select **Add** to turn on the next marker.

Note: The first marker defined will always be **MR**. The MR marker is the reference for delta marker readouts.

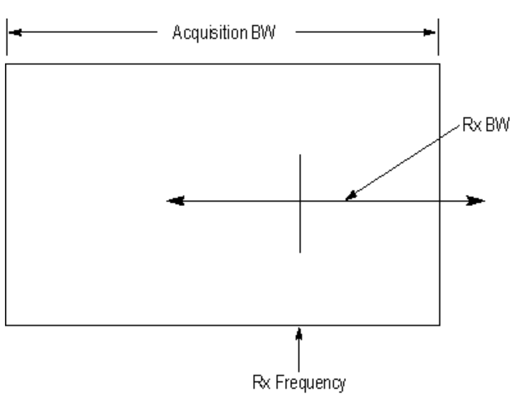
3. Select the trace to which the marker should be attached from the drop-down list.
4. Click **Add** to add additional markers. Assign them to the appropriate trace.
5. Click the close button to remove the Define Markers control panel.

Select markers. Select one of the markers in the Tune with drop-down list and then set the location of the marker to the frequency you want to demodulate. If the marker you select is not enabled, the analyzer will tune to the frequency the marker was last set to.

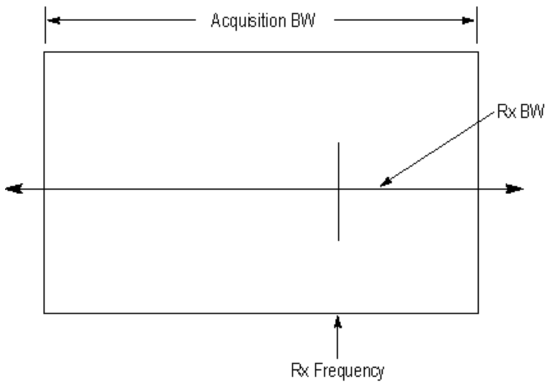
Receiver BW

The Receiver BW setting will not change the acquisition bandwidth. Thus, if the acquisition bandwidth is too narrow, audio demodulation will be disabled. The following three cases illustrate the relationship between the Acquisition BW, Receiver Frequency, and Receiver BW.

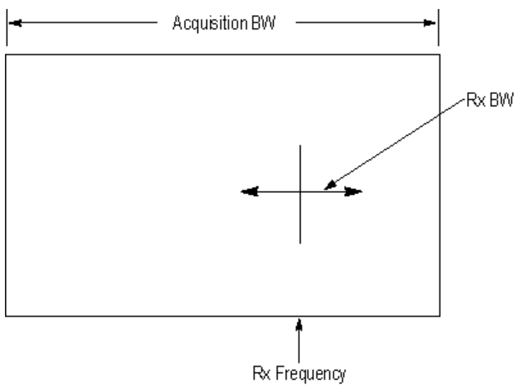
Case 1. In this case, the upper limit of the Receiver BW exceeds the upper limit of the acquisition bandwidth. When this occurs, audio demodulation is disabled and an error message is displayed.



Case 2. In this case, the upper and lower limits of the Receiver BW exceed the upper and lower limits of the acquisition bandwidth. When this occurs, audio demodulation will be disabled and an error message is displayed.



Case 3. In this case, the upper and lower limits of the Receiver BW fall within the upper and lower limits of the acquisition bandwidth. This is the desired relationship between the three settings, and audio demodulation is enabled.



Time overview

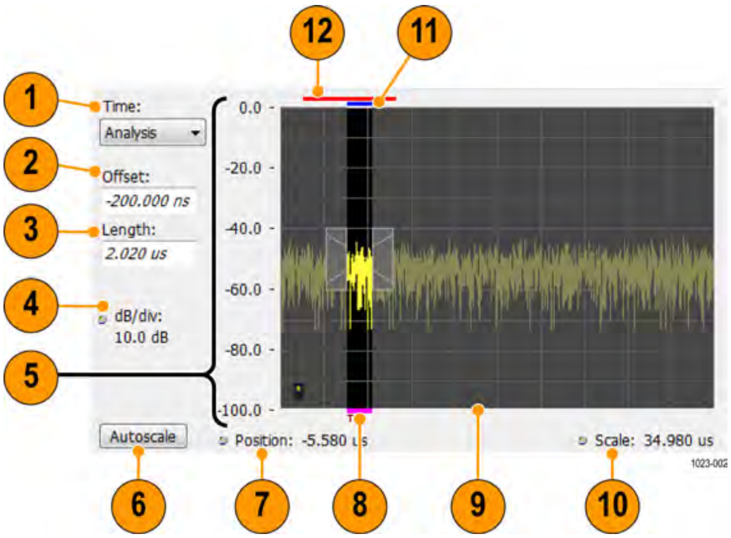
Time overview display

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



Item	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.

Table continued…

Item	Element	Description
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

Time overview settings

Menu Bar: Setup > Settings

Front Panel : Settings

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

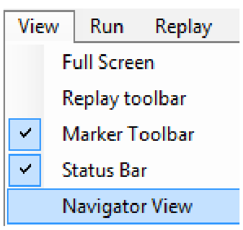
Settings tab	Description
Scale	Adjusts the vertical and horizontal scale and offset of the display.
Trace	Allows you to select the types of trace to display and its function.
Prefs	Specifies whether or not certain display elements are shown.

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.

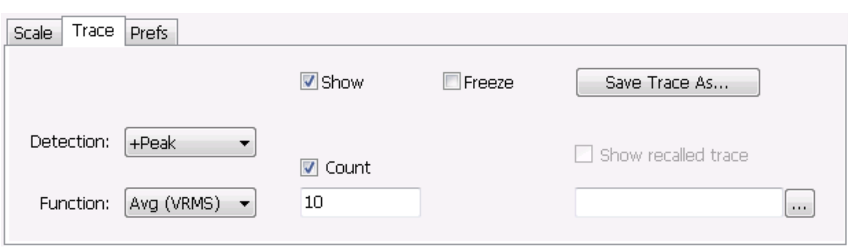
Show Navigator View

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.



Setting	Description
Show	Shows / hides the selected trace.
Detection	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.

Table continued…

Setting	Description
Function	Selects the trace processing method. Available settings are: Normal, Average, Max Hold, and Min Hold.
(Number of Traces)	Sets the number of traces averaged to generate the displayed trace. (Present only when Function is set to Average.)
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.

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:

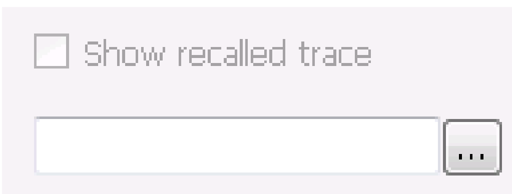
1. Select the Save icon . This displays the Save As dialog box.
2. Navigate to the desired folder or use the default.
3. Type a name for the saved trace and click **Save**.

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.



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).

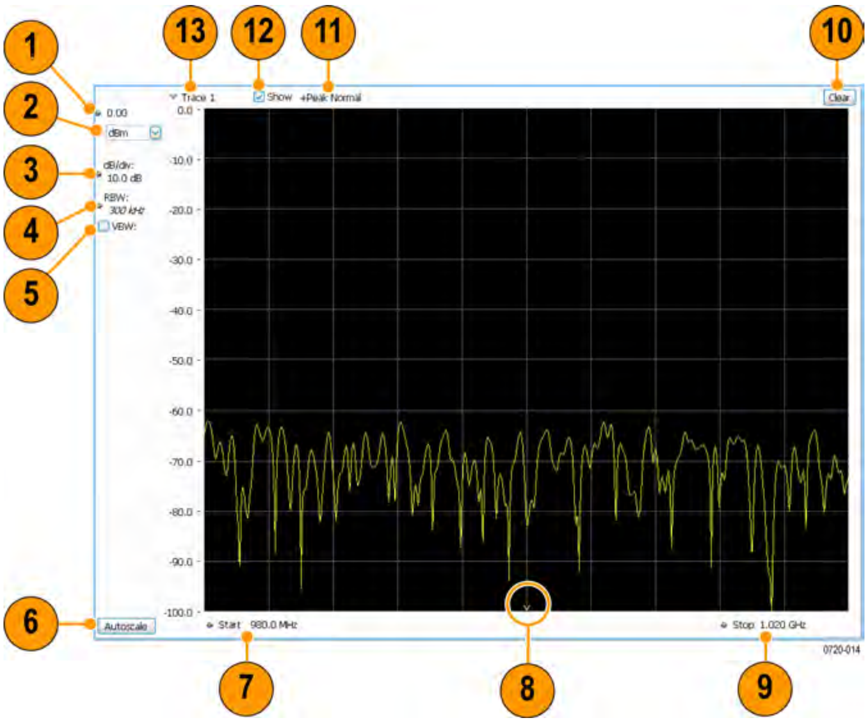
Spectrum

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



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 Amplitude control panel. By default, Vert Position = Ref Level.
2	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the Amplitude selection in the Units tab of Analysis Control panel.
3	dB/div	Sets the vertical scale value. The maximum value is 20.00 dB/division.
4	RBW	Sets the resolution bandwidth. Note that when the RBW is set to Auto, its value is italicized.
5	VBW	Enables the VBW (Video Bandwidth) filter. See Setup > Settings > *BW Tab*.
6	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen.
7	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.
8	CF indicator	Indicates the center frequency.

Table continued…

Item	Display element	Description
9	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.
10	Clear	Restarts multi-trace functions (Avg, Hold).
11	Function	Readout of the Detection and Function selections for the selected trace.
12	Show	Controls whether the selected Trace is visible or not. When trace is Off, the box is not checked.
13	Trace	Selects a trace. Clicking here pops up a context menu listing the available traces, whether they are enabled or not. If you select a trace that is not currently enabled, it will be made enabled.

Touchscreen Actions on Markers in the Graph Area

Action	Description
Mouse click within 1/2 div. of a marker	Selects the marker and updates the marker display to show the selected marker's values.
Touch marker to select and then use knob, or arrow keys	Adjust the setting associated with the Marker.
Touch and drag a marker	Changes marker position to the "drop point".

Changing the Spectrum Display Settings

Spectrum settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

Settings tab	Description
Freq & Span	Sets frequency and span parameters for the Spectrum Analysis display.
BW	Sets Resolution Bandwidth and windowing parameters.
Traces	Sets Trace display parameters.
Traces (Math)	Sets the traces used to create the Math trace.

Table continued…

Settings tab	Description
Scale Tab	Sets vertical and horizontal scale and position parameters.
Prefs Tab	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.

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

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.

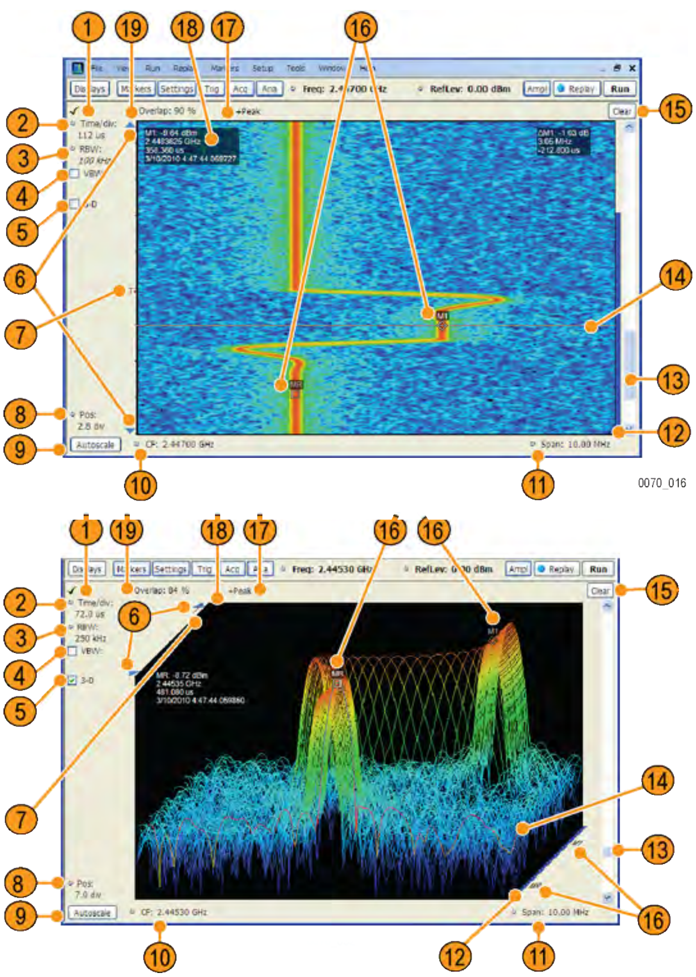
The spectrogram can also be displayed in a 3-D waterfall format. In the 3-D waterfall format, the spectrogram displays the time axis along a simulated Z-axis.

Note: Spectrogram data is shared with the Spectrum display. There is no linkage between DPX and Spectrogram.

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 > *BW Tab*.
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	T	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**.

Table continued…

Item	Display element	Description
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 *Settings > Trace* tab).
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 *Settings > Prefs*).
19	Time Scale status readout	Three readouts can appear here depending on settings: Time/update, Spectrums/line, and Overlap. See *Time Scale Status Readout*.

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

Spectrogram settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

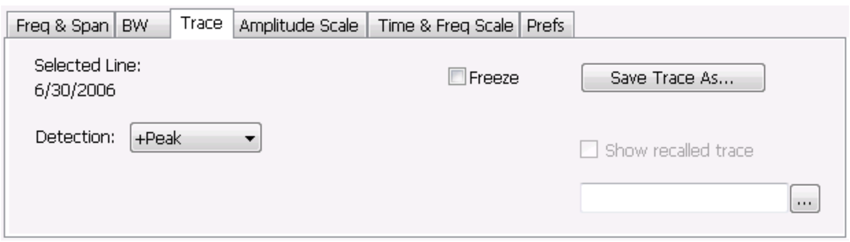
Settings tab	Description
Freq & Span	Sets frequency and span parameters for the Spectrogram display.
BW	Sets Resolution Bandwidth and windowing parameters.
Trace	Sets Trace display parameters.
Amplitude Scale	Selects between 2-D and 3-D, sets height scale, position and orientation for 3-D display. Sets color parameters for the spectrogram trace.

Table continued…

Settings tab	Description
Time & Freq Scale	Sets the vertical and horizontal scale parameters for the spectrogram trace. The Spectrum Monitor controls are also on this tab.
Prefs	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 *Traces Tab*.

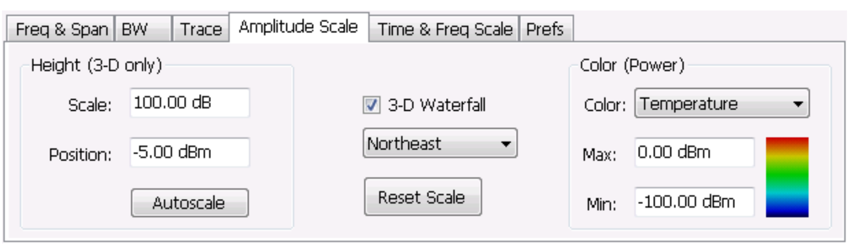


Selected Line

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.



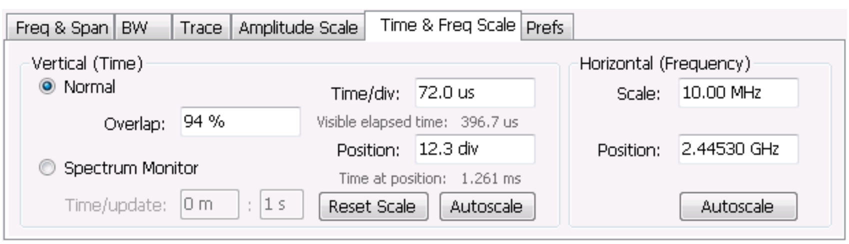
Setting	Description
Height (3-D only)	
Scale	Changes the vertical scale for trace Amplitude in the graph (not the vertical scale for Time).
Position	Specifies the level displayed at the bottom edge of the graph. (Bottom front edge in the 3-D view).
Autoscale	Adjusts the vertical position and scale of the trace lines to bring them into the visible portion of the graph.
3–D Waterfall	Displays the spectrogram in a 3-D format.

Table continued…

Setting	Description
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 and 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.



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.

Table continued…

Setting	Description
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 not 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

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.

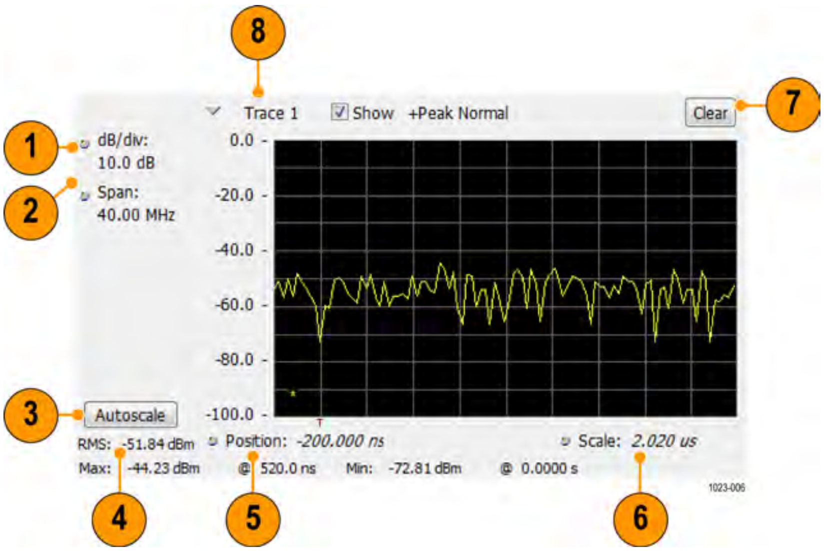
Note that the trace(s) in the Amplitude vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, 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



Item	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*

Amplitude vs time settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

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

Freq and 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
Time-domain Bandwidth filter	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)
Measurement BW, no filter	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.

Frequency vs time

Frequency vs time display

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

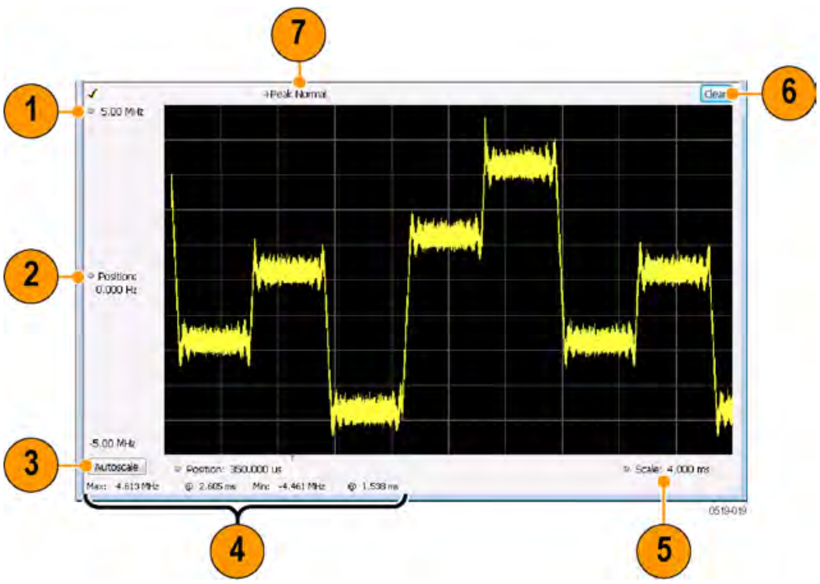
Note that the trace(s) in the Frequency vs. Time display can be set to a maximum of 100,000 points (however, the actual number of trace points can extend up to 1,000,000 points if Max trace points is set to Never Decimate). If the Analysis Length includes more than the selected Max trace points value, 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



Item	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

Frequency vs time settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

Settings tab	Description
Freq & BW	Sets the frequency and bandwidth parameters.
Trace	Sets the trace display parameters.
Scale	Sets the Vertical and Horizontal scale and offset parameters.
Prefs	Specifies whether certain display elements are visible.

Phase vs time

Phase vs time display

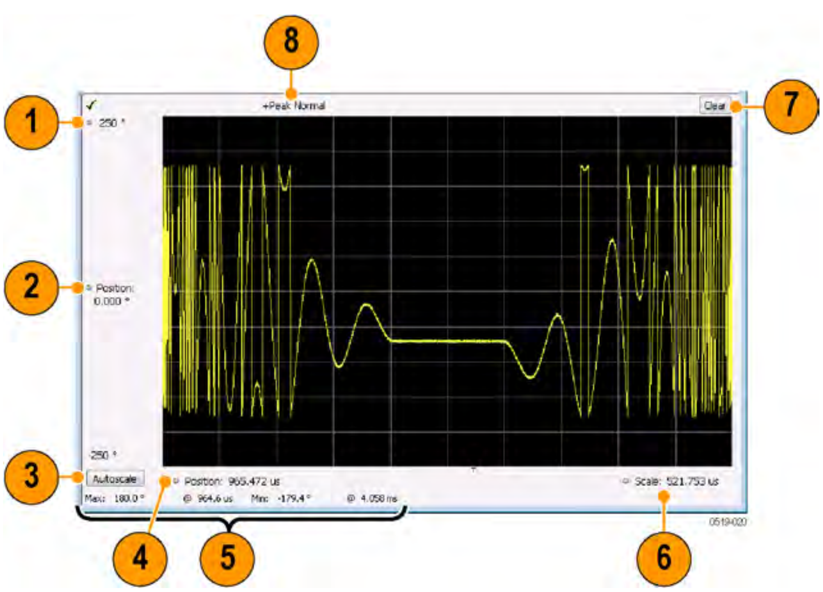
The Phase vs. Time display plots the signal phase against time. The phase appears on the vertical axis while time is plotted along the horizontal axis.

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



Item	Display element	Description
1	Top of graph adjustment	Adjusts the vertical scale. Use the knob to adjust the value of the top of the graph.
2	Vertical offset adjustment	Adjusts the phase error shown at the vertical center of the display.
3	Autoscale button	Adjusts the vertical and horizontal settings so that the entire trace fits in the view.
4	Horizontal Offset	Adjusts the horizontal position of the trace.
5	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.
6	Horizontal Scale	Sets the time spanned by the graph.
7	Clear button	Restarts multi-trace functions (Avg, Hold).
8	Trace function	Shows the trace function as set on the Settings > Trace tab.

Changing the Phase vs Time Display Settings

Phase vs time settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

Settings tab	Description
Freq & BW	Sets the frequency and bandwidth parameters.
Trace	Sets the trace display parameters.
Scale	Sets the Vertical and Horizontal scale and offset parameters.
Prefs	Specifies whether certain display elements are visible.

RF I and Q vs time

RF I and Q vs time display

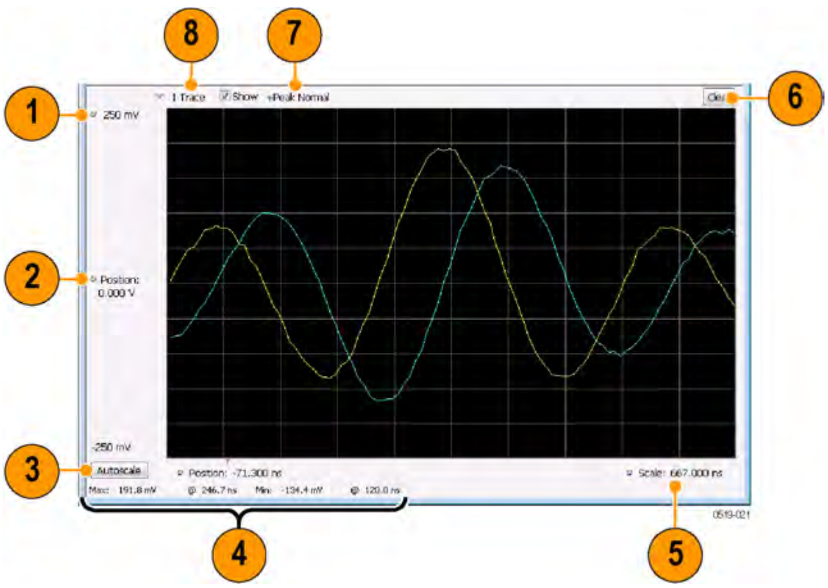
This is a plot of the baseband In-Phase (I) and Quadrature (Q) components of a modulated carrier. The plot is in the time domain, with I and/or Q values the Y-axis.

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



Item	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

RF I and Q vs time settings

Menu Bar: Setup > Settings

Front Panel: Settings

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

Settings tab	Description
Freq & BW	Sets the frequency and bandwidth parameters.
Trace	Sets the trace display parameters.
Scale	Sets the Vertical and Horizontal scale and offset parameters.
Prefs	Specifies whether certain display elements are visible.

Common controls for general signal viewing displays

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.

Table 7: Common controls for general signal viewing displays

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

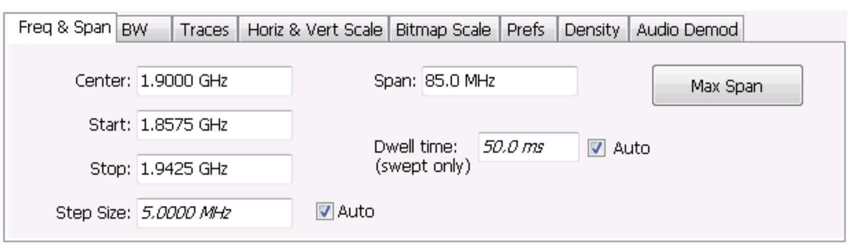
Freq and BW tab - freq vsTime phase vs time RF I and Q vs time display

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.

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 and 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.

Table continued…

Setting	Description
Dwell time (DPX display only)	The amount of time the DPX sweep remains in a frequency segment collecting data and updating the bitmap and traces before moving on to the next higher frequency segment. The minimum Dwell Time setting is 50 ms, the normal update rate for DPX computations. Maximum Dwell Time per frequency segment is 100 s. The number of frequency segments and their start/stop frequencies are internally determined based on span, acquisition bandwidth, RBW and other parameters.
Max Span	Sets the Span to the maximum value.
Auto checkbox	Sets the Step Size and Dwell time automatically when checked.

Center, Start, Stop, and Span Frequencies Are Correlated

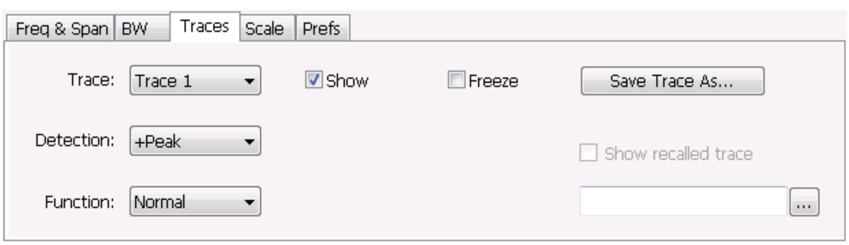
Changing the values for Center frequency, Start frequency, Stop frequency or Span will change the values for the other settings, depending on which setting you change. For example, if you change the Center frequency, the Start and Stop frequencies will be adjusted automatically to maintain the same Span.

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.



Setting	Description
Trace	Selects a trace. (This setting is not present for every display.)
Show	Shows / hides the selected trace.

Table continued…

Setting	Description
Detection	Sets the Detection method used for the trace. Not available for saved traces. Available detection methods are +Peak, -Peak, +/-Peak, Avg (VRMS), Sample, CISPR Avg, CISPR Pk, and CISPR QPk. Not all detection methods are available in all displays.
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. When a trace is recalled, controls such as show, freeze, function, and detection of trace will be disabled.

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.
- **CISPR QPk** – The trace value is calculated by the methods described for quasi peak detectors in the CISPR documents.
- **CISPR Avg** – The trace value is calculated by the methods described for average 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:

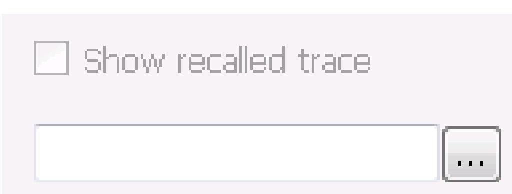
1. Select the **Save Trace As** button. This displays the Save As dialog box.
2. Navigate to the desired folder or use the default.
3. Type a name for the saved trace and click **Save**.

Recalling Traces

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

To select a trace for recall:

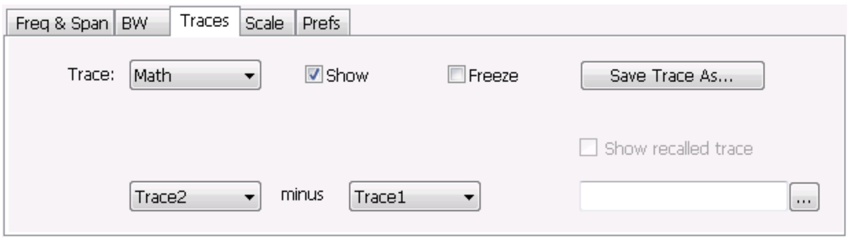
1. Select the trace into which the recalled trace will be loaded, from the Trace drop-down list.
2. Check the **Show** check box.
3. Click the **...** button to display the Open dialog box.



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.

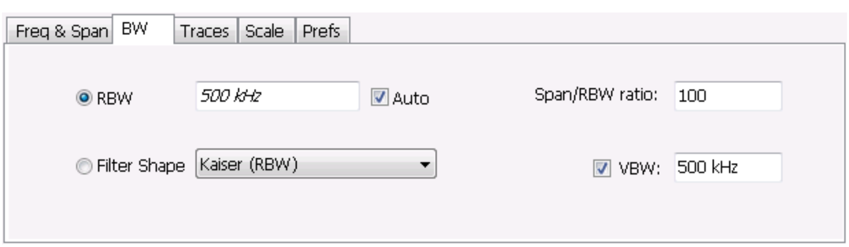


Trace 4 is a mathematically-derived trace defined as Trace A minus Trace B. You can select Trace 1, 2, or 3 to serve as either Trace A or Trace B.

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.

Table continued…

Setting	Description
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.

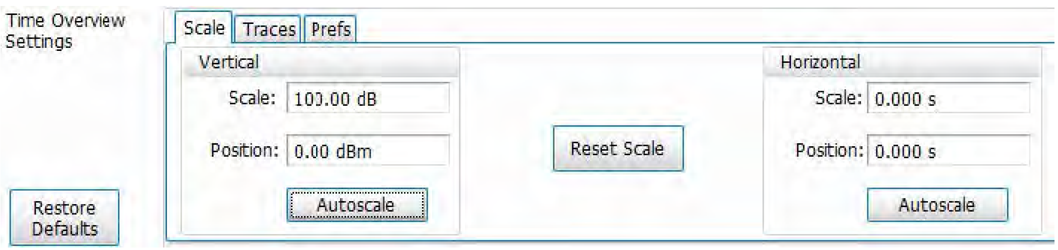
The maximum VBW value is 10 times the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting. VBW is disabled when the Filter shape is set to CISPR.

Note: If you are following a procedure that says to "set VBW to three times the RBW value or greater", it means that the test should be conducted with no VBW effects. In the analyzer, this condition is met by disabling the VBW function.

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.



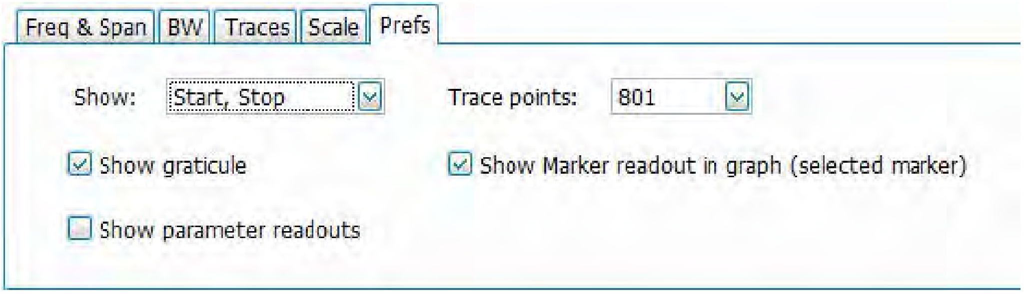
Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale.
Offset	Vertical Offset adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the span of the trace display and position of the trace.
Scale	Changes the range shown between the left and right sides of the graph.
Position	Changes the position of the acquisition record shown at the left edge of the graph.
Reset Scale	Resets all settings to their default values.

Prefs tab

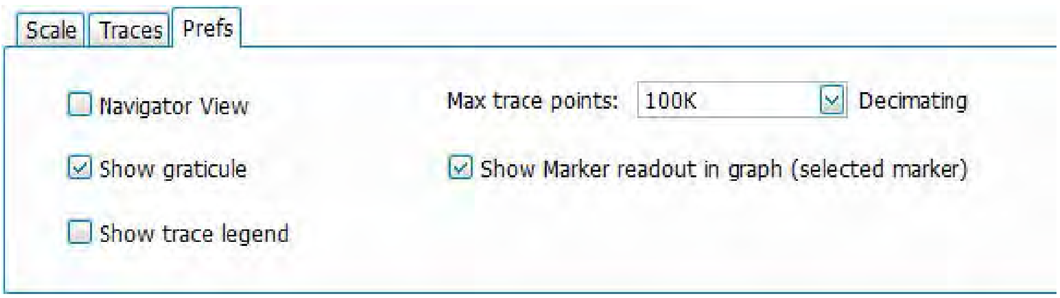
The Prefs tab enables you to change parameters of the measurement display. The parameters available on the Prefs tab vary depending on the selected display, but include such items as enabling/disabling marker Readout and switching the Graticule display on/off.

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.

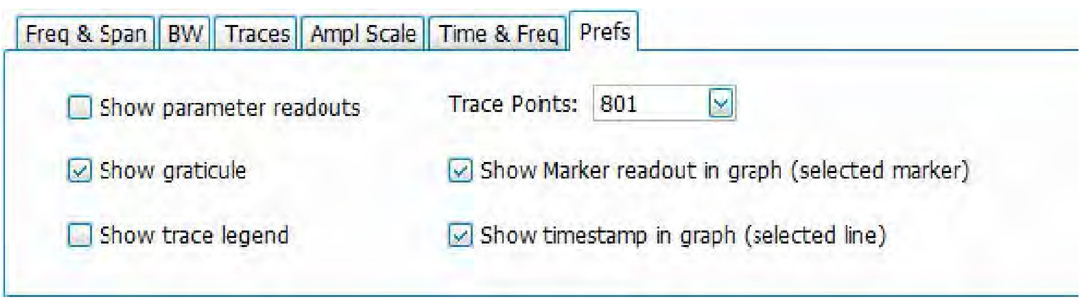
For example, in the following image, the Show Marker readout in graph check box appears in the Prefs tab for every display. However, the Show Power Trigger level check box only appears on the Amplitude vs Time Prefs tab.



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



The following image shows the Prefs tab for the DPX display when DPXogram or Split is the selected view.



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

Setting	Description
Show:	Sets the horizontal settings that appear below the graph area. You can select 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	Check to display the graticule. Uncheck to hide the graticule.

Table continued…

Setting	Description
Navigator View (Time Overview Display only)	Places the Time Overview display across the top of the application window, above all other active displays.
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.
DPX shows only trigger frames	For the DPX Spectrum display, check to show only trigger frames.
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.

Show Parameter Readouts (DPX Spectrum Only)

The elements of the Show Parameter Readouts are:

- 100% POI – This is the minimum event duration required to ensure 100% Probability of Intercept or event capture. This duration depends on interaction between span, RBW, and FFT length. You can use the POI time value to determine if you are at risk of either missing a narrow transient or of its captured amplitude being less than the actual signal.

Table 8: Minimum signal duration for 100% probability of trigger at 100% amplitude

Frequency-Mask and DPX signal processing				Minimum signal duration, 100% probability of intercept, Frequency-Mask and DPX density trigger (μs)			
Span	RBW (kHz)	FFT length	Spectrums/sec	Standard		Opt. 09	
				Full amplitude	-3 dB	Full amplitude	-3 dB
165 MHz	20000	1024	390,625	15.5	15.4	2.7	2.6
	10000	1024	390,625	15.6	15.4	2.8	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	300	2048	195,313	23.4	16.3	13.1	6.1
	100	8192	48,828	44.5	23.4	44.5	23.4
	30	32768	12,207	161.9	91.7	161.9	91.7

Table continued…

Frequency-Mask and DPX signal processing				Minimum signal duration, 100% probability of intercept, Frequency-Mask and DPX density trigger (µs)			
Span	RBW (kHz)	FFT length	Spectrums/sec	Standard		Opt. 09	
				Full amplitude	-3 dB	Full amplitude	-3 dB
85 MHz	10000	1024	390,625	15.6	15.4	2.8	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	500	1024	390,625	20.2	15.9	7.4	3.1
	300	1024	390,625	23.4	16.3	10.6	3.5
	100	4096	97,656	44.5	23.4	34.2	13.2
	30	16384	24,414	121.0	50.7	121.0	50.7
	20	16384	24,414	161.0	55.6	161.0	55.6
40 MHz	5000	1024	390,625	15.8	15.4	3.0	2.6
	1000	1024	390,625	17.8	15.7	5.0	2.9
	300	1024	390,625	23.3	16.3	10.5	3.5
	100	2048	195,313	39.4	18.3	29.1	8.1
	30	4096	97,656	90.4	21.8	90.4	21.8
	20	8192	48,828	140.7	36.3	140.7	36.3
	10	16384	24,414	281.3	72.6	281.3	72.6
25 MHz	3800	1024	390,625	16.0	15.4	3.2	2.6
	1000	1024	390,625	17.7	15.7	4.9	2.9
	300	1024	390,625	23.4	16.3	10.6	3.5
	200	1024	390,625	27.4	16.8	14.6	4.1

- Transforms/s – This is the number of transforms/second being performed by the DPX engine. It is a function of the selected resolution bandwidth and number of trace points. The desired RBW determines the number of points required in each transform, which alters the transform rate. Additionally, the selected trace length may place requirements on the number of points required in the transform independent of the selected resolution bandwidth.
- FFT Points – The approximate number of points in the FFT of the input signal. FFT points provides an indication of frequency resolution, but it is not an exact measurement. Note that higher numbers for FFT points mean that the instrument is taking a longer string of input samples for each FFT, which decreases the time resolution.

Table 9: Minimum FFT length versus trace length - independent of span and RBW

Trace length (points)	Minimum FFT length
801	1,024
2,401	4,096
4,001	8,192
10,401	16,384

Analog Modulation

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.

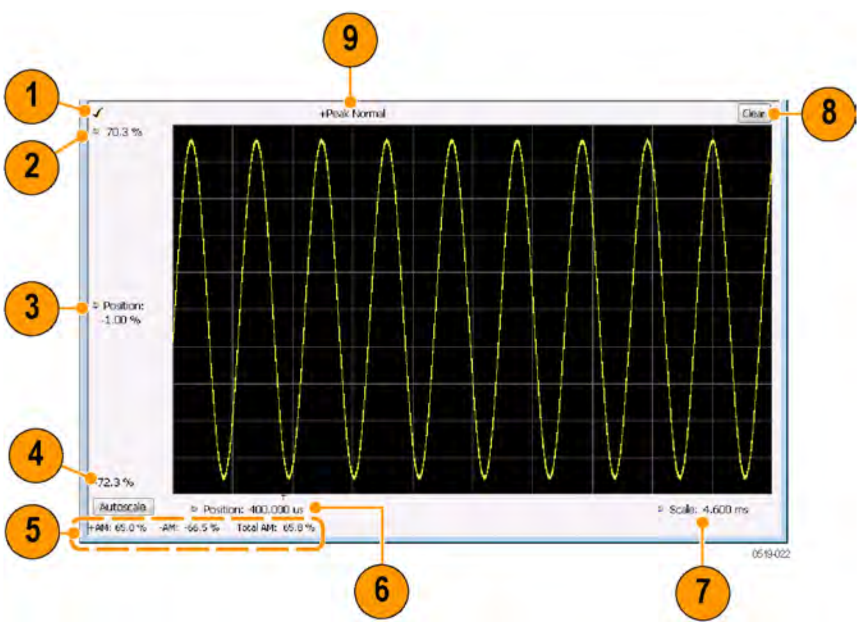
AM Display

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



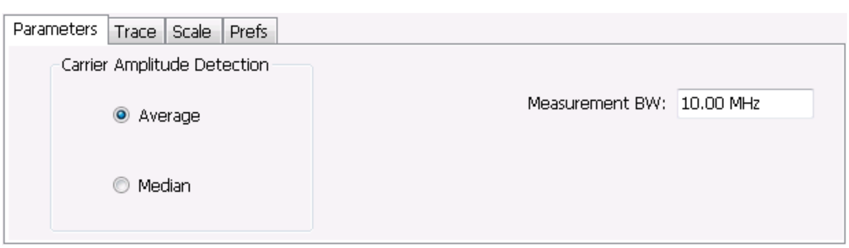
Item	Element	Description
1	Check mark indicator	The check mark indicator in the upper, left-hand corner of the display shows when the AM display is the optimized display. ⚠ **Note:** When *Best for multiple windows* is selected in the Amplitude control panel's RF & IF Optimization control, none of the 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

AM Settings

Main menu bar: Setup > Settings

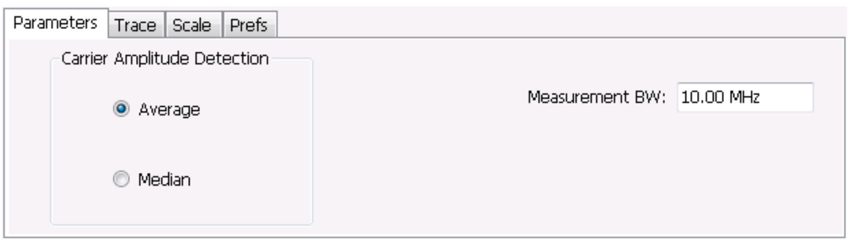
The AM Settings control panel provides access to settings that control parameters of the AM Display.



Setting	Description
Parameters	Sets the Carrier Amplitude Detection method. You can choose either Average or Median.
Trace	Sets Trace display parameters.
Scale	Sets vertical and horizontal scale and position parameters.
Prefs	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.



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.

Peak method

$$AM\,Modulation\,Depth = \frac{Max\,[A + a(t)]}{A}$$

Trough Method

$$AM\,ModulationDepth = \frac{Min\,[A + a\,(t)]}{A}$$

Max-Min Method

$$AM\,ModulationDepth = \frac{Max\,[A + a\,(t)] - Min\,[A + a\,(t)]}{2A}$$

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

$$A = Average\,\{E_M\,[KT]\}$$

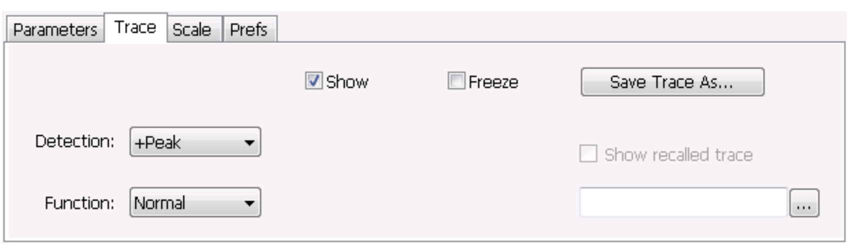
Median Method

$$A = Median\,\{E_M\,[KT]\}$$

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.



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.

Table continued…

Setting	Description
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

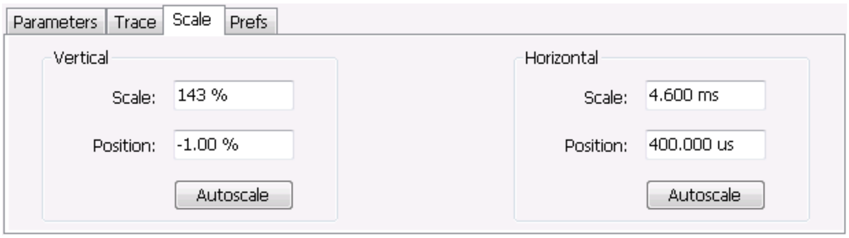
You can recall a previously saved trace for analysis or comparison to a live trace.

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

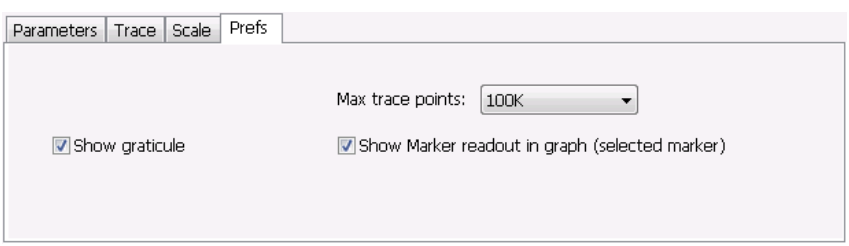
The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.



Setting	Description
Vertical	
Scale	Changes the range shown between the top and bottom of the graph.
Position	Adjusts the level shown at the center of the graph.
Autoscale	Resets the Position so that the entire trace is in 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 AM display.



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.

Table continued…

Setting	Description
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.

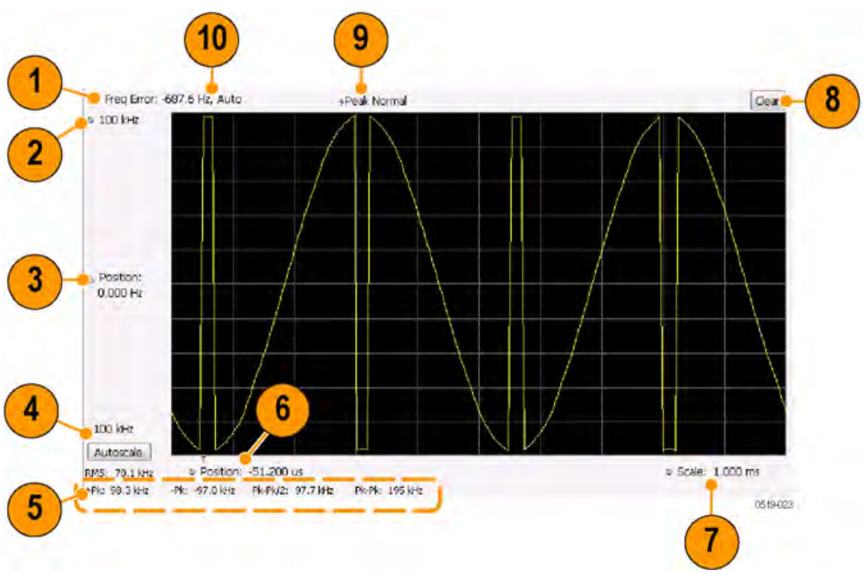
FM Display

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



Item	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.

Table continued…

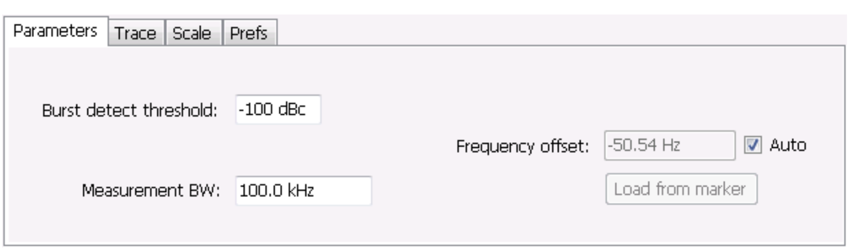
Item	Element	Description
2	Top of Graph control	Sets the frequency indicated at the top of the graph. Since the Position value at the vertical center of this graph remains constant as the Top of Graph value is adjusted, the Vertical Scale increases as the Top of Graph value increases, which also affects 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

FM Settings

Main menu bar: Setup > Settings

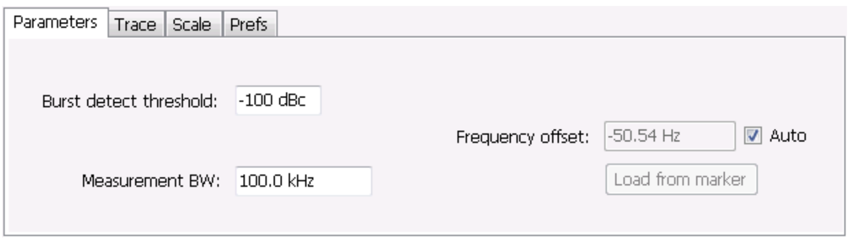
The FM Settings control panel provides access to settings that control parameters of the FM Display.



Setting	Description
Parameters	Sets the burst detection threshold, measurement bandwidth, and carrier frequency detection method.
Trace	Sets Trace display parameters.
Scale	Sets vertical and horizontal scale and position parameters.
Prefs	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.



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

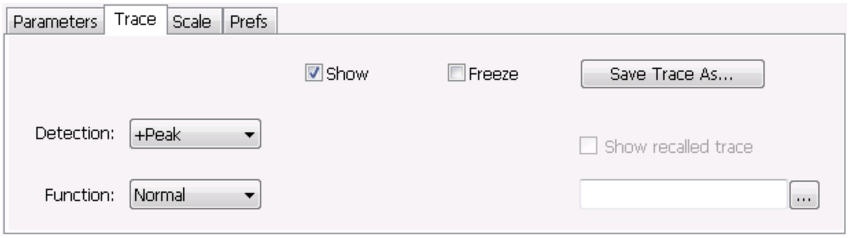
In Auto (Auto is selected), the instrument scans the measurement bandwidth about the measurement frequency and looks for the highest-powered signal. This is defined as the carrier frequency. In Manual (Auto is deselected), the carrier frequency is specified by adding/subtracting the specified Frequency 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.



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

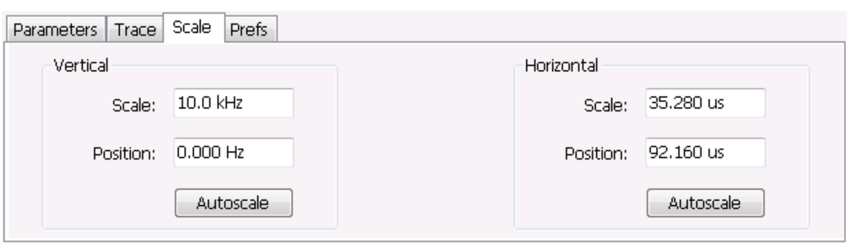
You can recall a previously saved trace for analysis or comparison to a live trace.

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.



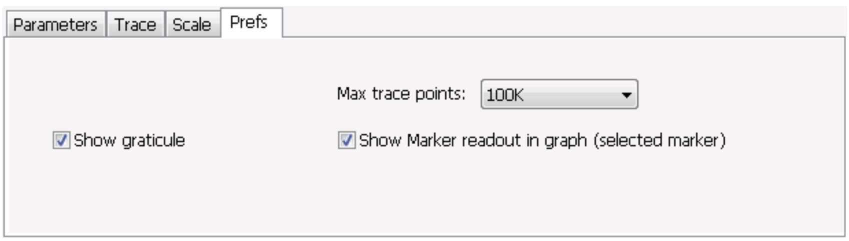
Setting	Description
Vertical	
Scale	Changes the range shown between the top and bottom of the graph.
Position	Adjusts the frequency shown at the center of the graph.
Autoscale	Resets the Position so that the entire trace fits within the graph.
Horizontal	

Table continued…

Setting	Description
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.

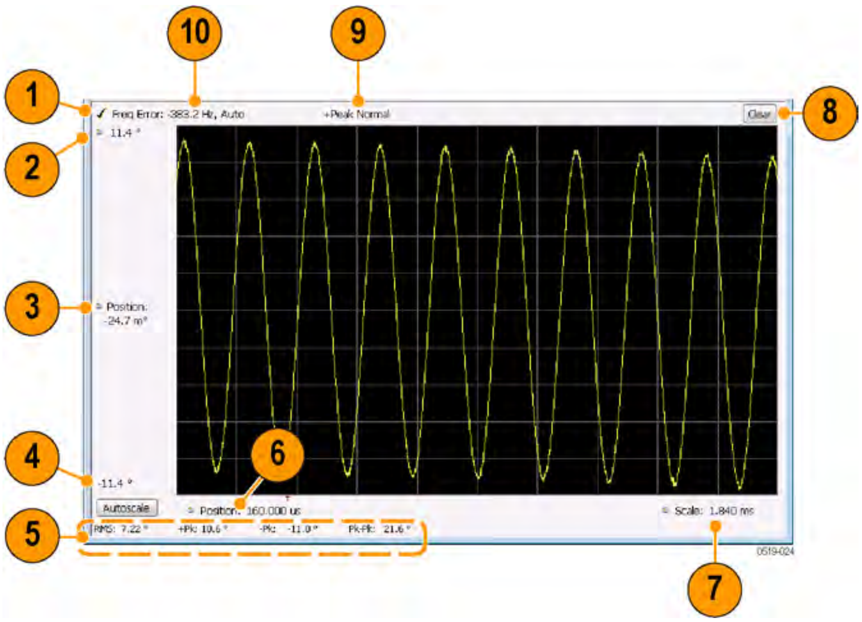


Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Max trace points	The trace in the FM display can be set to a maximum of 100,000 points (however, the actual number of trace 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



Item	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.

Table continued…

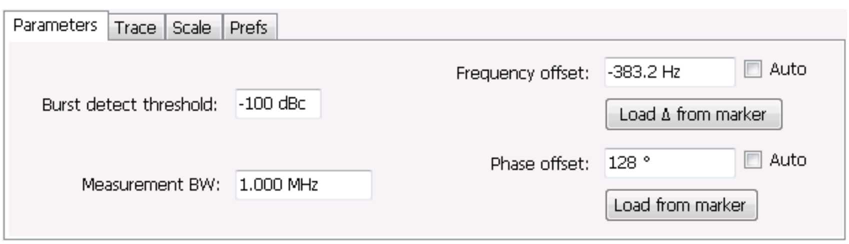
Item	Element	Description
8	Clear	Clears the measurement results.
9	Trace Detection readout	Displays the Trace Detection setting (see Settings > Trace > Detection).
10	Freq Error	This readout can show Freq Error or Freq Offset. When it displays Freq Error, it shows the difference between the instrument 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

PM Settings

Main menu bar: Setup > Settings

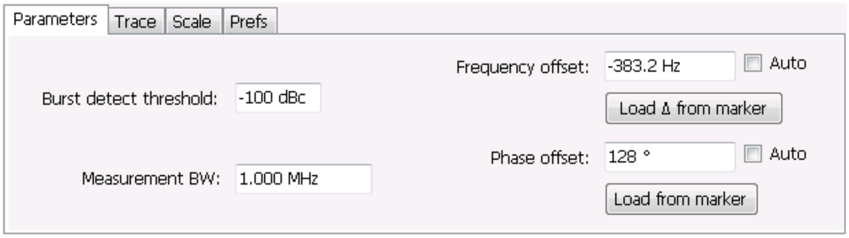
The PM Settings control panel provides access to settings that control parameters of the PM Display.



Setting	Description
Parameters	Sets the Carrier Frequency Detection method. You can choose either Automatic or Manual. Sets burst threshold and phase detection method.
Trace	Sets Trace display parameters.
Scale	Sets vertical and horizontal scale and position parameters.
Prefs	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.



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 Frequency offset to the frequency offset calculated from the difference between MR (the marker 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 phase 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

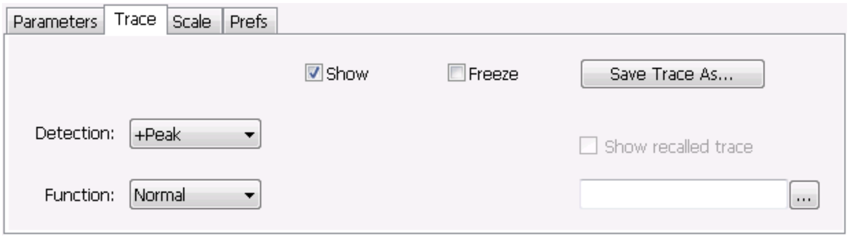
In Auto (Auto is selected), the instrument scans the measurement bandwidth about the Measurement Frequency and looks for the highest-powered signal. This is defined as the carrier frequency. In Manual (Auto is deselected), the carrier frequency is specified by adding/subtracting the specified Frequency 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°.

Trace Tab

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



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

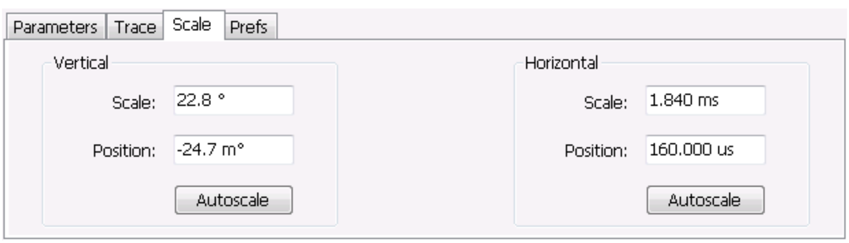
You can recall a previously saved trace for analysis or comparison to a live trace.

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

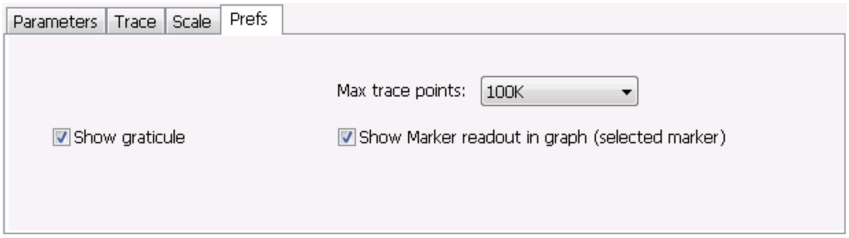
The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Measurement Frequency. In effect, these controls operate like pan and zoom controls.



Setting	Description
Vertical	
Scale	Changes the range shown between the top and bottom of the graph.
Position	Adjusts the phase shown at the center of the graph.
Autoscale	Resets the Position so that the entire trace in the graph.
Horizontal	
Scale	Changes the range shown between the left and right sides of the graph.
Position	Adjusts the phase shown at the left edge of the graph.
Autoscale	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.



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.

RF Measurements

Overview

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

- CCDF
- Channel Power and ACPR
- Frequency and Phase Settling Time (Option SVT)
- MCPR
- Occupied Bandwidth
- Spurious

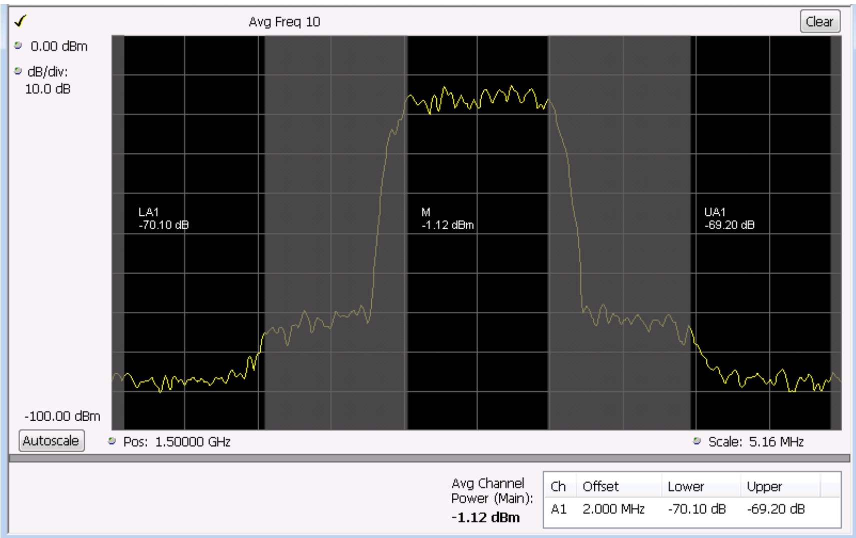
The RF Measurements power measurements and signal statistics help you characterize components and systems.

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 *Complementary Cumulative Distribution Function* (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.

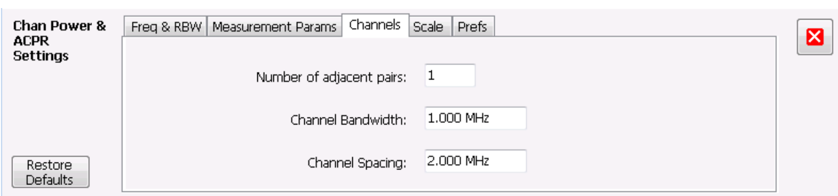
Channel Power and ACPR (Adjacent Channel Power Ratio) Display

Use the **Channel Power and ACPR** measurement to measure channel power by itself, or adjacent channel leakage ratio with one main channel.



Measuring Adjacent Channel Power Ratio

1. Select the **Displays** button.
2. Select **RF Measurements** from the **Measurements** box.
3. Double-click **Chan Power and ACPR** 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 your main channel.



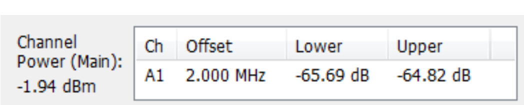
5. Select the Freq & RBW tab and adjust the frequency to that of your main channel. You can also change the frequency from the Status bar found at the bottom left side of the display.
6. To set the number of adjacent channels, select the **Channels** tab. Enter the number of channels in the **Number of adjacent pairs** value box. If zero is entered for the number of adjacent pairs, the resultant measurement will be channel power only.

   Note: As you add adjacent channels, the span of the display is adjusted so that all the channels can be seen. Use the horizontal scale and offset to zoom the display in on any portion of the trace.

7. To set the spacing between channel centers, enter the required value in the **Channel Spacing** value box.
8. To set the channel bandwidth, enter the required value in the **Channel Bandwidth** value box.
9. After you have configured the channel settings, click the close button in the Settings panel or press **Settings** again to remove the Settings panel.

Viewing Results

Measurement results are displayed in a table below the graph and within the graph itself (which can be enabled/disabled in the Settings > Prefs tab). To see all measurements, you might need to scroll the table. The size of the results table can be changed by dragging the horizontal divider bar between the graph and table areas.



Channel Power (Main): -1.94 dBm

Ch	Offset	Lower	Upper
A1	2.000 MHz	-65.69 dB	-64.82 dB

Heading	Description
Channel	Identifies the displayed channels. A1 means the first adjacent channel. A2 means second adjacent channel. Adjacent channels are numbered according to their offset from the Main channel. The closest channel is numbered 1. The next closest channel is numbered 2; and so forth.
Lower	The power measured for the lower adjacent channel. Adjacent channel power measurements are displayed in dB relative to the Main channel.
Upper	The power measured for the upper adjacent channel. Adjacent channels power measurements are displayed in dB relative to the Main channel.
Avg Channel Power (Main)	The power measured for the Main channel. The detection type used for measuring channel power and adjacent channel powers is Average. This means that the average of the linear (pre-log) samples is used to determine the power. The Main channel power is displayed in dBm.

Setting Channel Power and ACPR Settings Parameters

RF Channel Power Measurement

The RF channel power gives an indication of the total average (and other measures) RF power in a given channel.

For some communications systems, there is an “out-of-service” total power measurement defined in the specifications that calls for a specified constant modulation. In this case, the output power should be relatively constant. For many measurements, this may not be the case, and the Power Measurement results will vary as the signal varies.

Average power is the square root of the sum of the squares of the voltage samples over the measurement time.

The defined “channel” width for the Power Measurement defines the bandwidth and shape of the filter used to remove any RF power on frequencies outside of the channel bandwidth.

Channel Power

The total RF power in the selected frequency band. The detection type used for measuring channel power is Average. This means that the average of the linear (pre-log) samples is used to determine the channel power. To measure channel power, use the ACLR measurement, and set the number of adjacent channels to zero. This results in only the channel power being measured.

Average Channel Power

The total RF power in the selected channel (located in the ACPR display).

Adjacent Channel Leakage Power Ratio

Adjacent Channel Leakage power Ratio (ACLR) 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, both the main channel and adjacent channels are required to be filtered with RRC (Root Raised Cosine) filters.

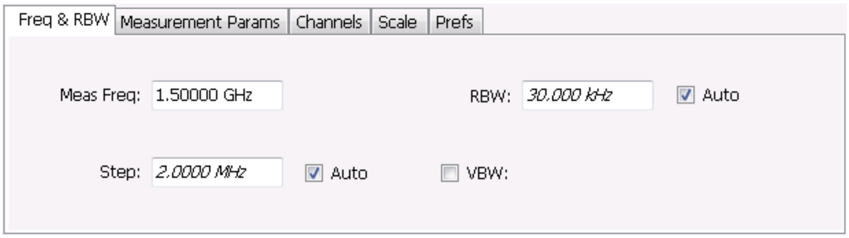
Adjacent Channel Power

Measure of the signal power leaking into nearby channels.

Channel Power and ACPR Settings

Main menu bar: Setup > Settings

The settings for the Channel Power and ACPR display are shown in the following table.

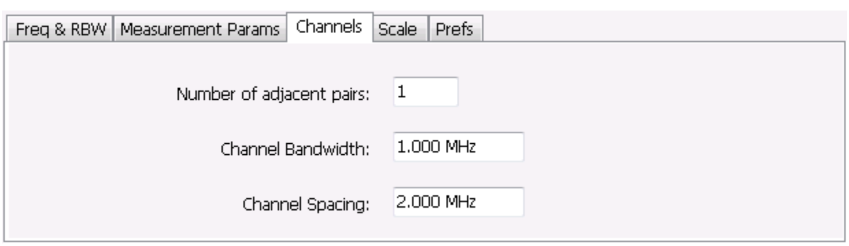


Settings tab	Description
Freq & RBW	Specify the frequency and resolution bandwidth used for the ACPR measurement.
Measurement Params	Specify several parameters that control the measurement, such as channel filter, chip rate, averaging, and correcting for noise floor.
Channels (ACPR)	This tab specifies the BW and offset parameters of the Channels for the selected ACPR measurement.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether certain display elements are visible.

Restore defaults. Sets parameters for a 1-channel WCDMA measurement.

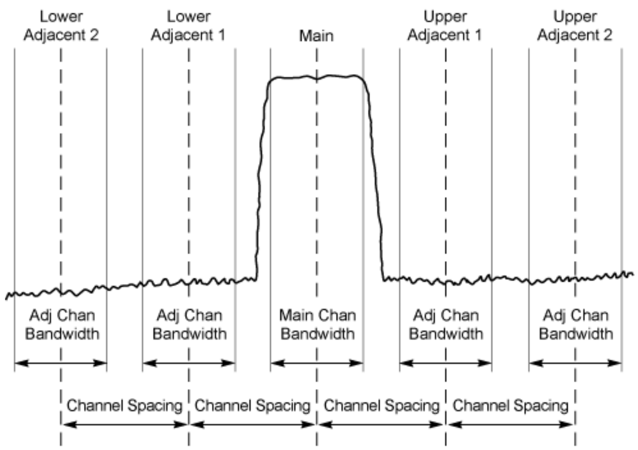
Channels Tab for ACPR

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



Setting	Description
Number of adjacent pairs	Specifies the number of adjacent channel pairs. Range: 1 - 50; Resolution 1.
Channel Bandwidth	The maximum channel bandwidth is limited to approximately the maximum acquisition bandwidth of the instrument, ranging from 25 MHz to 165 MHz depending on the option installed.
Channel Spacing	Specifies the difference in frequency between the centers of each channel.

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



Changing the Number of Adjacent Pairs

1. Select **Number of adjacent pairs** number entry box.
2. Enter a value for the number of adjacent pairs using the knob or the keypad.

   Note: As you change the value for the number of adjacent pairs, the analyzer will update the spectrum display to identify the adjacent channels.

3. Select the Close box when you have finished making changes.

Changing the Channel Bandwidth

1. Select the **Channel Bandwidth** number entry box.
2. Enter a value for the number of adjacent pairs using the knob or the keypad.

   Note: As you change the value for the number of adjacent pairs, the analyzer will update the display to indicate the channel bandwidth.

3. Select the Close box when you have finished making changes.

Channel Spacing

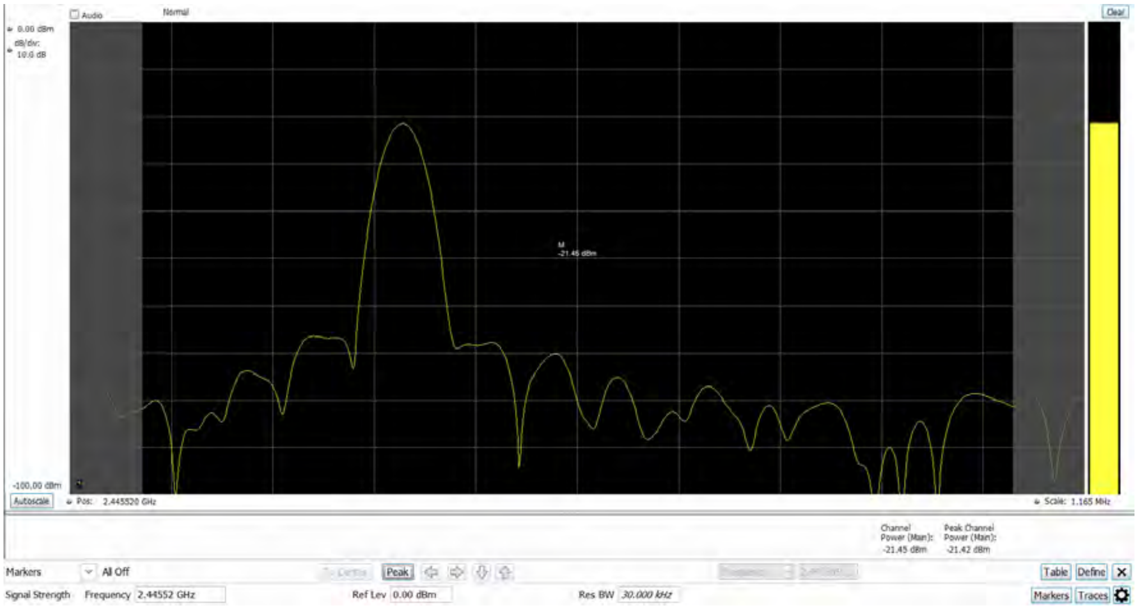
1. Select **Channel Spacing** number entry box.
2. Enter a value for the difference in center frequency between channels using the knob or the keypad.

   Note: As you change the value for the number of adjacent pairs, the analyzer will update the display to indicate the channel bandwidth.

3. Select **Close** when you have finished making changes.

Signal Strength Display

Use the **Signal Strength** display to measure signal strength (channel power and peak channel power).



Measuring channel power and field strength

1. Select the **Displays** button.
2. Select **RF Measurements** from the **Measurements** box.
3. Double-click **Signal Strength** in the Available displays box. Click **OK** to complete your selection.
4. Tune the analyzer to the channel. To do this, you can enter the frequency directly into the Frequency field on the Basic Toolbar (see the bottom of the above image), or you can use the **Select Channel** button on the Channel Navigation toolbar.
5. Press the **Run** button to take the measurements. If you are using a data acquisition file, click **Replay**.
6. If you are measuring a signal with a directional antenna, select the **Audio** check box located above the graph, on the left side.

   When Audio is checked, the analyzer sounds a tone that varies in frequency with the channel power. If you change the direction of the antenna and the channel power drops, the frequency of the audio tone will also drop. If the channel power increases, the audio tone frequency will also increase.

   As channel power changes, the vertical channel power bar graph located on the far right side of the measurement display will rise and fall with the channel power.

Viewing Results

Measurement results are displayed below the graph and within the graph itself (the latter of which can be enabled/disabled in the Signal Strength Settings > Prefs tab).

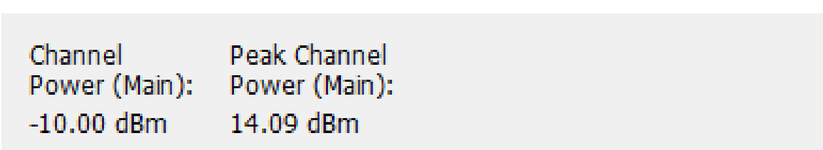


Figure 39: Results for Signal Strength measurement

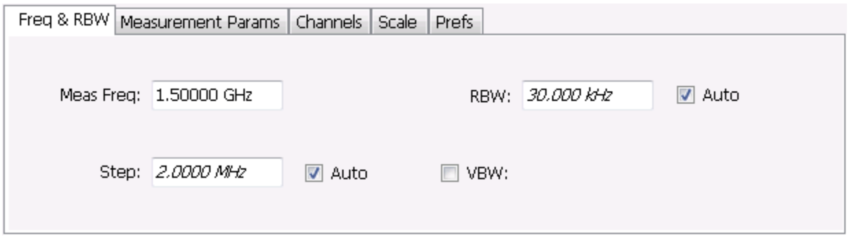
Heading	Description
Channel Power (Main)	The integrated power measured for the Main channel.
Peak Channel Power (Main)	The maximum integrated power measured for the Main channel.

Signal Strength Settings on page 155

Signal Strength Settings

Menu Bar: Setup > Settings

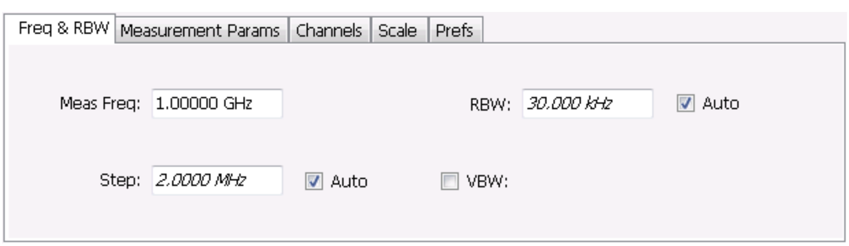
The settings for the Signal Strength display are shown in the following table.



Settings tab	Description
Freq & RBW	Specify the frequency and resolution bandwidth used for the signal strength measurements.
Measurement Params	Specify several parameters that control the measurement, averaging. External amplitude corrections, and display units.
Channels	This tab specifies the BW
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies trace points, trace detection, and visible display elements (graticule, marker readouts, etc) for the Signal Strength measurement display.

Freq & RBW Tab for Signal Strength display

The Freq & RBW tab specifies frequency parameters for the signal strength measurements.



Setting	Description
Meas Freq	Specifies the center/measurement frequency.
Step	The Step control sets the increment/decrement size for the knob adjustment of the center frequency. Arrow key adjustment of frequency is also affected (it is 10x the knob adjustment). If Auto is enabled, the signal analyzer will adjust the Step size as required.

Table continued…

Setting	Description
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 = 10 times the 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 10 times the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.

Measurement Params Tab for Signal Strength display

The Measurement Params tab is where you set parameters that control the Signal Strength measurement.

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.
Off	This setting turns averaging off.
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.
Amplitude Units	Opens the *Units Tab* on page 647 dialog box.
Ext Corrections	Opens the *External Gain/Loss Correction* dialog box.

Correct for noise floor

When this setting is enabled, the instrument applies a correction to the ACPR or MCPR measurement to reduce the effect of instrument noise on the results. It generates this correction by taking a preliminary acquisition to measure the instrument noise floor. Once this is done, the measurement proceeds, applying the correction to each result. When any relevant settings (reference level, attenuator, frequency, or span) are changed, the instrument performs a new noise measurement and correction.

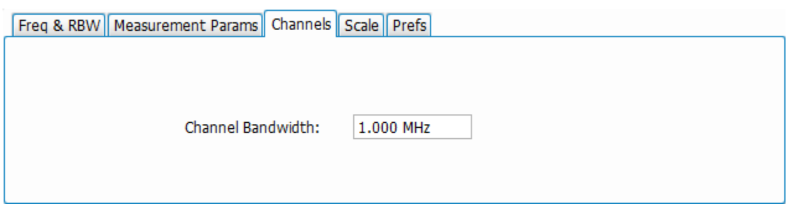
The noise correction signal is created by switching off the input to the RTSA and performing acquisitions of the instrument internal noise. A minimum of 100 acquisitions are averaged to create the noise reference signal. It is possible to increase the number of acquisitions for creation of the noise reference signal. When frequency domain averaging is enabled and the number of averages exceeds 100, the number of frequency domain averages becomes the total number of acquisitions to determine the instrument internal noise. Noise is measured for each channel defined by the measurement. The noise reference from each channel is subtracted from the incoming signal power for each channel 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 12 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 measured values differ from the displayed trace in two ways. First, any filtering applied to the channels is not displayed on the trace. Second, the single value of measured noise for a channel is subtracted from each trace point in the channel, rather than offsetting the entire channel by a single amount. This produces a smooth trace with no discontinuities at the channel edges.

Channels Tab for Signal Strength display

The Channels tab is where you specify the channel bandwidth measured in the Signal Strength display.

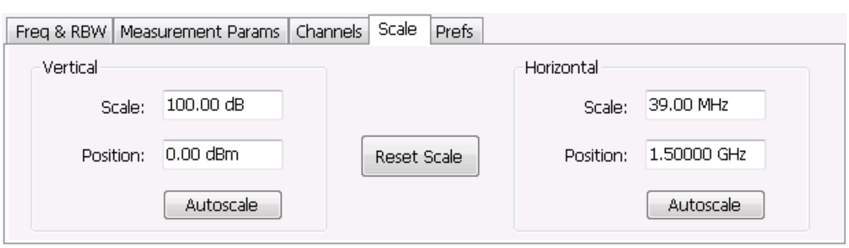


Changing the Channel Bandwidth

1. Select the **Channel Bandwidth** number entry box.
2. Enter a value for the channel bandwidth.
3. Select the Close box when you have finished making changes.

Scale Tab for Signal Strength display

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.



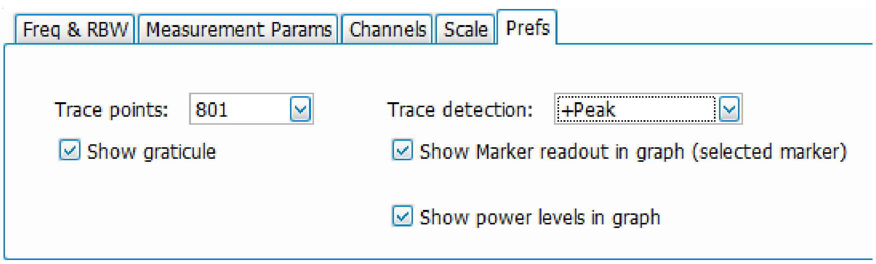
Setting	Description
Vertical	Controls the vertical position and scale of the trace display.

Table continued…

Setting	Description
Scale	Changes the vertical scale units. This is only accessible when the vertical units are set to dBm.
Autoscale	Automatically scales 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.
Autoscale	Automatically scales the horizontal axis to optimize the display of the 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 include enabling/disabling Marker Readout, switching the Graticule display on/off, and trace points and detection.



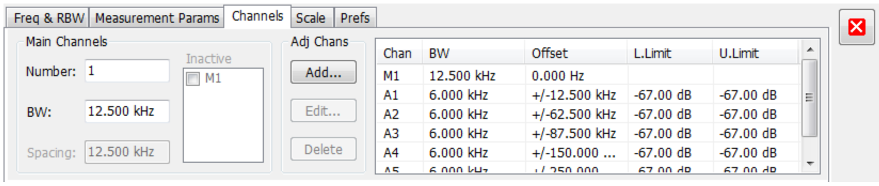
Setting	Description
Trace Points	Sets the number of trace points computed for each line. These are the points used for marker measurements and for results export.
Show graticule	Shows or hides the graticule.
Trace Detection	**+Peak**: Shows the peak power in a bin (of chosen RBW) if there are multiple 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 Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.

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

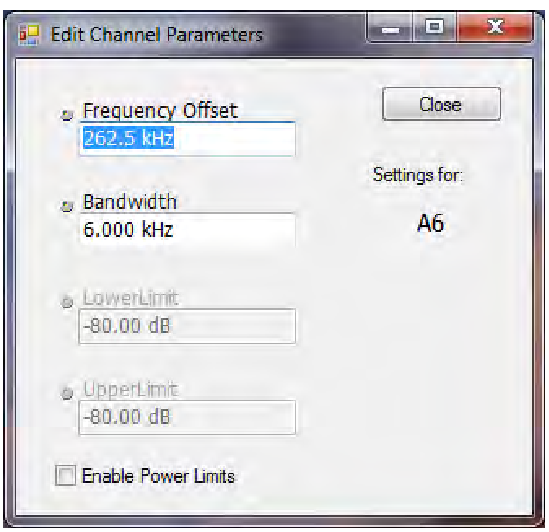
1. Press the front-panel **Displays** button.
2. From the **Select Displays** window, select **RF Measurements** or **P25 Analysis** from the Measurements box.
3. Double-click the **MCPR** icon in the **Available displays** box. Click **OK** to complete your selection.
4. Press the front-panel **Freq** 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. Select the **Freq & RBW** tab and adjust the frequency to that of the main channel. You can also adjust the frequency on the Status bar using the Frequency field on the bottom left of the display.
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.

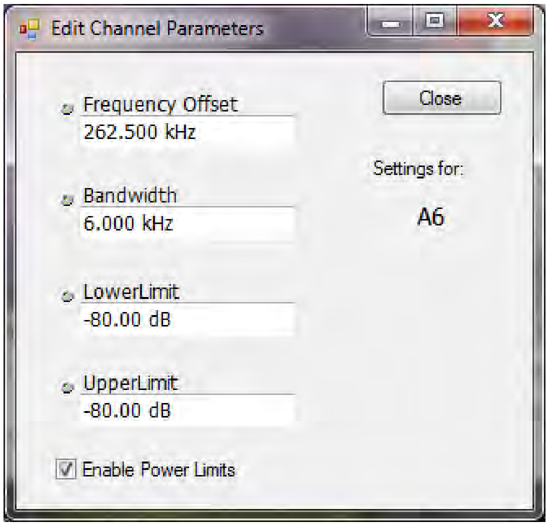
7. To set the bandwidth of all main channels, enter a value in the **BW** value box.
8. To set the spacing between the main channels, enter a value in the **Spacing** value box.
9. To prevent a main channel power level from being included in the Power Reference (Total) calculation, select the channel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



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.

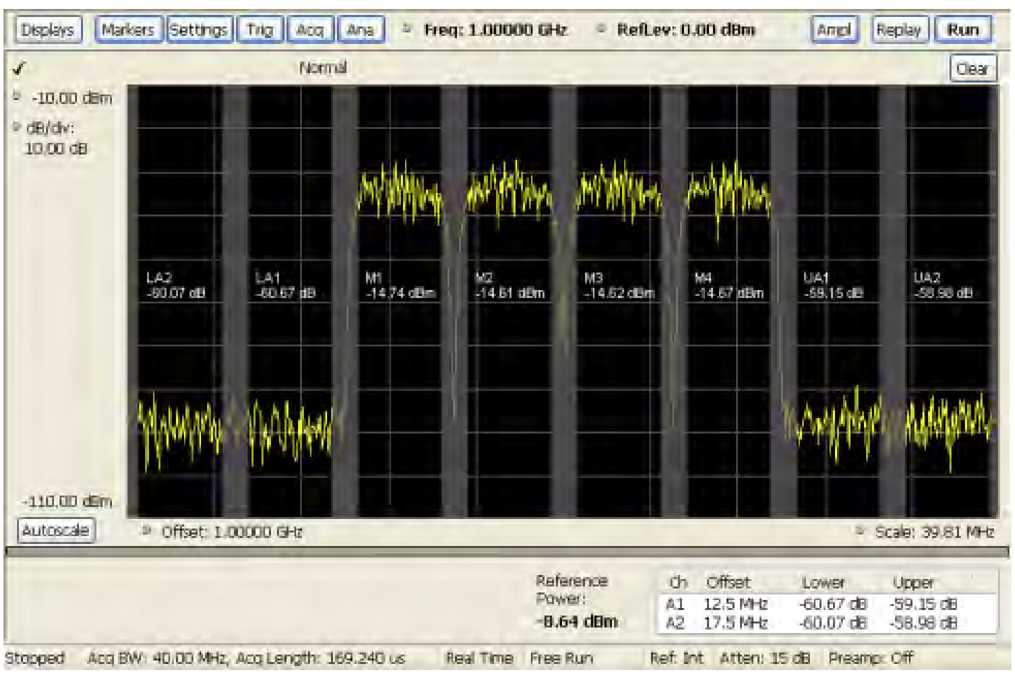
12. To enable and define power limits, check the **Enable Power Limits** box and enter the desired Upper and Lower limits. You can read more about power limits *here*.



13. After you have configured the Main and Adjacent channels, click the close button in the Settings panel or the **Settings** button to remove the settings panel.
14. Click the **Run** button to take the measurements. Click the **Replay** button if you are using a recalled acquisition data file.

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.



The following table details the entries in the results table.

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 and the center 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.

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

Setting Power Limits

When power limits are enabled (**Settings** > **Channels** > **Add** or **Settings** > **Channels** > **Edit**), 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.

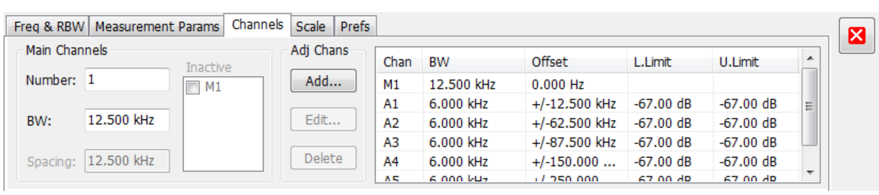
Multiple Carrier Power Ratio

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

MCPR Settings

Main menu bar: Setup > Settings

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



Settings tab	Description
Freq & RBW	Specify the frequency and resolution bandwidth used for the MCPR measurements.
Measurement Params	Specifies parameters controlling how the MCPR measurement is made.
Channels	Specifies the parameters of the channels to be measured.
Scale	Specifies the vertical and horizontal scale and offset values.

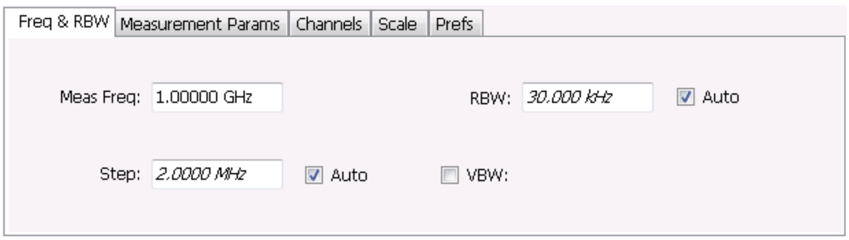
Table continued…

Settings tab	Description
Prefs	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.



Setting	Description
Meas Freq	Specifies the center/measurement frequency.
Step	The Step control sets the increment/decrement size for the knob adjustment of the center frequency. Arrow key adjustment of frequency is also affected (it is 10x the knob adjustment). If Auto is enabled, the signal analyzer will adjust the Step size as required.
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 = 10 times the 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.

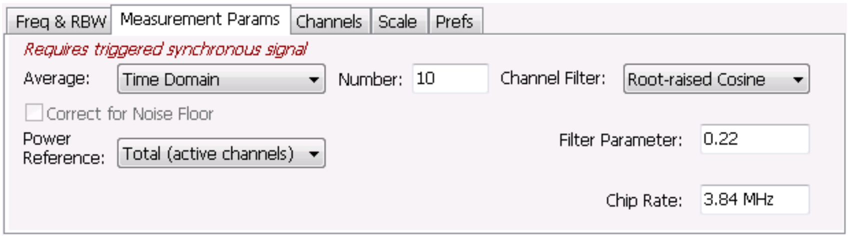
VBW

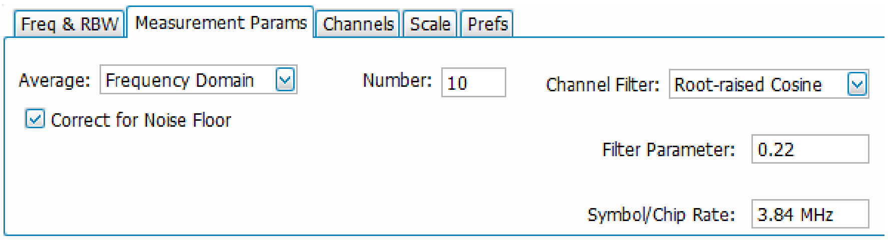
The VBW setting enables/disables the Video Bandwidth filter. VBW is used in traditional swept analyzers to reduce the effect of noise on the displayed signal. The VBW algorithm in the analyzer emulates the VBW filters of traditional swept analyzers.

The maximum VBW value is 10 times 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.
Correct for Noise Floor	Enables/disables the Noise Floor Correction function.
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.
Chip Rate	Value entry box for the Root-raised Cosine chip rate. Present only when the Channel Filter is set to Root-raised Cosine.

Correct for Noise Floor

When this setting is enabled, the instrument applies a correction to the ACPR or MCPR measurement to reduce the effect of instrument noise on the results. It generates this correction by taking a preliminary acquisition to measure the instrument noise floor. Once this is done, the measurement proceeds, applying the correction to each result. When any relevant settings (reference level, attenuator, frequency, or span) are changed, the instrument performs a new noise measurement and correction.

The noise correction signal is created by switching off the input to the RTSA and performing acquisitions of the instrument internal noise. A minimum of 100 acquisitions are averaged to create the noise reference signal. It is possible to increase the number of acquisitions for creation of the noise reference signal. When frequency domain averaging is enabled and the number of averages exceeds 100, the number of frequency domain averages becomes the total number of acquisitions to determine the instrument internal noise. Noise is measured for each channel defined by the measurement. The noise reference from each channel is subtracted from the incoming signal power for each channel to create the corrected result. All calculations are performed in Watts, and then converted to the desired units.

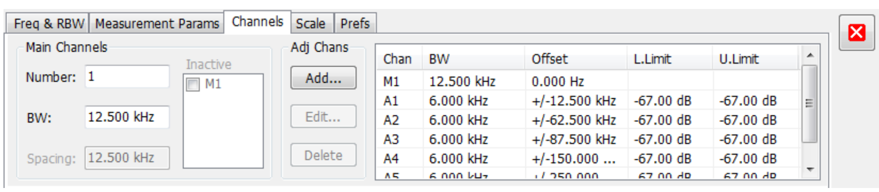
The amount of noise correction is limited to 12 dB to avoid the possibility of a negative power measurement. This is a rare condition that could occur if the subtraction of the reference power from the channel power results in a negative value (or ‘infinite’ dBm).

The measured values differ from the displayed trace in two ways. First, any filtering applied to the channels is not displayed on the trace. Second, the single value of measured noise for a channel is subtracted from each trace point in the channel, rather than offsetting the entire channel by a single amount. This produces a smooth trace with no discontinuities at the channel edges.

Channels Tab for MCPR

Main menu bar: Setup > Settings > Channels

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

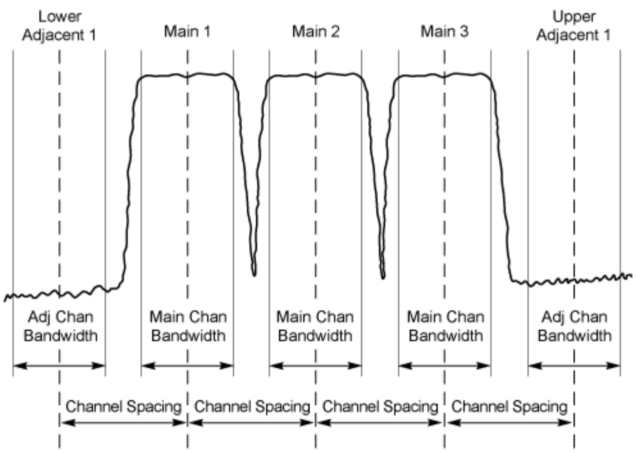


Setting	Description
Main Channels	
Number	Sets the number of Main channels.
BW	Maximum channel bandwidth is limited to approximately the maximum acquisition bandwidth of the instrument, ranging from 25 MHz to 165 MHz depending on the option installed.
Spacing	Sets the frequency difference between the centers of the Main channels.
Inactive	Selected channels are ignored by the measurement routine.
Adj Chans	
Add	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.

Table continued…

Setting	Description
Edit	Opens the Edit Channel Parameters dialog box. (You must first select a channel to enable the Edit button.)
Delete	Deletes the selected main channel or adjacent channel pair.
Channel Definition table	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.

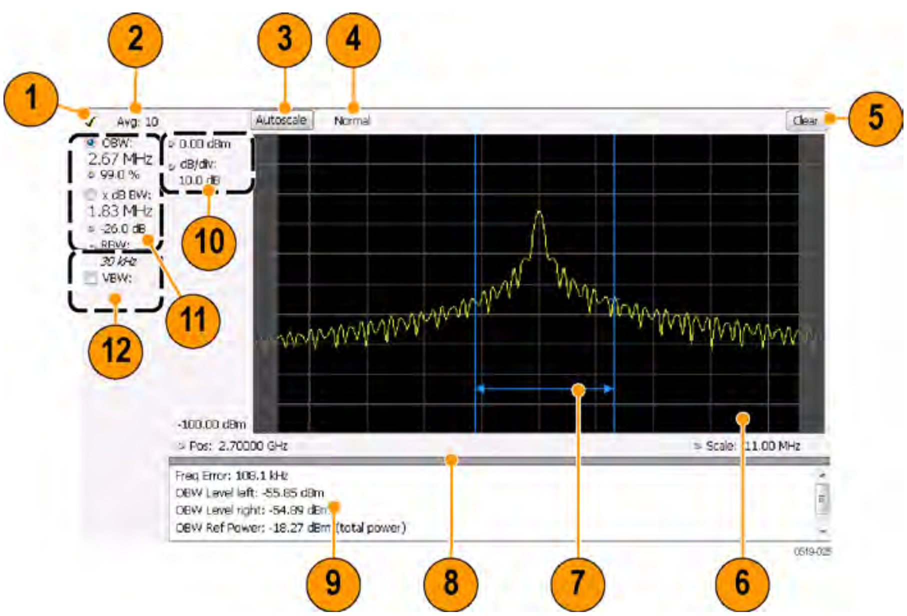
Occupied BW & x dB BW Display

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



Item	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 Units (not shown)	Position sets the top of graph value. The dB/div setting is the vertical scale value. Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
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*.

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.

Table continued…

Measurement	Description
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

Occupied Bandwidth

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

Occupied BW & x dB BW Settings

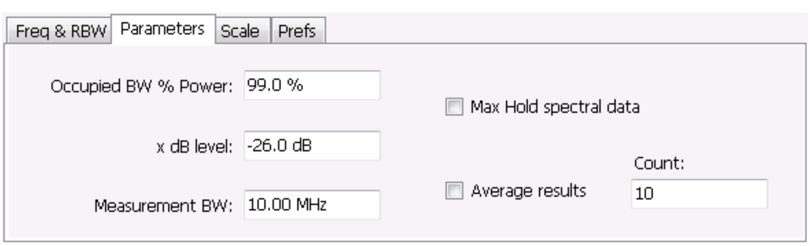
Main menu bar: Setup > Settings

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

Settings tab	Description
Freq & RBW	Allows you to specify the Center Frequency, Step size and RBW.
Parameters	Allows you to specify the Occupied BW % Power, x dB level, Measurement BW, enable averaging and the Max Hold function.
Scale	Allows you to set the vertical and horizontal scale parameters.
Prefs	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.



Setting	Description
Occupied BW % Power	Specifies the proportion of power within the occupied bandwidth (referenced against the total power in the measurement bandwidth).

Table continued…

Setting	Description
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 trace, but an 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.

Spurious display

To show the Spurious display:

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

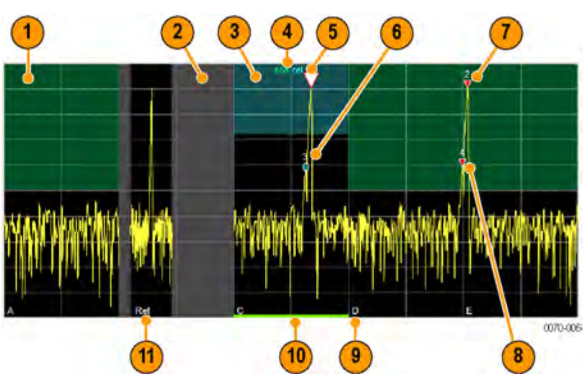
Elements of the Spurious Display

Item	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	Vert 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.
3	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the Amplitude selection in the Units tab of Analysis Control panel.
4	dB/ div	Sets the vertical scale value. The maximum value is 20.00 dB/division.
5	Bottom-of-graph readout	Indicates the amplitude at the bottom of the graph. This value changes with the dB/div and Vertical Position settings.
6	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen. Selects Multi-range display mode.
7	Start	Adjusts the graph start frequency. This setting affects only visual scaling, not measurement parameters.

Table continued…

Item	Display element	Description
8	Green bar	Indicates the range that is selected on the Settings > Ranges and Settings > Limits tabs.
9	Spur table	Displays spur measurements. See the following table for details.
10	Stop	Adjusts the graph stop frequency. This setting affects only visual scaling, not measurement parameters.
11	Clear	Restarts multi-trace functions (Average, Max Hold).
12	Trace function	Indicates the trace processing method. If Average or Max Hold is selected, this readout displays the number of traces being processed (averaged or compared for the Max Hold value).
13	Show	Controls whether the selected trace is visible or not. When trace is Off, the box is not checked.
14	Trace	Selects a trace. Clicking here pops up a context menu listing the available traces, whether they are enabled or not. If you select a trace that is not currently enabled, it will be made enabled.
15	Ref:	If enabled, displays the power reference level.
16	Pass / Fail readout	Indicates whether one or more spurs have exceeded a limit specified on the **Settings** > **Limits** tab.

Elements of the Spurious Graph Display



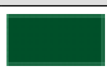
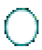
Item	Display element	Description
1		The green line or shading indicates an Abs (absolute) limit. The absolute limit is enabled when the mask is set to Abs, Abs & Rel, or Abs OR Rel. Note that absolute and relative amplitude masks can overlap.
2		The gray-shaded area indicates a portion of the spectrum where no measurements are being taken.

Table continued…

Item	Display element	Description
3		The cyan line or shading indicates a Relative limit. The relative limit is enabled when the mask is set to Rel, Abs & Rel, or Abs OR Rel. Note that absolute and relative amplitude masks can overlap.
4	abs rel	Reminder that green-shaded areas highlight absolute limits and cyan-shaded areas highlight relative limits.
5		This indicates the selected spur, when it is in violation of the limits. In Run mode, this is the peak spur violation. The selected marker is highlighted in the Spur table below the graph with a blue background.
6		A spur marker. Indicates a spur that does not exceed the mask settings. See the *Settings > Ranges and Limits tab*.
7		A violation marker. Indicates a spur that exceeds the mask settings. See the *Settings > Ranges and Limits tab*.
- -		Indicates the selected spur when it is not in violation of the limits. The selected marker is highlighted in the Spur table below the graph with a blue background.
8	1, 2, 3...	A Spur number. The number indicates the row in the spur table that corresponds to the spur. The instrument can display up to 999 spurs.
9	A, B, C, D...	Identifies the enabled ranges.
10	Green bar	Indicates the range selected on the *Settings > Ranges and Limits tab* tab.
11	Ref	Indicates the location of the power reference. See *Settings > Reference*.

Elements of the Spur Table

Spur	Range	Freq Abs	Freq Rel	Ampl Abs	Ampl Rel	Limit Abs	Limit Rel
1	B	1.751145 GHz	-- Hz	-5.91 dBm	4.09 dB	-15.00 dBm	-15.00 dB
2	E	2.053875 GHz	-- Hz	-8.99 dBm	1.01 dB	-15.00 dBm	-10.00 dB
3	D	1.903950 GHz	-- Hz	-10.48 dBm	-0.48 dB	-50.00 dBm	-57.00 dB
4	A	1.748826 GHz	-- Hz	-39.57 dBm	-29.57 dB	-57.00 dBm	-30.00 dB
5	D	1.899062 GHz	-- Hz	-40.31 dBm	-30.31 dB	-50.00 dBm	-57.00 dB

Column	Description
Spur	A number that identifies a spur in the graph area. The instrument can display a maximum of 999 spurs.
Range	The letter representing the frequency range where the spur is located.
Freq Abs	The absolute frequency at which the spur occurs.

Table continued…

Column	Description
Freq Rel	The relative frequency at which the spur occurs. The relative frequency is the difference between the absolute frequency (absolute) and the carrier frequency.
Ampl Abs	The absolute amplitude of the spur.
Ampl Rel	The relative amplitude at which the spur occurs. The relative amplitude is the difference between the absolute amplitude and the carrier amplitude. See the Settings > Limits tab.
Lim Abs	The value of the absolute amplitude limit at the spur frequency. This value can vary even with small spur frequency changes if the start and stop limit values are different. See the *Settings > Ranges and Limits tab*.
Lim Rel	The relative amplitude limit at which the spur occurs. This value can vary even with small spur frequency changes if the start and stop relative amplitude limit values are different. See the *Settings > Ranges and Limits tab*.
Blue background	The cell in the Spur column with a blue background identifies the selected spur.
Red background	Cells in the Spur column with a red background identify violations. Cells in the results area with a red background identify the measurement that exceeded a limit.

Rearranging the Columns in the Spur Table

You can rearrange the order of the columns in the Spur Table. To move a column, click on the column heading and drag it to the desired position.

Sorting the Rows in the Spur Table

You can sort the rows in the Spur table by clicking on the column heading. For example, if you click on the Freq Abs heading, the results in the Spur table will be sorted by frequency. If you click on Range, the rows will be sorted by range. Clicking a second time on the same heading reverses the order.

Changing the Spurious Display Settings

Spurious display settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Parameters	Specifies whether the graph displays one range or multiple ranges. Specifies whether all spurs are shown or only spurs over specified limits.
Reference	Specifies the Power Reference level.

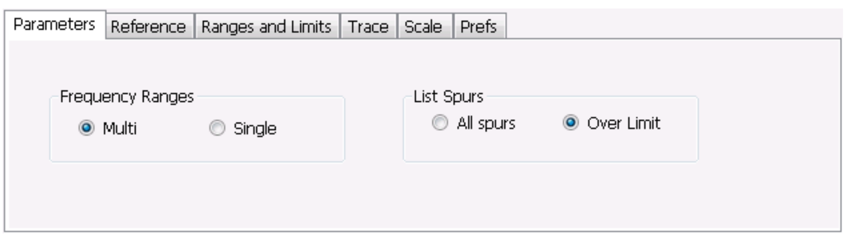
Table continued…

Settings tab	Description
Ranges	Specifies start and stop frequencies of ranges and which ranges to take measurements in. Sets parameters that define a spur. Review, save and load the Range table from this tab.
Limits	Specifies Pass/Fail limit parameters.
Traces	Specifies the trace Function.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies the appearance features of the graph area.

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

Parameters Tab

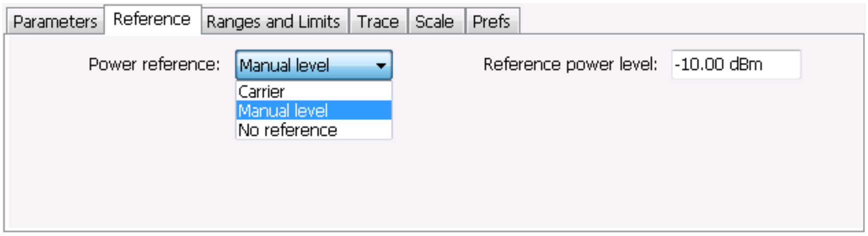
The Parameters tab enables you to specify settings that control the Spurious measurement.



Setting	Description
Frequency Ranges	
Multi	Enables the instrument to display all enabled ranges in the graph.
Single	Limits the graph to the display of only one range. The displayed range is set to the range that contains the selected spur.
List Spurs	
All spurs	Displays any spur that exceeds the Threshold and Excursion values set on the Ranges tab.
Over Limit	Displays only spurs that exceed both the Threshold and Excursion values set on the Ranges tab and the limits specified on the Limits tab.

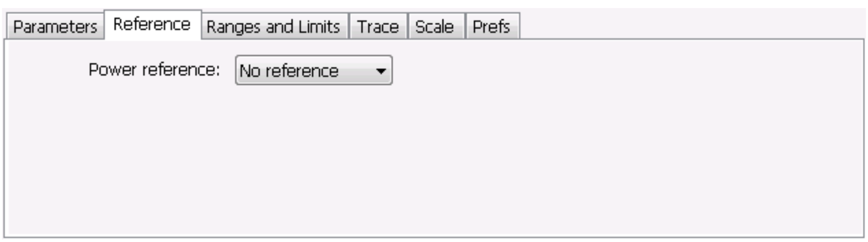
Reference Tab

The Reference tab enables you to specify the Power Reference parameter. The Power reference parameter is used to calculate relative values in the Spur table and to calculate relative amplitude limits.



Setting	Description
Power Reference	Specifies the power reference level used for relative values and limits.
No reference	Power level readings are calculated only for absolute values, no relative values are calculated.
Manual level	The reference level for relative measurements is specified by the Reference power level setting.
Carrier	The reference level for relative measurements is based on the power level calculated at the specified carrier frequency.

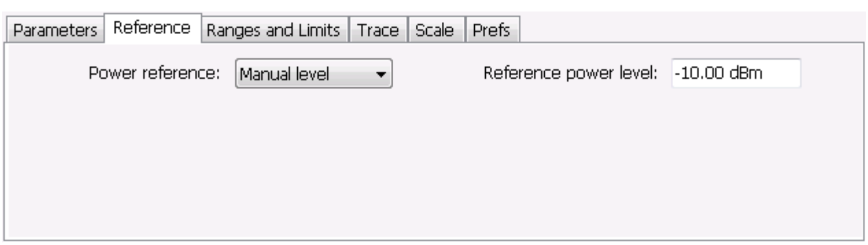
Setting the Power Reference Level to No Reference



To set the power reference to No Reference:

- Select **No reference** from the **Power reference** drop-down list.

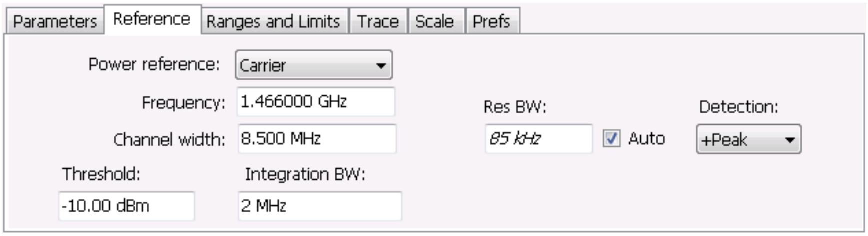
Setting the Power Reference Level to Manual Level



To set the power reference to manual level:

1. Select **Manual level** from the **Power reference** drop-down list. This displays the **Reference power level** entry box.
2. Specify the desired power level in the **Reference power level** entry box.

Setting the Power Reference Level to Carrier



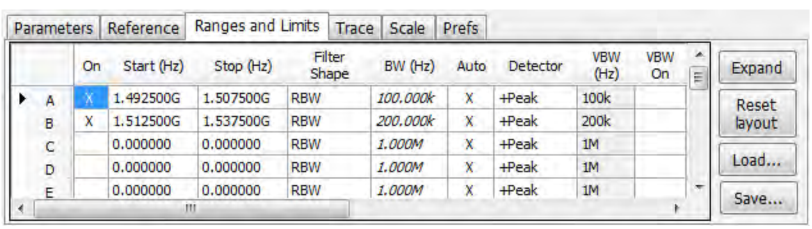
To set the power reference to Carrier:

1. Select **Carrier** from the **Power reference** drop-down list.
2. To set the Carrier frequency, specify the necessary values in the **Frequency** and **Channel width** entry boxes .
3. Specify the **Threshold** level.
4. Specify the **Integration BW**. The Integration BW is the bandwidth over which the carrier is measured.
5. If necessary, specify the Resolution Bandwidth by changing the value in the **Res BW** entry box. Auto is the recommended setting.
6. Set the **Detection** method. Select **+Peak**, **Avg (VRMS)**, or **Avg (of logs)**.

Note: If the power level measured over the Integration BW about the carrier frequency is below the threshold level, the instrument concludes that no carrier is present and no relative measurements will be taken. Absolute measurements will still be taken.

Ranges and Limits Tab

Use the Ranges and Limits tab to specify the parameters that control the Spurious measurement. From the Ranges and Limits tab, you specify the start and stop frequencies for ranges, whether or not a range is enabled, the parameters that specify what constitutes a spur, measurement filter shape and bandwidth, and the detection method used for processing signals, as well as the pass/fail parameters for limit testing.



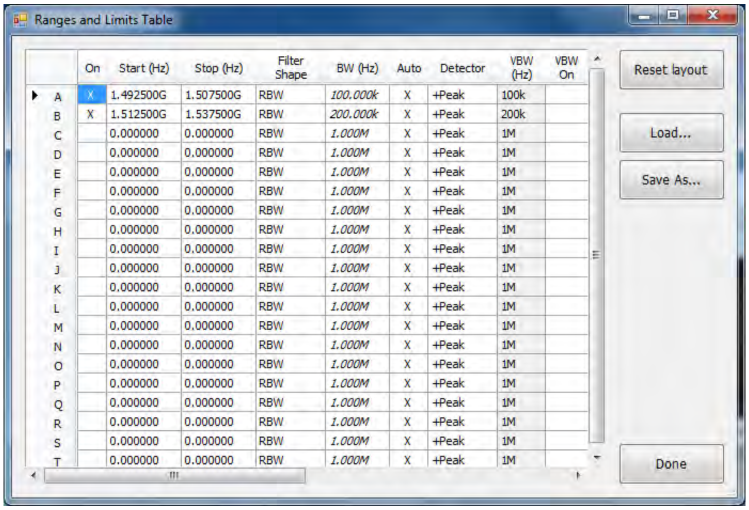
Setting	Description
Expand	Displays the Ranges and Limits Table in a new, resizeable window.
Reset layout	You can reorder columns in the Ranges and Limits Table by dragging the columns to a new position. Clicking Reset Layout returns the column order to the factory default order.
Load	Click to load a saved Ranges and Limits table from a file. The default directory is the last folder to which you saved an Acq data export (.CSV)” file.
Save	Click to save the current Ranges and Limits table to a file. The default directory is the last folder to which you saved an Acq data export (.CSV)” file.

To specify the ranges and limits for the Spurious measurement:

- Edit the values in the Ranges and Limits table.

You can edit the Ranges and Limits table in two ways:

- Edit values directly from the Ranges and Limits tab. You will need to scroll the table to access all settings.
- Click the **Expand** button. This displays the Ranges and Limits Table in a new window that can be sized to the full screen.



The following table describes the parameters that are set in the Ranges and Limits Table.

Table 10: Ranges and Limits Table Settings

Setting	Description
On	Specifies whether or not measurements are taken in the specified range.
Start (Hz)	Readout of the start frequency for the selected range.
Stop (Hz)	Readout of the stop frequency for the selected range.
Filter shape	Specifies the filter shape used for the Spurious measurement.
BW (Hz)	Specifies the bandwidth used for the selected filter shape.
Auto	Sets the BW automatically. If CISPR is selected for Filter shape, this control is disabled.
Detector	For CISPR detectors, this selection enables calculation as per the methods described in the CISPR documents. Supported CISPR detectors include CISPR Pk, CISPR QPk, and CISPR Avg. For non-CISPR detectors, this selection indicates the processing method used for compressing excess intermediate data into the desired number of trace points.
VBW (Hz)	Adjusts the VBW (Video Bandwidth) value. VBW Maximum: 10 times RBW current value; VBW Minimum: 1/10,000 RBW setting. Disabled when Filter shape is set to CISPR.
VBW On	Specifies whether the VBW filter is applied.

Table continued…

Setting	Description
Thrshld (dBm)	Threshold specifies the level that must be exceeded for a signal peak to be recognized as a spur. A signal peak must also exceed the Excursion setting to be considered a spur.
Excrsn (dB)	Excursion specifies the peak to peak magnitude that must be exceeded for a signal peak to be recognized as a spur. A signal transition must also exceed the Threshold setting to be considered a spur.
Mask	Selects the type of limits used for Pass/Fail testing. Spurs that exceed the mask settings are considered violations. The available choices are shown below.
Abs	Spurs that exceed the Absolute limits settings are identified as violations.
Rel	Spurs that exceed the Relative limits settings are identified as violations.
Abs & Rel	Spurs that exceed both the Absolute and Relative limits settings are identified as violations.
Abs OR Rel	Spurs that exceed either the Absolute or Relative limits settings are identified as violations.
Off	Turns off limit testing for the selecting range. Measurements are still taken in the range, but violations are not flagged. Signal peaks that exceed the Threshold and Excursions values will still be identified as spurs.
(Abs Start and Abs Stop)	Absolute amplitude limits are not based on the measured carrier amplitude or manual reference. Start and stop values can be different.
Abs Start (dBm)	Abs Start specifies the limit at the start frequency of the range.
Abs Stop (dBm)	Abs Stop specifies the limit at the stop frequency of the range.
Abs Same	Sets the limit at the start and stop frequencies to the value set for the start frequency.
(Rel Start and Rel Stop)	Relative amplitude limits are calculated from the Power Reference. If the Power Reference is set to the Carrier level, the relative amplitude limits will change with the carrier level. Start and stop values can be different.
Rel Start (dB)	Specifies the limit at the start frequency of the range.
Rel Stop (dB)	Specifies the limit at the stop frequency of the range.
Rel Same	Sets the limit at the stop frequency to the value set for the start frequency.
Save As	Click to save the current Ranges and Limits table to a file.
Load	Click to load a saved Ranges and Limits table from a file.
Done	Save changes and close the Ranges and Limits Table window.

Changing the Range Start and Stop Frequencies

To change the range start and stop frequencies, edit the Start and Stop frequencies in the Ranges and Limits Table:

1. Click the **Expand** button on the **Settings** > **Range and Limits** tab. This displays the Ranges and Limits Table.
2. Click the **On** box for a range to take measurements in the range.
3. Click on the Start or Stop frequency setting to change it. Type in a number for the frequency and a letter as a multiplier. You can use k, m, or g to set the frequency multiplier.
4. Click **Done** to save your changes.

Specifying Spur Requirements

A spur is a signal peak that exceeds both the Threshold and Excursion settings in the Ranges and Limits table. The Threshold and Excursion settings are absolute values; they are not calculated relative to a reference. The Threshold and Excursion settings are specific to the selected range. If you want to use different settings for spurs in different ranges, you have to set the values separately for each range. The Excursion control is used to avoid interpreting a single spur as multiple narrower spurs by requiring the amplitude to drop by the Excursion amount between spurs. Raising the Threshold value means that fewer, larger signals will be identified as spurs.

To specify the spur requirements for a range:

1. Click the **Expand** button on the **Range and Limits** tab. This displays the Ranges and Limits Table.
2. Select the **Range** (A–T) for which you want to specify the spur requirements.
3. Set the **Thrshld** value.
4. Set the **Excrsn** value.

Setting Limits

Use the Limits settings in the Ranges and Limits Table to specify the pass/fail parameters for the Spurious measurement. When the Mask setting is set to any value except off, the instrument identifies any signal peak that exceeds the specified limits as a violation and displays Fail on the screen. If no signal peak exceeds the limits, the instrument displays Pass on the screen.

Performing Pass/Fail Limit Testing

To set limits:

1. Click the **Expand** button on the **Range and Limits** tab. This displays the Ranges and Limits Table.
2. Adjust the Start and Stop frequencies as required for each range you want to test.
3. For ranges that you wish to test, verify that the **On** box is checked.
4. For each range you wish to test, select the desired **Mask** type from the drop-down list.
5. Set the limits as desired in the **Abs Start**, **Abs Stop**, **Rel Start**, and **Rel Stop** boxes. The values you can edit depend on the mask type you select.
6. Verify that the **Thrshld** and **Excrsn** values are set as required. These are the values that define a spur.
7. Click **Done** to save your changes and close the Range and Limits Table window.
8. Click **Run** to begin testing.

CCDF Display

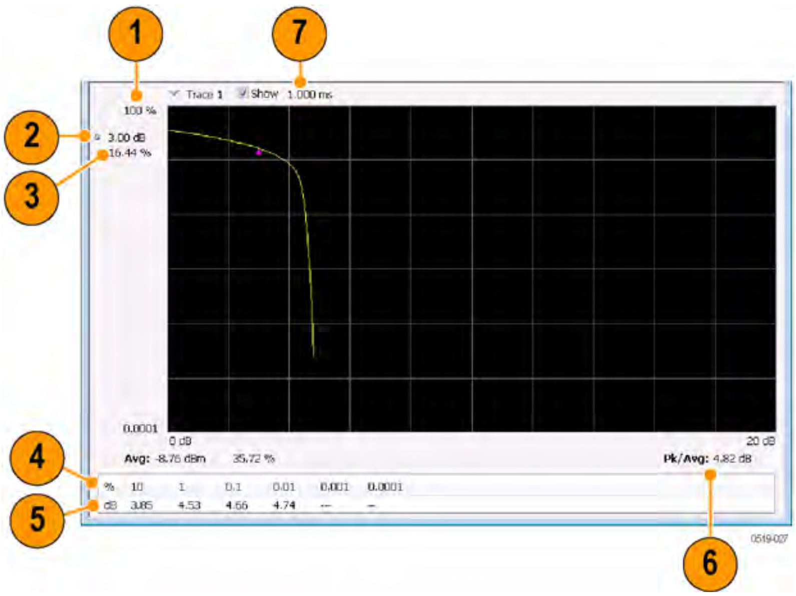
The CCDF (Complementary Cumulative Distribution Function) is a statistical characterization that plots power level on the x-axis and probability on the y-axis of a graph. Each point on the CCDF curve shows what percentage of time a signal spends at or above a given power level. The power level is expressed 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. Recall an appropriate acquisition data file.

2. Press the **Displays** button or select **Setup** > **Displays**. This shows the **Select Displays** dialog box.
3. From the **Measurements** box, select **RF Measurements**.
4. Double-click the **CCDF** icon in the **Available Displays** box. This adds the CCDF icon to the **Selected displays** box.
5. Click the **OK** button.
6. Press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the CCDF Display



Item	Display element	Description
1	100%	The top of the graph represents the 100% probability that the signal will be at or above the average signal level.
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

CCDF Settings

Main menu bar: Setup > Settings

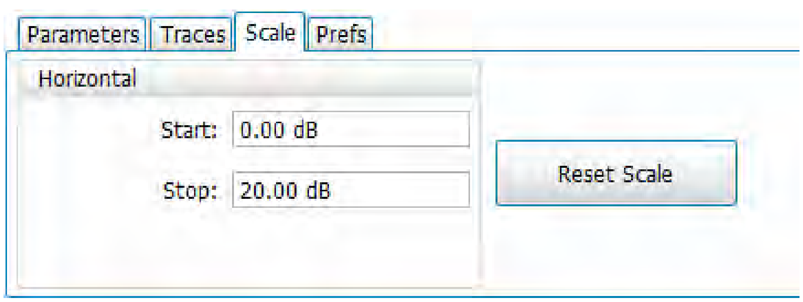
The control panel tabs for the CCDF Display are shown in the following table.

Settings tab	Description
Parameters	Specifies the time to be measured.
Traces	Select the trace to be measured and select reference trace for display.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether on not certain display elements are shown.

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

Scale Tab

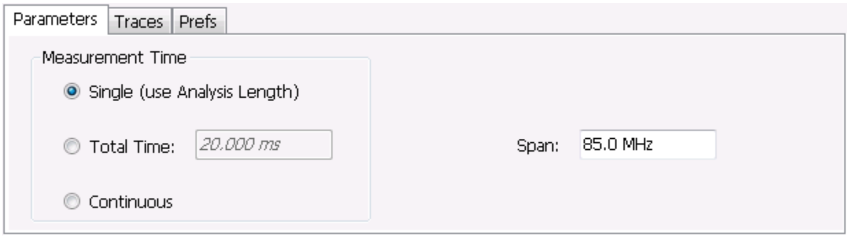
The Scale tab for the CCDF display allows you to change the start and stop points for the horizontal trace. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Center Frequency.



Setting	Description
Rest Scale	Resets all settings to their default values.
Horizontal	Controls the span of the trace display and position of the trace.
Start	Sets the starting range of the trace.
Stop	Sets the end range of the trace.

Parameters Tab

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



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 changes the Analysis Length (and Acquisition Length, if needed) to 20 msec. If the Total Time value is longer than the Analysis Length, CCDF uses multiple acquisitions to collect signal data.
Continuous	When Continuous is selected, the CCDF measurement combines each new record (Actual Analysis Length) into the existing result. It does not erase and start over until user 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".

Total Time

Setting the Measurement Time to Total Time changes the Analysis Length (and Acquisition Length, if needed) to 20 msec. This can impact other measurements. For instance, the OBW measurement would change because it would get more analysis length than it normally needs, so switching in/out of the CCDF Total Time selection noticeably affects OBW results. This happens to a lesser amount when Measurement Time is set to Single or Continuous. This is because each sets Analysis Length to 1 msec. These different Analysis Lengths may affect other measurements, too.

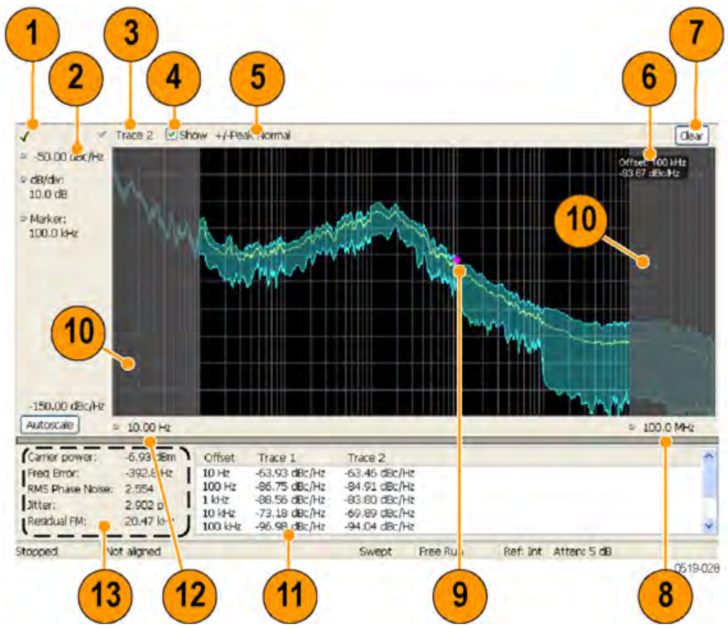
Phase Noise Display

Phase Noise measures and graphs the power in a 1 Hz bandwidth referenced to the carrier power. This is repeated for many frequency points across a user-adjustable span.

To show the Phase Noise display:

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

Elements of the Phase Noise Display



Item	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	Vert Position (dBc/Hz)	Sets the top of graph value. This is only a visual control for panning the graph.
3	Trace selector	Selects a trace.
4	Show check box	Shows/hides the selected trace.
5	Detection method / Average count	Displays the Detector method used for the trace. If Average detection is enabled, the number of averaged traces appears here.
6	Measurement Marker readout	Readout of the value of the phase noise at the selected offset. The Phase Noise measurement marker does not affect the results reported in the readouts or table below the graph, nor is it associated with markers in any other display.
7	Clear	Restarts multi-trace function (Average).
8	Horizontal stop	Readout of the Right Horizontal frequency value. This setting affects only visual scale, not measurement bandwidth. (See *Settings > Scale*)
9	Measurement marker	Indicates the position of the measurement point.
10	Integration frequency range indicators	The gray-shaded areas denote the frequencies outside the integration frequency range. (See Settings > *Settings > Frequency*)

Table continued…

Item	Display element	Description
11	Phase Noise Table	Displays the phase noise values at different offsets.
12	Horizontal start	Readout of the Left Horizontal frequency value. Affects only visual scaling, not measurement bandwidth. (See *Settings > Scale*)
13	Measurement results readouts	Display of the different measured values.

Elements of the Measurement Results Readout / Phase Noise Table

Readout	Description
Carrier power	The power level at the carrier frequency.
Freq Error	The measured carrier frequency error.
RMS Phase Noise	The RMS value of the phase noise, measured over the Integration BW.
Jitter	The jitter in seconds, measured over the Integration BW. Includes the effects of random and coherent jitter.
Residual FM	The residual frequency modulation, measured over the Integration BW.
Trace 1	The phase noise on trace 1 at different frequency offset values. Note that if Trace 1 is set to +/- Peak detection, the value displayed in the table is the +Peak value.
Trace 2	The phase noise on trace 2 at different frequency offset values. Note that if Trace 2 is set to +/- Peak detection, the value displayed in the table is the +Peak value.

Changing the Phase Noise Settings

How Phase Noise Is Measured

If carrier tracking is on, the instrument measures phase noise relative to the highest-amplitude signal within about 20 MHz of the user-entered frequency. The difference between center frequency and the frequency of the measured carrier is reported as frequency error. If carrier tracking is not on, the instrument measures phase noise relative to the amplitude at the user-entered frequency.

The unit will tune to a number of offsets from the carrier frequency, and calculate the spectrum for the frequency range about each offset using a resolution bandwidth appropriate for the offset frequency. This is done to optimize speed while maintaining acceptable frequency resolution. A table of the values used for measurement frequency offset, resolution bandwidths, hardware IF filter bandwidths and RF attenuations is shown below.

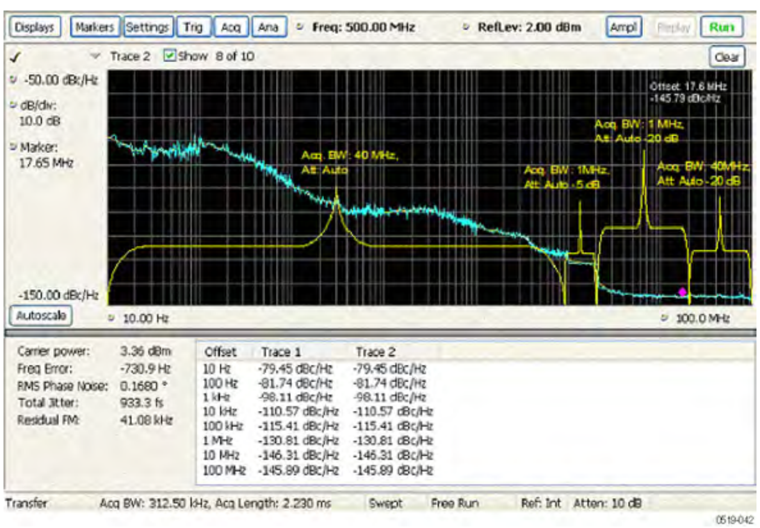
Measurement frequency offset range	Measured span	RBW use for spectrum calculation	Hardware IF filter	RF Attenuation
10 Hz to 100 Hz	312.5 kHz	1 Hz	40 MHz	Auto from ref level
100 Hz to 1 kHz	312.5 kHz	2 Hz	40 MHz	Auto from ref level
1 kHz to 10 kHz	312.5 kHz	20 Hz	40 MHz	Auto from ref level
10 kHz to 100 kHz	3 MHz	200 Hz	40 MHz	Auto from ref level
100 kHz to 1 MHz	3 MHz	1 kHz	40 MHz	Auto from ref level
1.0 MHz to 1.9 MHz	300 kHz	1 kHz	1 MHz	Auto from ref level (-5 dB)[1]
1.9 MHz to 20.0 MHz	300 kHz	1 kHz	1 MHz	Auto from ref level (-20 dB)[1]
20 MHz to 100 MHz	20 MHz	10 kHz	40 MHz	Auto from ref level (-5 dB)[1]
100 MHz to 1000 MHz	20 MHz	100 kHz	40 MHz	Auto from ref level (-5 dB)[1]

After acquisition and calculation, the spectrum is corrected to display power in a 1 Hz bandwidth referenced to the carrier power (dBc/Hz). The correction algorithm does not discriminate between noise signals and coherent signals in making the dBc/Hz correction. Since all measured signals are corrected as if they were noise, coherent signal measurement results can contain errors in level. This is a key difference between an SA-based measurement and a dedicated phase noise tester.

The largest difference between operation of a swept spectrum analyzer and a real-time signal analyzer when measuring phase noise is a result of the wide acquisition bandwidths found in the real-time signal analyzer.

The real-time signal analyzer can select between 1 MHz, 40 MHz and 165 MHz IF filters when performing acquisitions.

By contrast, a traditional spectrum analyzer uses an IF bandwidth that can range from a few kHz wide up to 10 MHz wide, depending upon the selected resolution bandwidth. When the IF bandwidth is small it is able to reject out-of-band carriers so they don't overload the final IF and digitizers in the instrument. This allows the signal analyzer to begin to reduce attenuation as the phase noise measurement tunes farther away from the carrier, improving dynamic range. The same thing is done in the real-time signal analyzer, but the 1 MHz final IF section in the real-time signal analyzer can't reject signal within about 1 MHz whereas a conventional spectrum analyzer can reject signals within a few kHz of the desired carrier. This is the reason for the shape of the phase noise plot seen in the following illustration.



1 Attenuator adjustment when 'optimize dynamic range' is selected

In the previous illustration, the effect of choosing ‘optimize dynamic range’ is seen. In the offsets between 10 Hz and 1 MHz, the 40 MHz acquisition bandwidth is used, and the RF attenuator is set based on the reference level of the instrument to prevent overload of the RF/IF signal path.

At an offset of >1 MHz, a 1 MHz IF bandwidth is applied, 5 dB of RF attenuation is removed from the signal path and the noise ‘floor’ of the measurement is reduced. At 2 MHz offset from carrier, 20 dB of attenuation is removed with a resultant increase in dynamic range. Finally, at 20 MHz offsets, the 40 MHz filter is used again with 20 dB attenuation removed. In order to be able to use the 40 MHz BW filter at a 20 MHz offset, the measurement frequency is moved so that the carrier is 30 MHz from the measurement point, and well down the filter rejection skirt.

Phase Noise Settings

Main menu bar: Setup > Settings

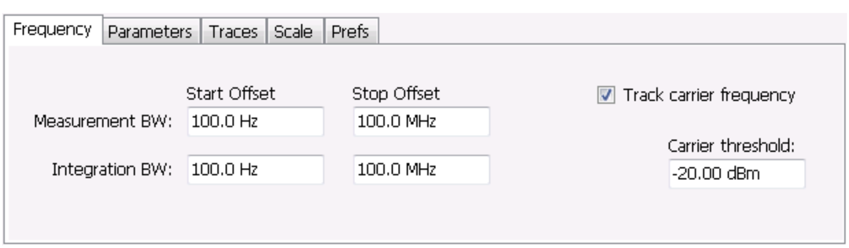
The control panel tabs for the Phase Noise display are shown in the following table.

Settings tab	Description
Frequency	Specify Measurement BW and Integration BW. Enable carrier frequency tracking and specify the Carrier threshold level.
Parameters	Specifies the Optimization method.
Traces	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	Specify vertical and horizontal scale settings.
Prefs	Specify appearance features of the graph area.

Restore defaults. Sets the Phase Noise parameters to their default values.

Frequency Tab

Use the Frequency tab to specify parameters used for taking the Phase Noise measurement.



Setting	Description
Measurement BW	This sets the frequency range for the phase noise measurement range. The instrument's Frequency control is used to set the "carrier frequency of interest". The widest available start/stop range is from 10 Hz greater than the carrier frequency (“Stop Offset”) to 1 GHz above the carrier (“Stop Offset”). Very small start offsets will take significant time to measure as very narrow resolution bandwidths are used in to achieve small-offset measurements. Large-offset stop frequencies cause small effects on measurement time, but will increase the displayed scale of the phase noise plot.
Start Offset	Sets the starting point for the Phase Noise plot. Offset is from the carrier frequency. The minimum start offset is 10 Hz. The maximum start offset is 100 MHz. The setting is limited to powers of ten (1, 10, 100...).
Stop Offset	Sets the stopping point for the Phase Noise plot. Offset is from the carrier frequency. The minimum start offset is 100 Hz. The maximum stop offset is 1 GHz. The Stop offset value must be at least 10X the Start offset value. The setting is limited to powers of ten (1, 10, 100...).
Integration BW	Integration bandwidth sets the frequency range over which integrated results for phase noise (labeled “RMS Phase Noise”) and jitter are calculated. Integration start and stop cannot exceed the measurement bandwidth. If you set the integration bandwidth greater than the measurement, the error message ‘Setup error: Integration BW exceeds Measurement BW’ will appear.
Start Offset	Specifies the Integration BW's start offset from the carrier frequency.
Stop Offset	Specifies the Integration BW's stop offset from the carrier frequency.
Track carrier frequency	The instrument finds the carrier signal and measures its frequency at least once each time the Phase Noise measurement is taken and reports the error between the Freq setting and the measured frequency of the carrier. When Track carrier frequency is enabled, the measurement adjusts its tuning to counteract the carrier error or drift. When carrier tracking is disabled, the measurement is made using the Freq setting specified by the user.
Carrier threshold	The minimum power level required for the signal to be recognized as a carrier. If no signal is found above this level within 20 MHz of the Freq setting, the Phase Noise measurement will fail.

Parameters Tab

The Parameters tab enables you to specify acquisition settings that control the Phase Noise measurement.

Average. Specifies whether averaging is used or not. This setting affects integrated numeric results and the trace display. The range for this setting is 2 to 100. The default setting is disabled.

Settling Time Measurement Overview

The Settling Time measurement (Option 12) is used to measure frequency and phase settling time of frequency-agile oscillators and subsystems. Automated measurements can reduce user-to-user measurement variations, improve repeatability and measurement confidence, and save time in gathering results.

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*.

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 *Mask Test Settings* on page 636 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.

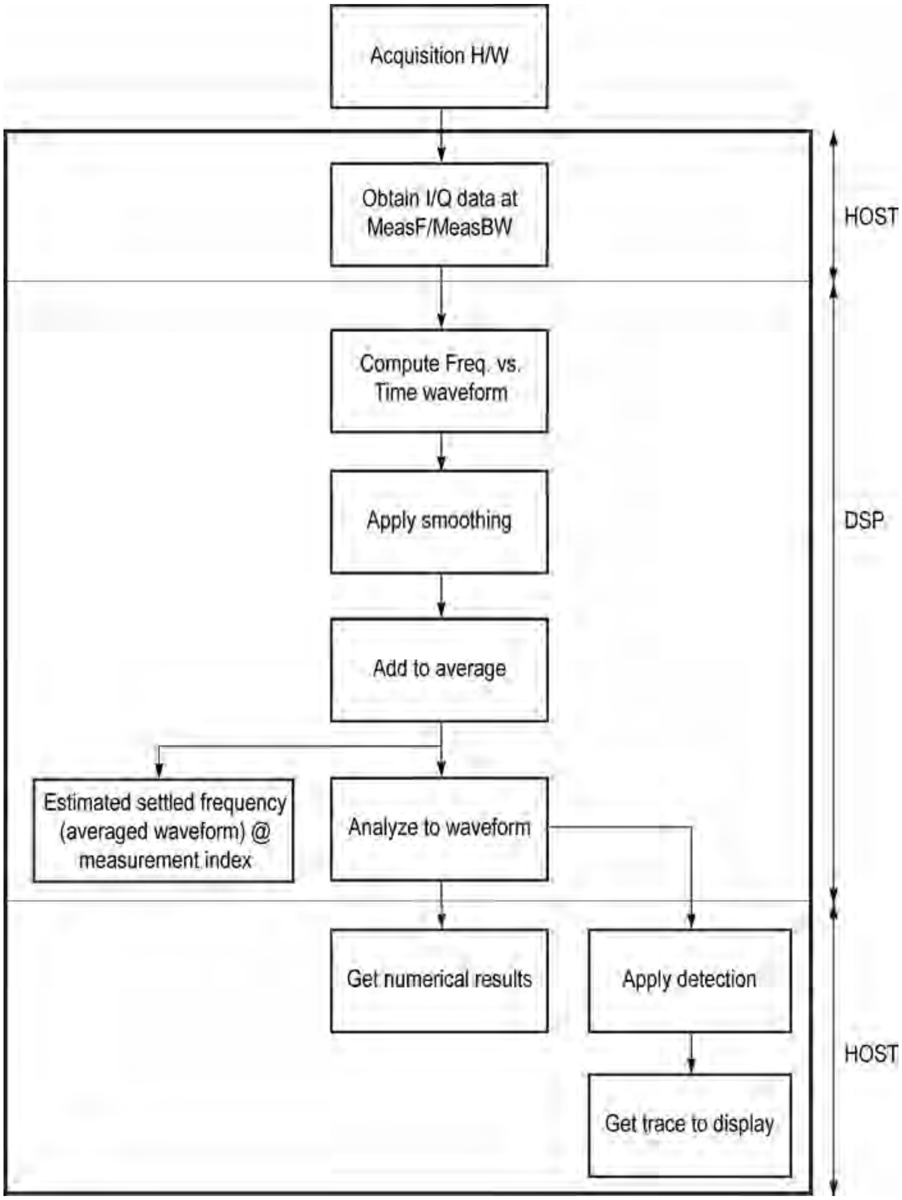


Figure 40: Frequency settling time flow diagram

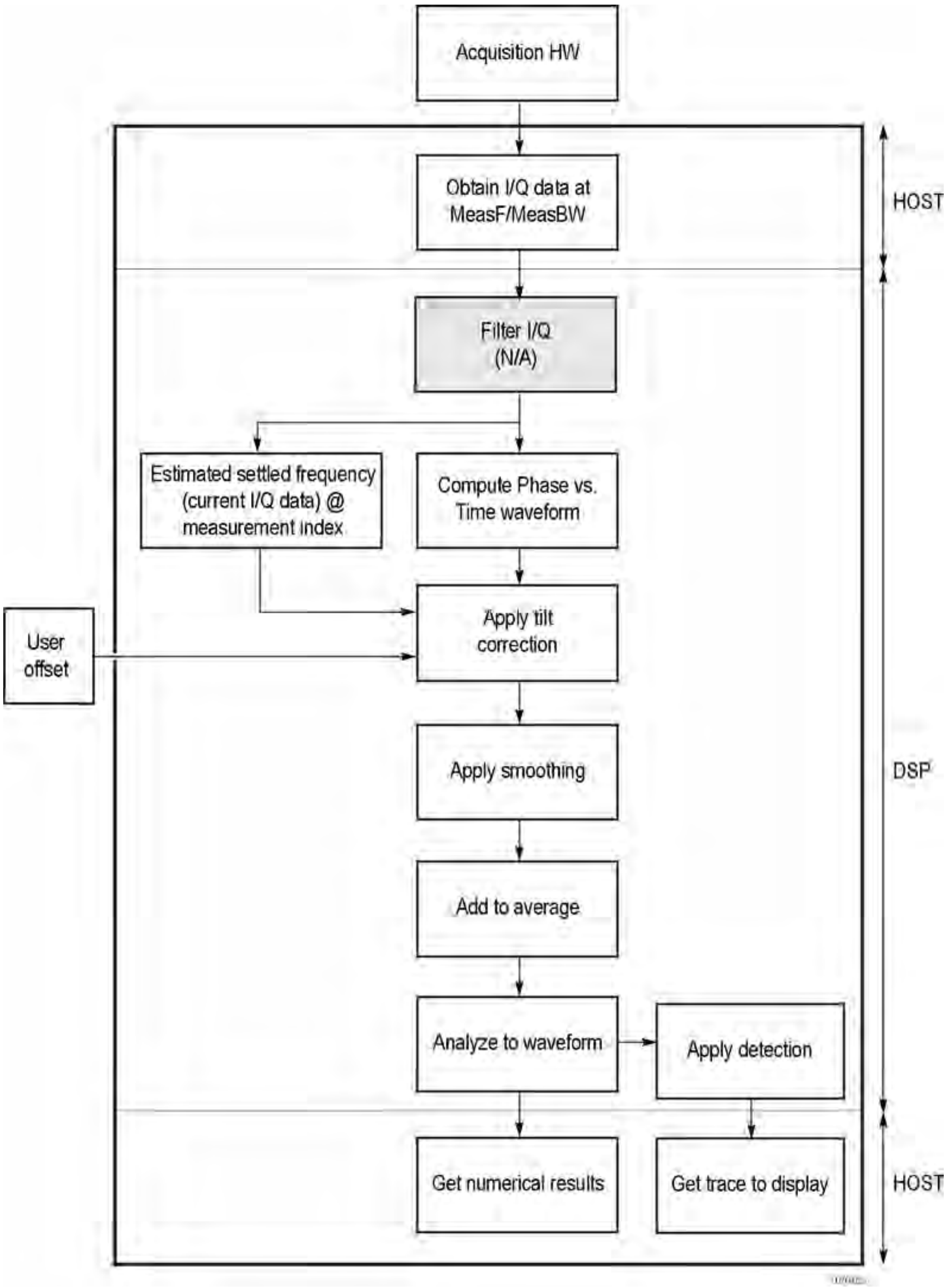


Figure 41: Phase settling time flow diagram

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

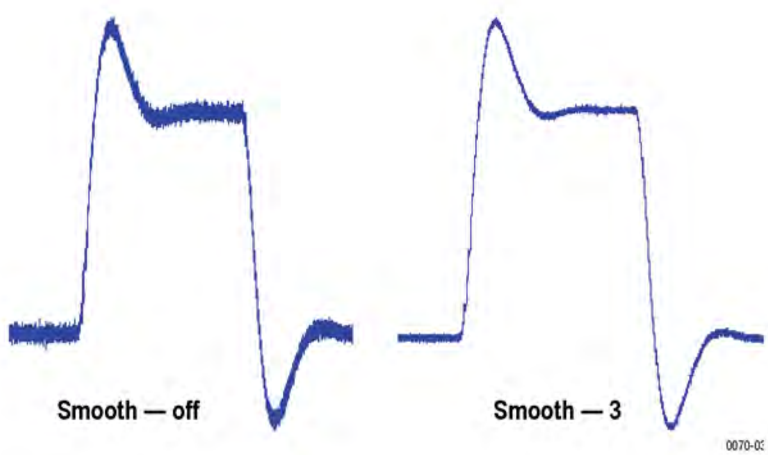
The instantaneous phase is computed as:

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

The instantaneous frequency is the derivative of the phase:

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

Data smoothing is applied (if selected by the user). This filtering method uses ±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.

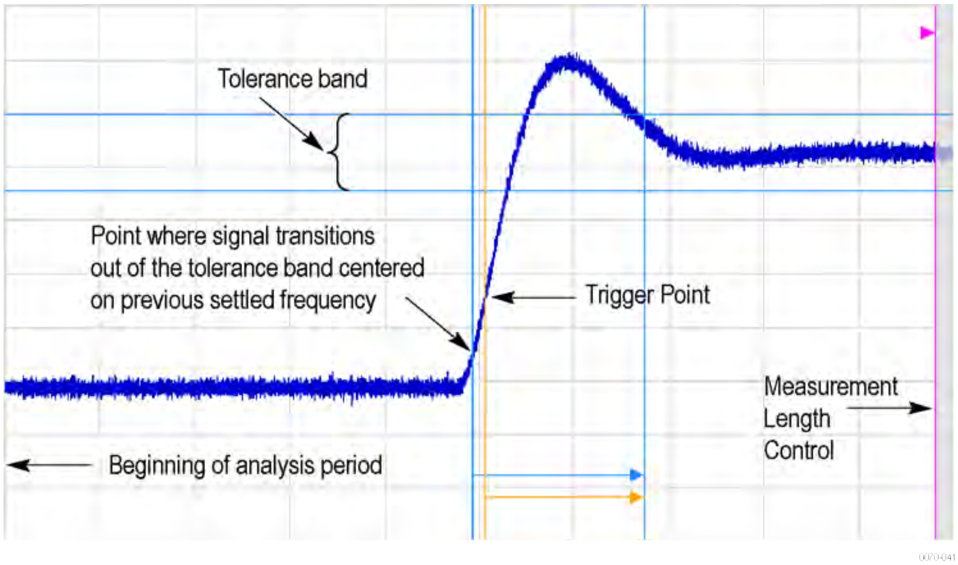


Figure 42: Settling time start reference points

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.

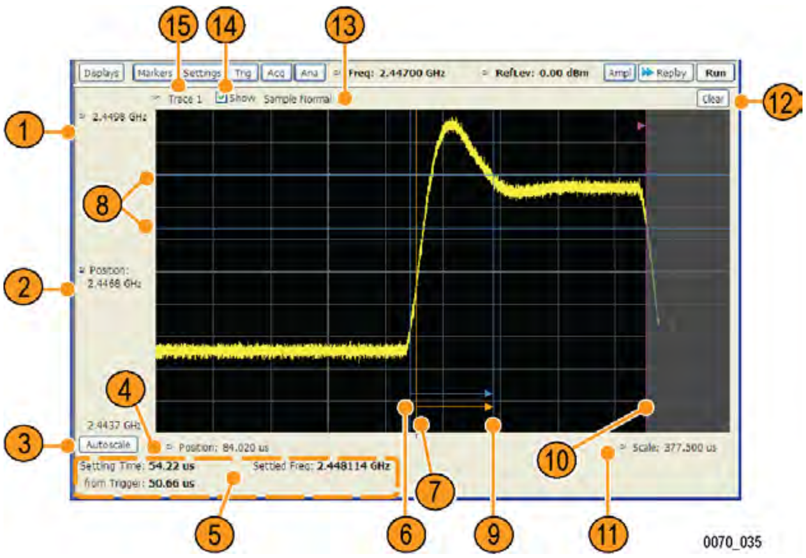


Figure 43: Frequency settling time display

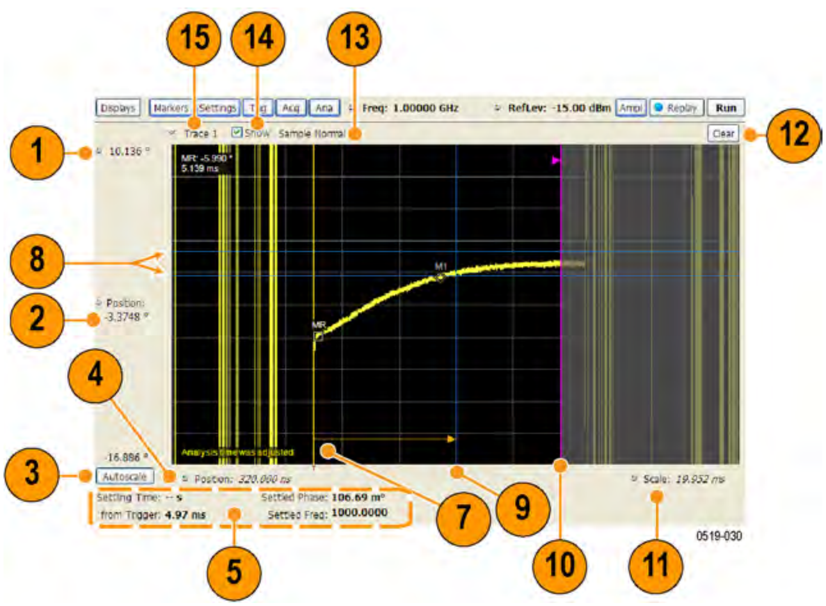


Figure 44: Phase settling time display

Elements of the Display

Item	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.

Table continued…

Item	Display element	Description
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

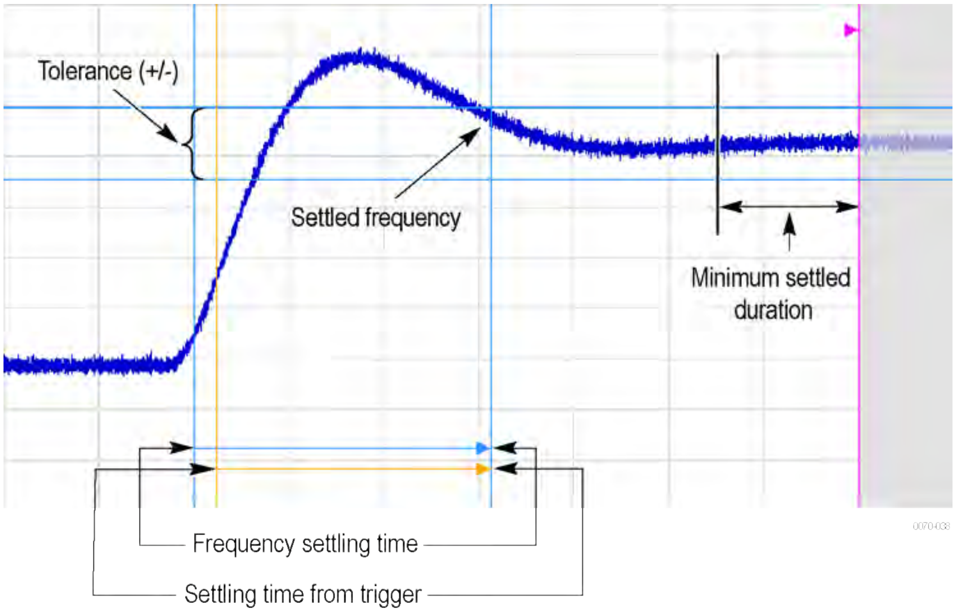
The measurement readouts can appear in either black text or red text. Measurement results that appear in black text indicate:

- 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

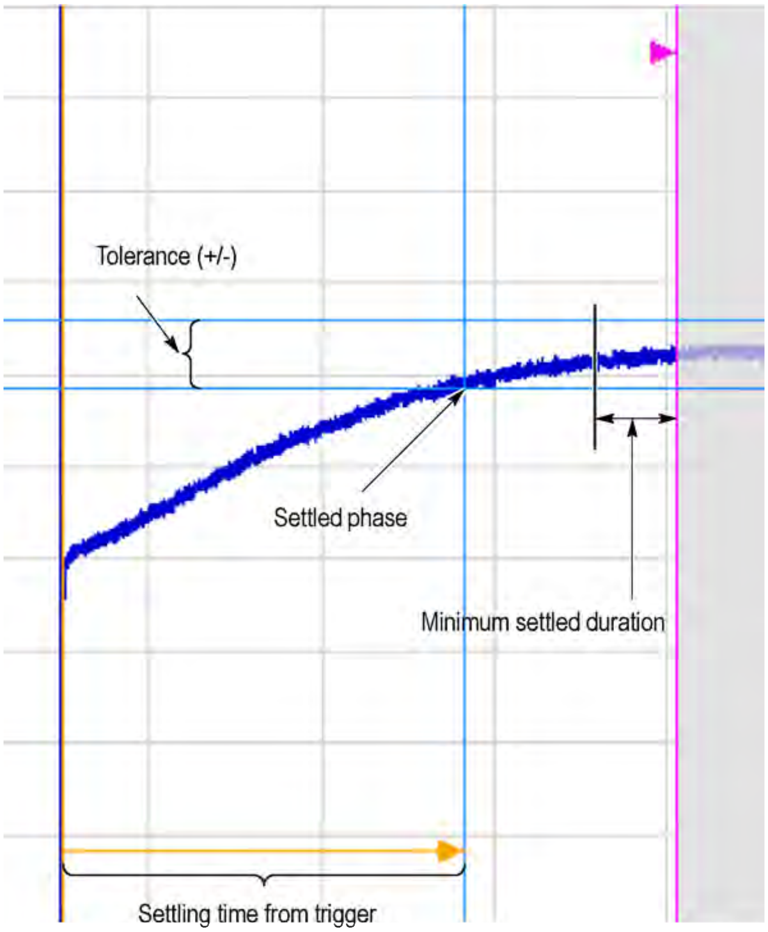
The following illustration shows the various indicators that appear in the Frequency Settling Time graph.



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.

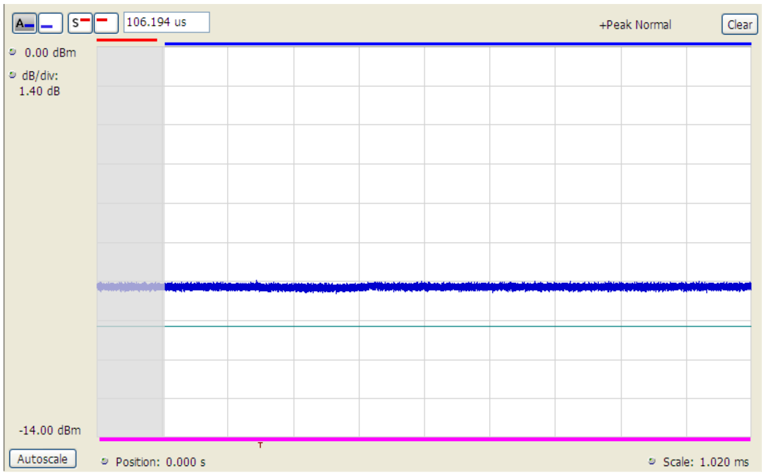


Figure 45: Setting the starting point of the settling time measurement

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* 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 *Target Reference* on page 201 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* 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* on page 202 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.

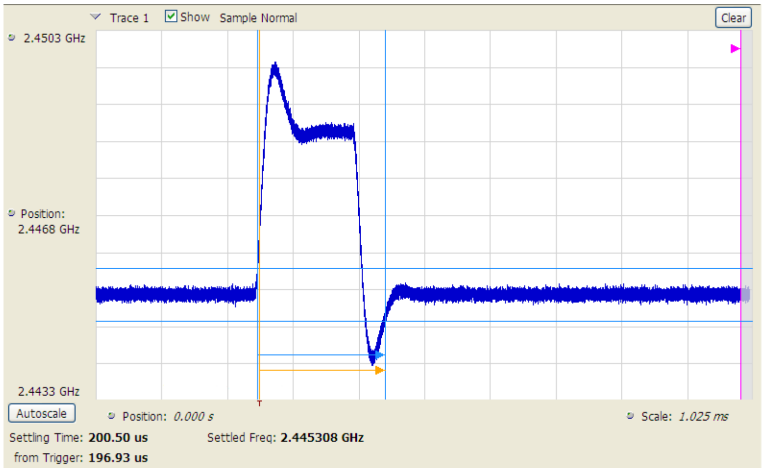


Figure 46: Frequency settling time display before setting the measurement length

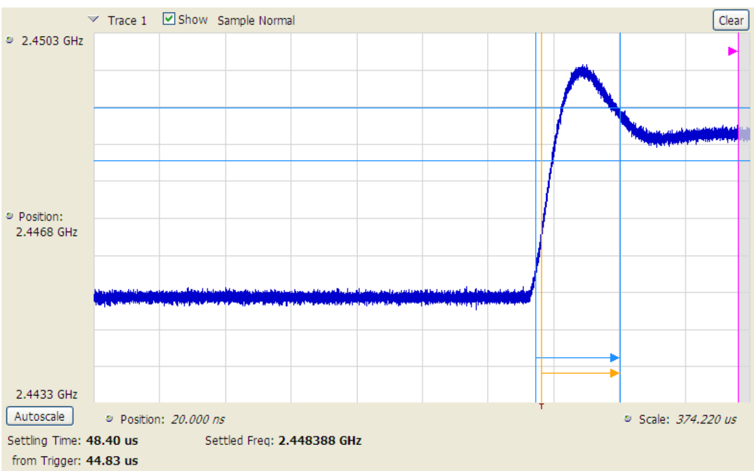


Figure 47: Frequency settling time display after setting the measurement length

Settling Time Settings

Main menu bar: Setup > Settings

The settings for the Frequency and Phase Settling Time displays are shown in the following table.

Settings tab	Description
Define	Sets the measurement parameters that characterize the settling time measurement.
Time Params	Sets measurement end-time and minimum settled duration parameters.
Mask	Enable or disables mask testing and sets the parameters that specify the three zones used for mask testing.
Trace	Specifies trace display characteristics and which traces are displayed.

Table continued…

Settings tab	Description
Scale	Sets vertical and horizontal scale and position parameters.
Prefs	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.

Common Controls Settling Time Displays Shared Measurement Settings

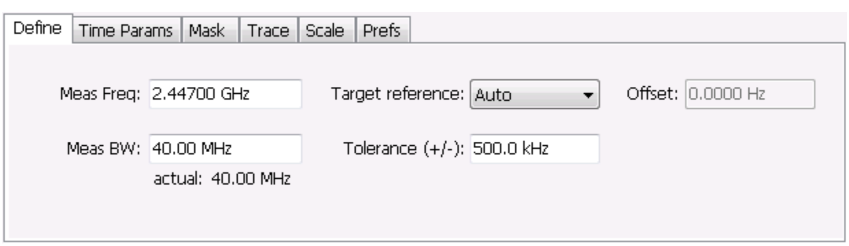
The control panel tabs in this section are shared by the Frequency and Phase Settling Time displays. These control panel tabs are not shared with other RF Measurement displays. With few exceptions, each display shares values for each of the controls on these tabs. For example, Vertical Scale values are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

Table 11: Common controls for settling time measurement displays

Settings tab	Description
Define	Specifies the parameters that characterize the settling time measurement.
Time Params	Specifies the Measurement length and minimum settled duration for the settling time measurement.
Mask	Specifies the parameters used for Mask testing.
Trace	Specify which traces to show and how they are computed.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies display parameters of the Settling Time 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.



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

This control limits the bandwidth of the Settling Time measurement. 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. The measurement bandwidth is 100 Hz to 165 MHz (Option B16x) or 100 Hz to 40 MHz (Standard). To see the effect of measurement bandwidth on measurement uncertainty, see the Specifications and Performance Verification manual. This manual is supplied on the Documents CD or can be downloaded from www.tek.com/manuals.

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 ± 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:

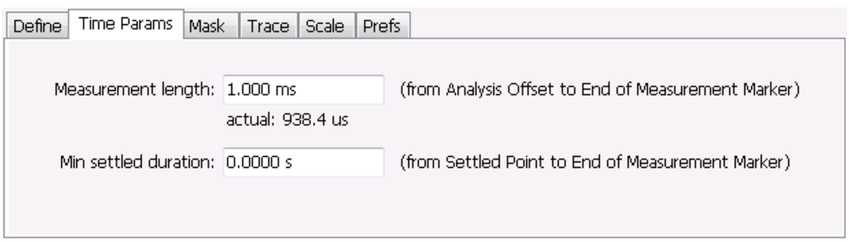
- If Target Reference is set to **AUTO**, then the target value is the settled value (the frequency at which the signal is considered settled).
- If Target Reference is set to MeasFreq, then the Target value = **Meas Frequency** + **Offset**.

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.



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 *Analysis Time* 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.

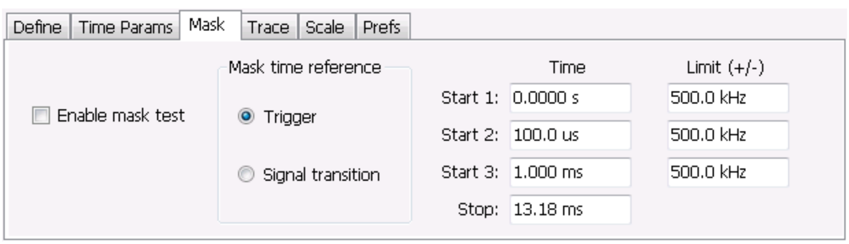
Note: If your signal does not settle to within your tolerance bands, make sure that the measurement time ends during the settled portion of the waveform.

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.



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.

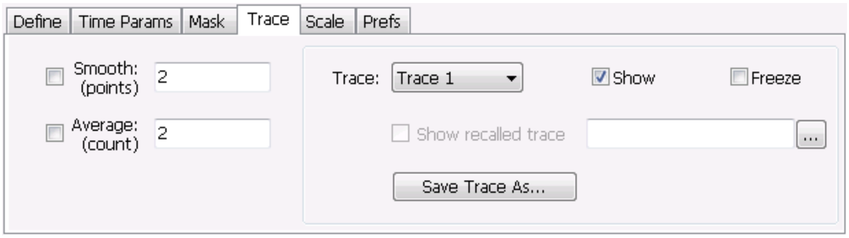
Mask Time Reference

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.

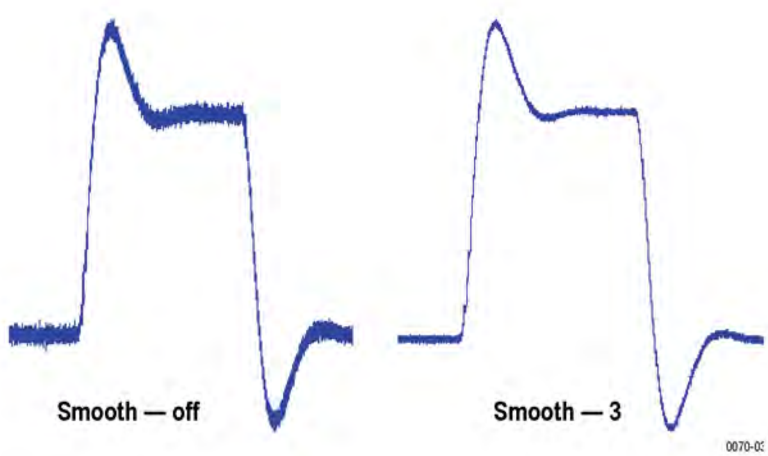
Trace Tab for Settling Time Displays

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



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. 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 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.

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.

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.

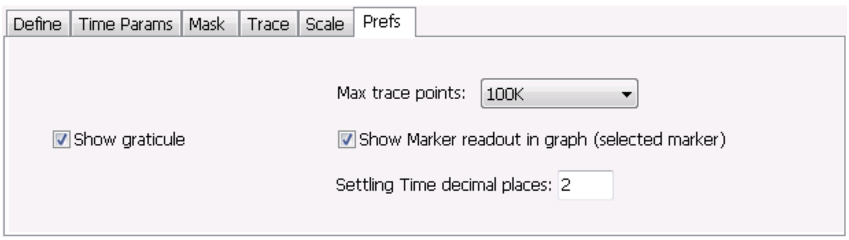
Setting	Description
Vertical	
Scale	Changes the vertical scale or span of the graph.
Position	Sets the frequency (or phase) at the vertical center of the graph.
Relative Freq	Sets the vertical (position) display readouts to show frequency values relative to the center frequency or as absolute values.
Autoscale	Resets the Scale and Position to center the trace in the graph.

Table continued…

Setting	Description
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.



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.

Elements of the Display

Item	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.
(not shown)	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
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.

Table continued…

Item	Display element	Description
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).

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.

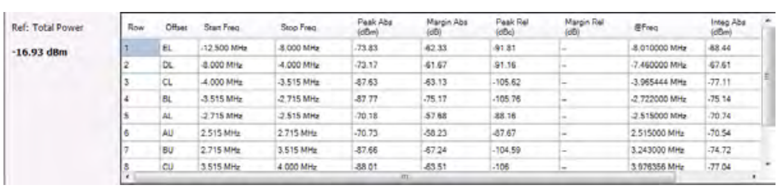
How the fail percentage is determined. Each offset has two sides, one lower and one upper. For example, Offset A has two sides: AL (lower side) and AU (upper side). In the SEM display, there is a maximum of six offsets (A-F) and each offset can have a maximum of two sides (if Both is selected for Side 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.



Ref: Total Power
-16.93 dBm

Row	Offset	Start Freq	Stop Freq	Peak Abs (dBm)	Margin Abs (dB)	Peak Rel (dBc)	Margin Rel (dB)	@Freq	Integ Abs (dBm)
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
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

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).

Table continued…

Readout	Description
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

Main menu bar: Setup > Settings

Favorites 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**.

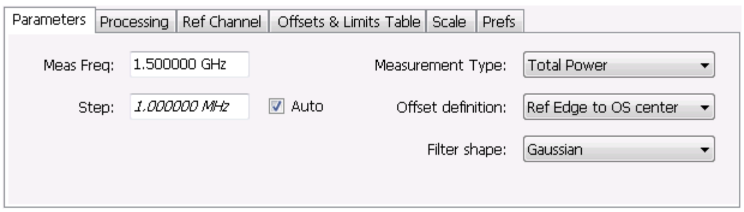
Settings tab	Description
Parameters Tab	Specifies several characteristics that control how the measurement is made.
Processing Tab	Specifies settings for detection on the Reference channel and the offsets. Specifies the function setting.
Ref Channel Tab	Specifies how the measurements on the reference channel are performed.
Offsets & Limits Table	Specifies characteristics of offsets and mask limits.

Table continued…

Settings tab	Description
Scale Tab	Specifies the vertical and horizontal scale settings.
Prefs Tab	Specifies the appearance features of the graph area and the maximum trace points.

Parameters Tab - SEM

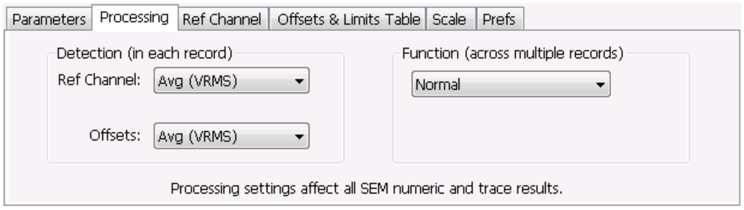
The Parameters tab specifies several characteristics that control how the Spectrum Emission Mask measurements are made.



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

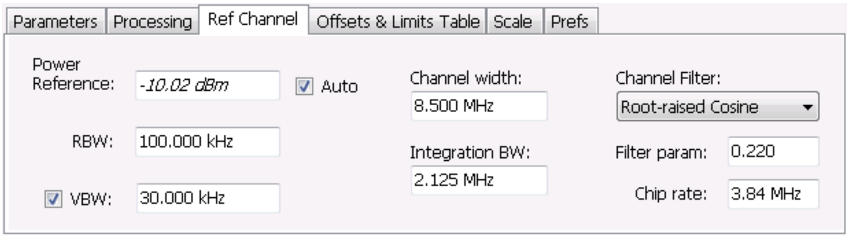
The Processing tab controls the Detection settings for the Reference Channel and Offsets, as well as selecting the Function.



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 is 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.



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.

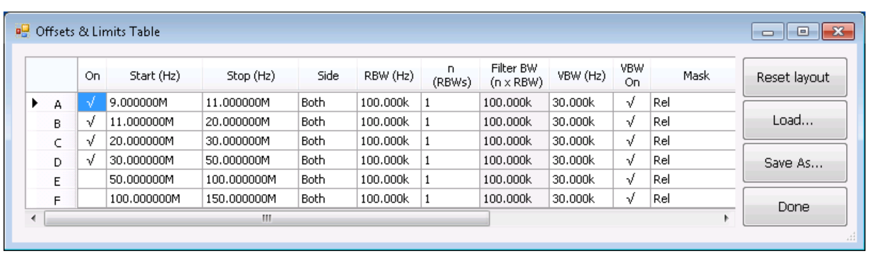


Figure 48: Expanded display of Offsets & Limits Table

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.

Table continued…

Setting	Description
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.

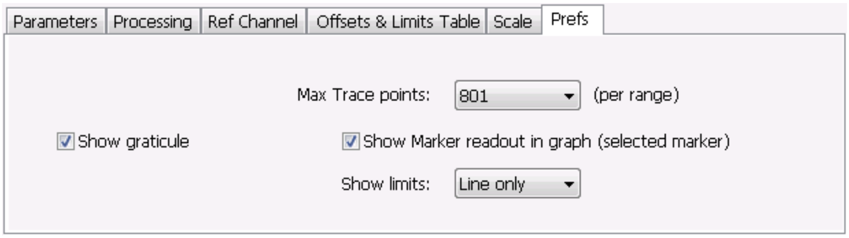
Scale Tab - SEM

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.

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 and switching the Graticule display on/off. Some parameters appear with most displays while others appear with only one display.



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. Blue shading is used to indicate Relative limits.
Line only	Shows limits using only a line. A green line is used to identify Absolute limits. A blue line is used to indicate Relative limits.
None	No lines or shading are used to indicate limits in the graph. Violations of the mask are still identified by red shading.

Common Controls RF Measurements Shared Measurement Settings

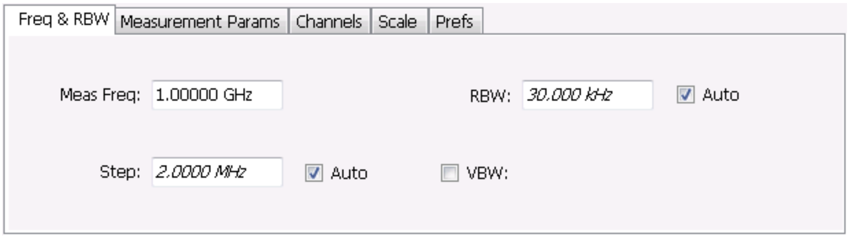
The control panel tabs in this section are shared by multiple displays in the RF Measurement folder (Setup > Displays). With few exceptions, each display maintains separate values for each of the controls on these tabs. For example, Scale values are independent for each of the displays.

Table 12: Common controls for RF measurement displays

Settings tab	Description
Freq & RBW	Allows you to specify the Center Frequency, Step size and RBW.
Traces	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	Specify vertical and horizontal scale settings.
Prefs	Specify appearance features of the graph area.

Freq & RBW Tab

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



Setting	Description
Meas Freq	Specifies the measurement frequency.
Step	The Step control sets the increment/decrement size for the knob adjustment of the center frequency. Arrow key adjustment of frequency is also affected (it is 10x the knob adjustment). If Auto is enabled, the analyzer will adjust the Step size as required.
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.

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.

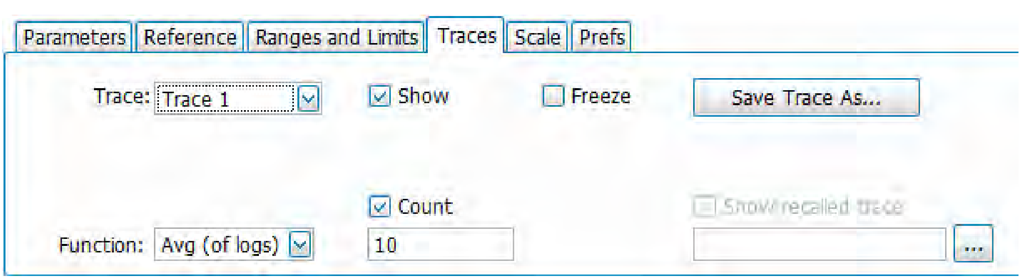
The maximum VBW value is 10 times the current RBW setting. The minimum VBW value is 1/10,000 of the RBW setting.

Note: If you are following a procedure that says to "set VBW to three times the RBW value or greater", it means that the test should be conducted with no VBW effects. In the SignalVu software, this condition is met by disabling the VBW function.

Traces Tab

The Traces tab enables you to select traces for display. You can choose to display live traces and/or recalled traces. The *Trace tab* 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.



Setting	Description
Trace	Selects a trace for display. CCDF display: Choices are Trace 1, 2, and Gaussian. Trace 1 and 2 can be recalled. Spurious display: Choices are Trace 1, 2, 3, 4, and Math trace. All traces can be recalled. Math trace is computed for all ranges.
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. When a trace is recalled, controls such as show, freeze, and function will be disabled.
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) Average: (count)	Available for Phase and Frequency Settling Time displays only. 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 *Trace Tab for Settling Time Displays* on page 203 for complete details.

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** – Selects the highest and lowest values of all the samples contained in an acquisition interval.
- **Avg (V_{RMS})** [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 (Function)

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}] – 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).
- **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:

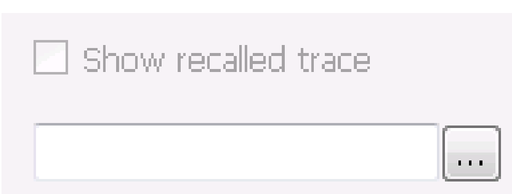
1. Select the **Save Trace As** button. This displays the Save As dialog box.
2. Navigate to the desired folder or use the default.
3. Type a name for the saved trace and click **Save**.

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.

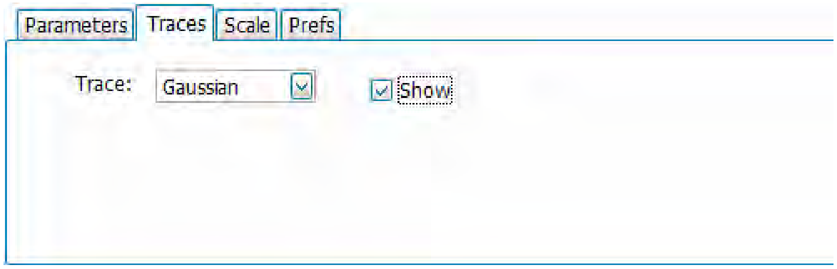


1. Navigate to the desired file and click **Open**.
2. Check the **Show Recalled Trace** check box.

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).

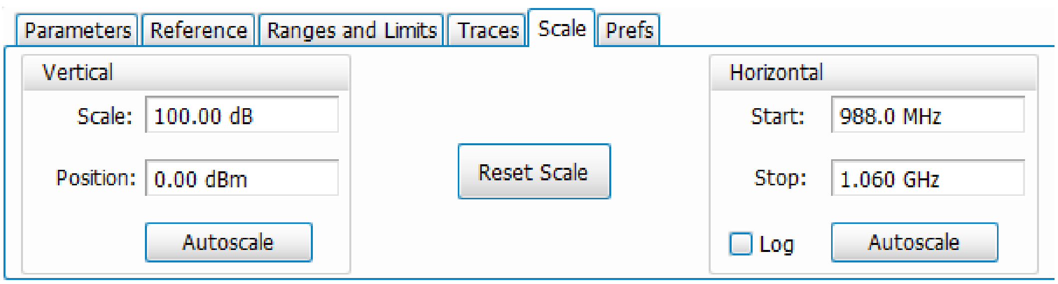
Gaussian Trace (applies only to CCDF)

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.



Scale Tab

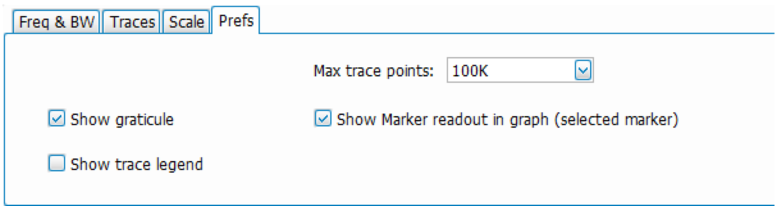
The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change control settings such as Center Frequency. Parameters on this tab may vary depending on the selected display.



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.
Position	Adjusts the level shown at the center of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Rest Scale	Resets all settings to their default values.
Horizontal	Controls the span of the trace display and position of the trace.
Scale (Start)	Allows you to, in effect, change the span.
Position (Stop)	Adjusts the position of the acquisition record shown at the left edge of the graph.
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 and switching the Graticule display on/off. Some parameters appear with most displays while others appear with only one display.



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 Measurements

WLAN Measurements 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 *Standards Presets*.

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*.

Table 13: WLAN presets standards, bandwidths, center frequencies, and displays

Standard	Bandwidth (MHz)	Center frequency (GHz)	Displays loaded
802.11a	20	5.18	SEM, Time Overview, WLAN Constellation, WLAN Summary
802.11g	20	2.412	
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	

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:

- *SEM*
- *WLAN Channel Response*
- *WLAN Constellation*
- *WLAN EVM*
- *WLAN Magnitude Error*
- *WLAN Phase Error*
- *WLAN Power versus Time*
- *WLAN Spectral Flatness*
- *WLAN Summary*

WLAN Channel Response Display

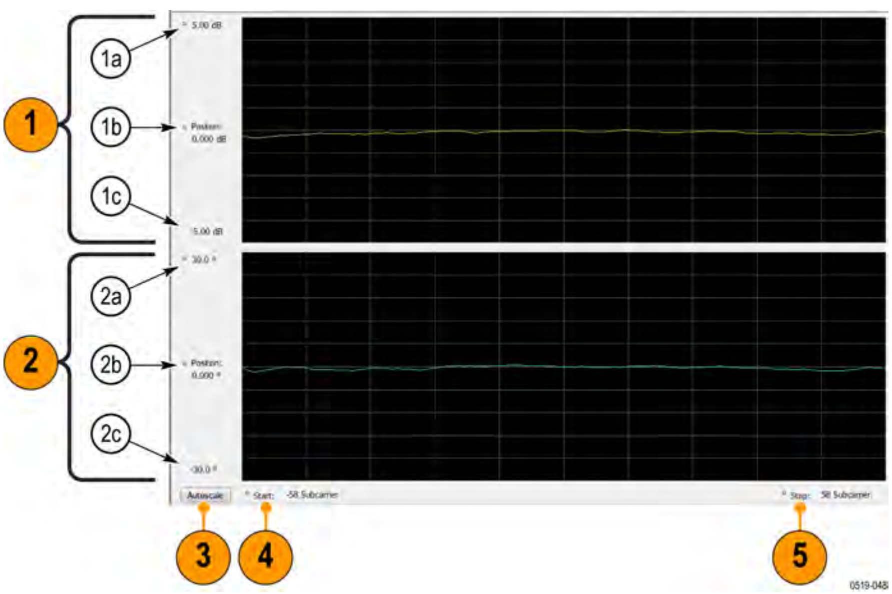
The WLAN Channel Response display plots the channel response (magnitude and phase) versus the subcarrier or frequency. Here, the channel refers to all sources of signal frequency response impairment up to the analyzer input, including the transmitter itself, as well as any transmission medium through 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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Chan Response display.
6. Set the Frequency appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the Modulation Params tab. Set the Standard, Guard Interval, Subcarrier Spacing, and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	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.

Table continued…

Item	Display element	Description
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.
3	Autoscale	Adjusts the Vertical and Horizontal scaling to optimize the trace display on screen.
4	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	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range Tab	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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.
Traces Tab	Enables you to select from magnitude or phase trace, save a trace, and recall an trace
Scale Tab	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

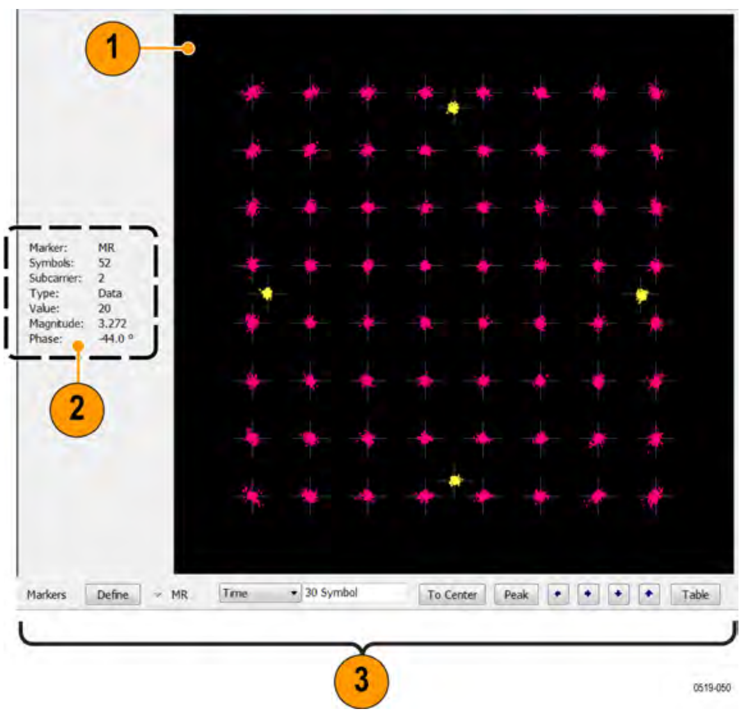
WLAN Constellation Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Constellation** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Constellation display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Channel Bandwidth, and Subcarrier Spacing controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	Display element	Description
1	Plot	Constellation graph.

Table continued…

Item	Display element	Description
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

Main menu bar: Setup > Settings

Favorites toolbar: ⚙

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

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to freeze the display or hide the measurement or average trace.
Scale Tab	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab	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).

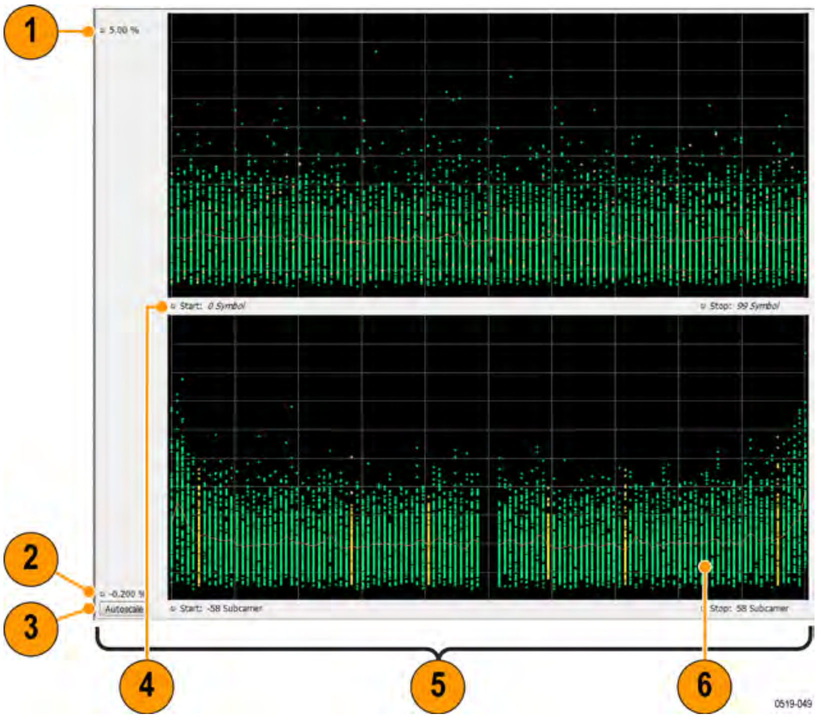
⚠ **Note:** For 802.11b analysis, the subcarrier graph is not displayed.

To show the WLAN EVM display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN EVM** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN EVM display.
6. Set the **Frequency** appropriate for the signal.

7. Select **Setup** > **Settings** to display the control panel.
8. 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.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	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

Main menu bar: Setup > Settings

Favorites toolbar:

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
Trace	Enables you to freeze the display or hide the measurement or average trace.
Scale	Specifies the vertical, subcarrier (for non-b standards only) and symbols scale and position settings.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Magnitude Error Display

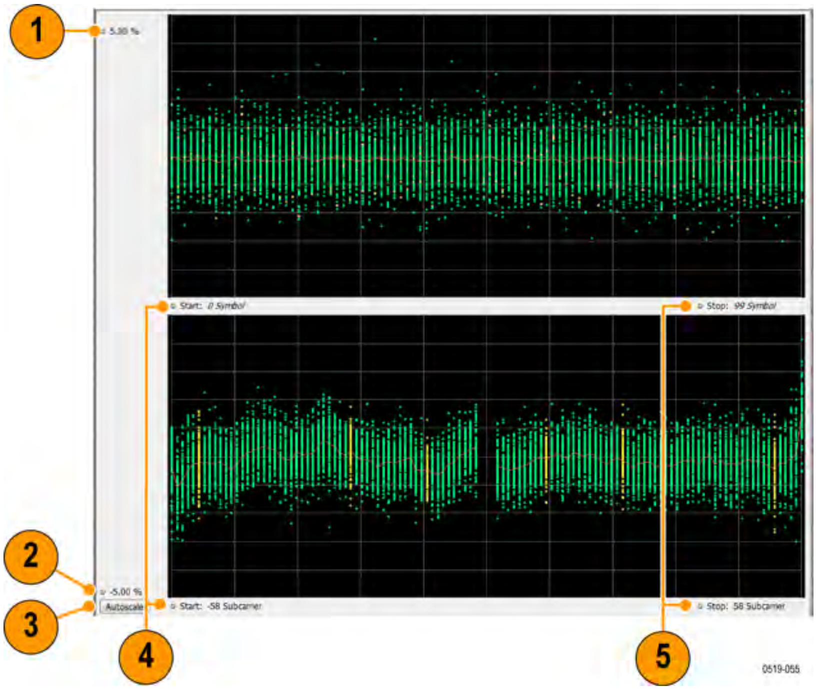
The WLAN Magnitude Error display shows the data symbols' individual subcarrier Magnitude Error values versus symbol interval (time) and subcarrier (frequency).

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

To show the WLAN Magnitude Error display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Mag Error display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



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.

WLAN Magnitude Error Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.

Table continued…

Settings tab	Description
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Phase Error Display

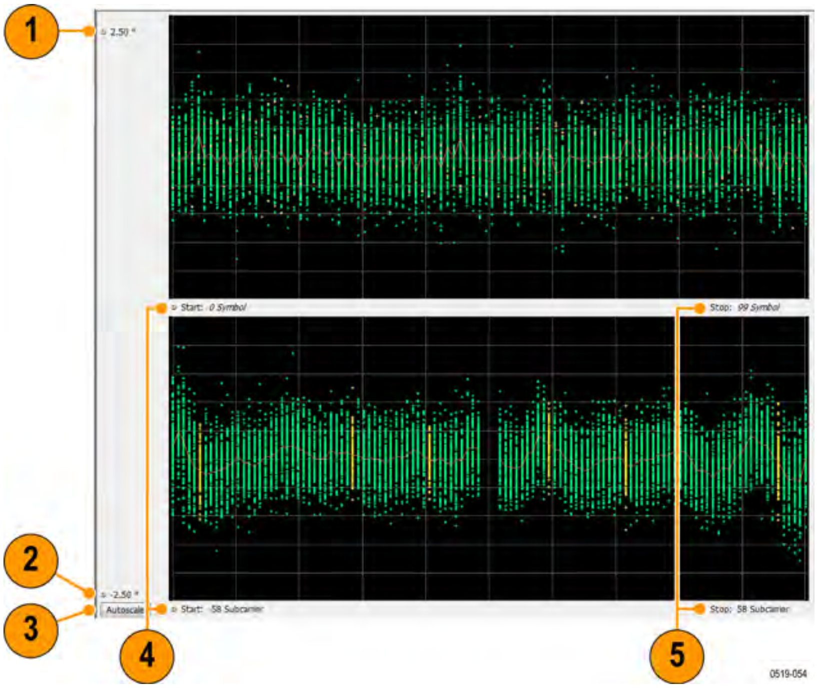
The WLAN Phase Error display shows the data symbols' individual subcarrier Phase Error values versus symbol interval (time) and subcarrier (frequency).

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

To show the WLAN Phase Error display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Phase Error display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

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.

WLAN Phase Error Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.

Table continued…

Settings tab	Description
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

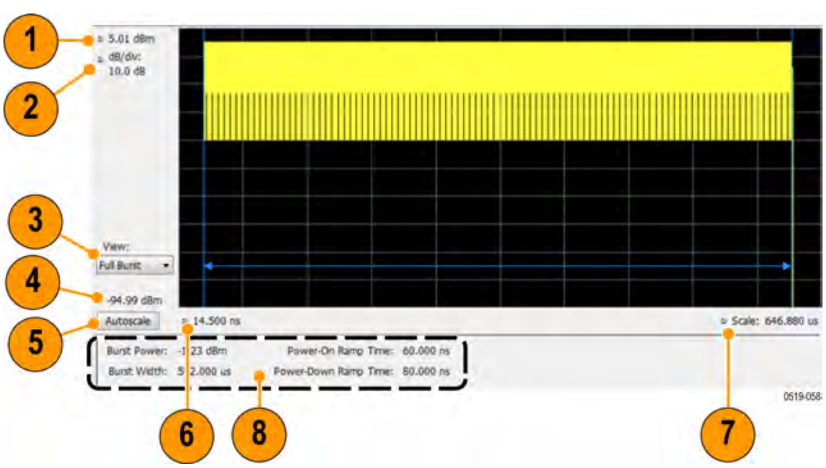
WLAN Power vs Time Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Power vs Time display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	Display element	Description
1	Top of graph, first setting	Sets the Power level that appears at the top of the graph, in dBm. This is only a visual control for panning the graph.
(not shown)	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
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

Main menu bar: Setup > Settings

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
Scale	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs	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.

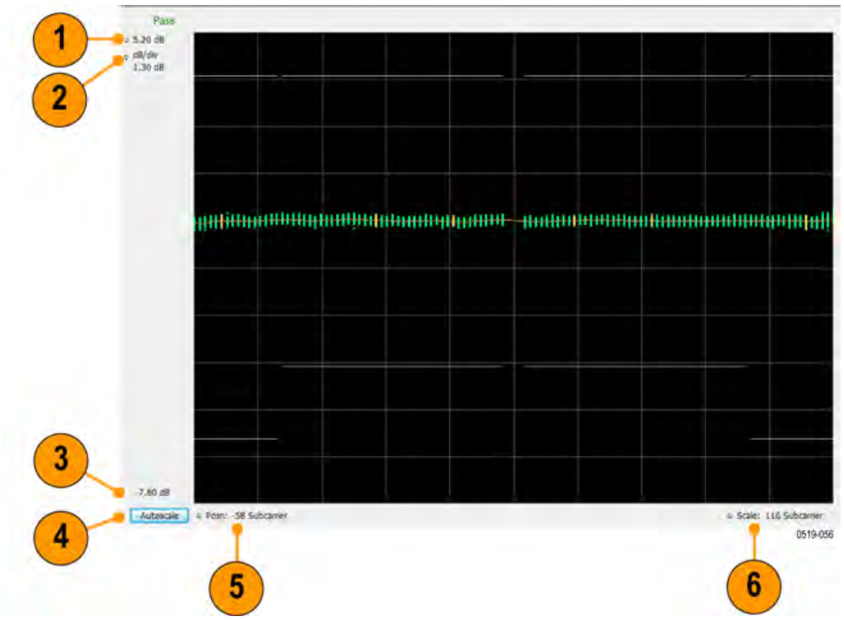
The averaged subcarrier level is shown as a line on the display, while the individual subcarrier levels are shown as points. The Pass or Fail result indicates whether the average line remains between the upper and lower limit mask boundaries.

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

To show the WLAN Spectral Flatness display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Flatness display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Subcarrier Spacing, and Channel Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

Elements of the Display



Item	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

Main menu bar: Setup > Settings

Favorites toolbar:

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.

Table continued…

Settings tab	Description
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

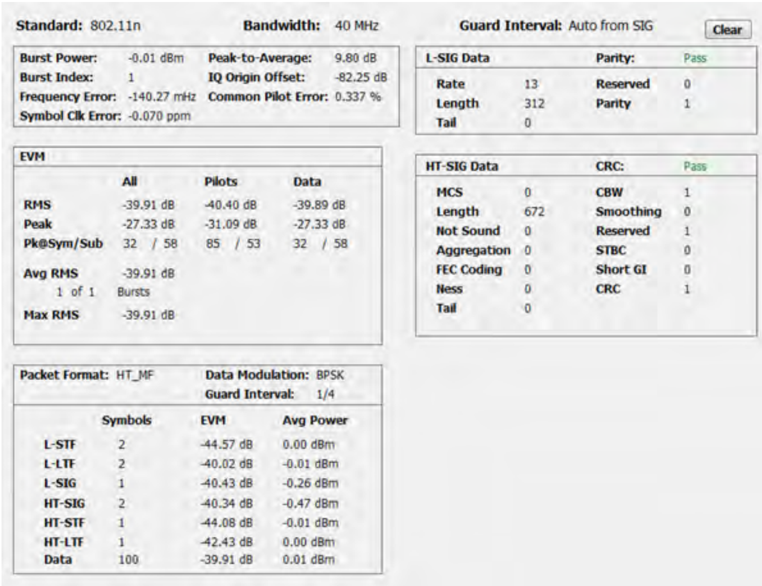
WLAN Summary Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the WLAN Summary display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

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



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

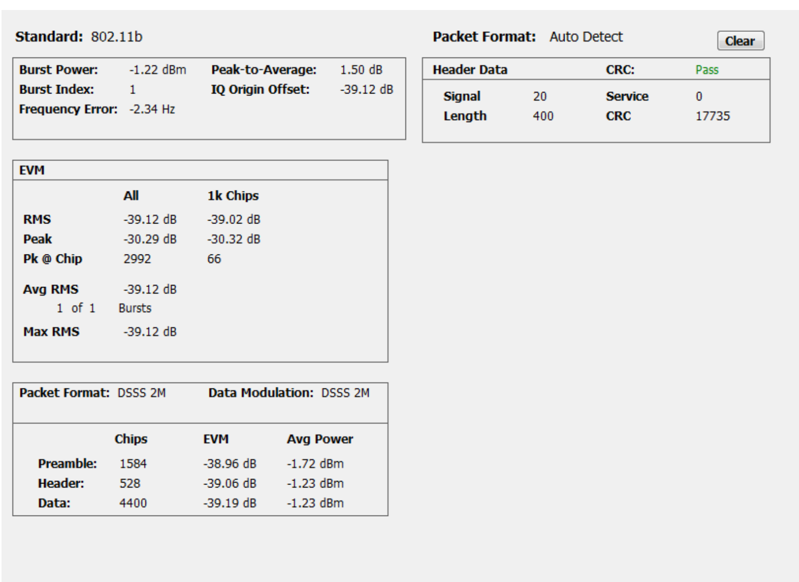
Table 14:

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.

Table continued…

Measurement	Description
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 Data L-SIG Data HT-SIG Data VHT-SIG Data	Displays he decimal values of the received packet SIGNAL, HT-SIGNAL and VHT-SIGNAL symbols' fields. The Pass/Fail result in each heading line indicates whether the calculated Parity or CRC value matches the received Parity or CRC value of the corresponding SIGNAL symbol grouping.

WLAN Summary Display for 802.11b Signals



Elements of the Display for 802.11b Signals

Table 15:

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 Preamble, Header 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

Main menu bar: Setup > Settings

Favorites toolbar: 

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.

Table continued…

Settings tab	Description
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
EVM	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	Specifies the units of the display and whether elements of the graphs are displayed.

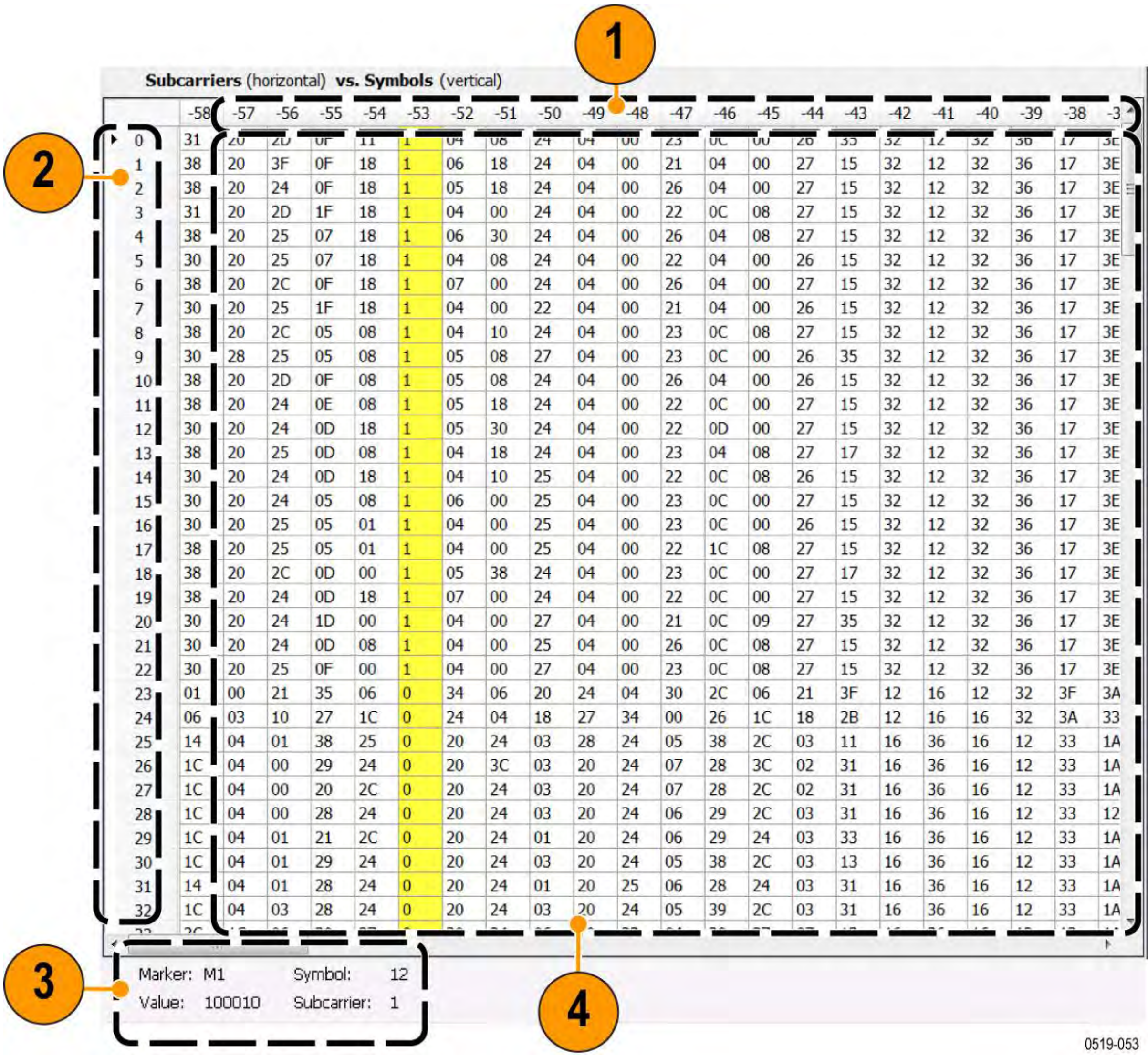
WLAN Symbol Table Display

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:

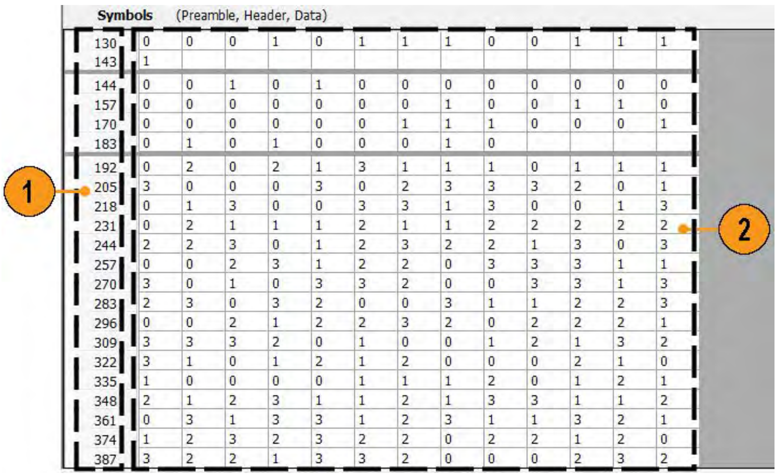
1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup > Displays**.
3. In the **Select Displays** dialog, select **WLAN Analysis** in the **Measurements** box.
4. In the Available displays box, double-click 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.
5. Click **OK** to show the WLAN Symbol Table display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup > Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.
9. If you are analyzing a data file, press the **Replay** button to take measurements on the recalled acquisition data file.

WLAN Symbol Table for OFDM signals



Item	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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

WLAN Analysis Shared Measurement Settings

Main menu bar: Setup > Settings

Favorites toolbar: 

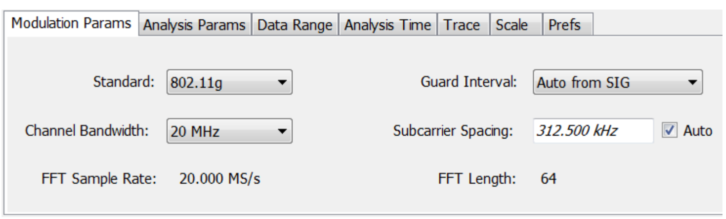
The control panel tabs in this section are shared between the displays in the WLAN Analysis folder (**Setup > Displays**). Some tabs are shared by all the displays, some tabs are shared by only a subset of displays. The settings available on some tabs change depending on the selected display.

Table 16: Common controls for WLAN analysis displays

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
Trace	Enables you to display or hide the measurement or average trace.
Scale	Specifies the vertical, subcarrier (for non-b standards only), and symbols scale and position settings.
EVM	Specifies the EVM units and max burst averages.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

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.



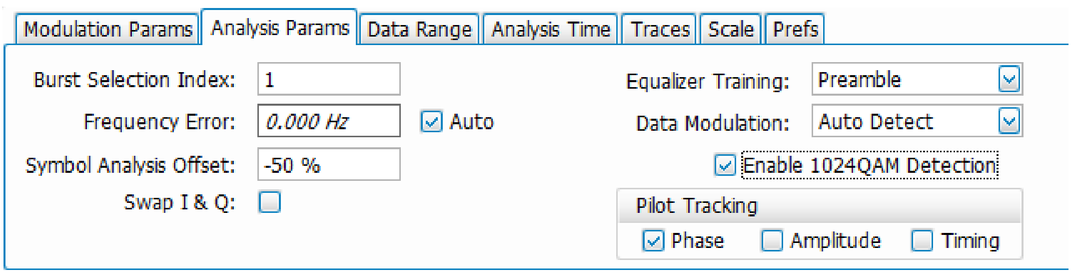
Settings	Description
Standard	Specifies the standard used for the input signal. Choices are 802.11a/b/g/j/n/p/ac.
Guard Interval	Specifies the guard interval used in the input signal. You can select the following: – Auto from SIG uses the Guard Interval value extracted from the signal – 1/8 allows setting 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.

Table continued…

Settings	Description
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.



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.

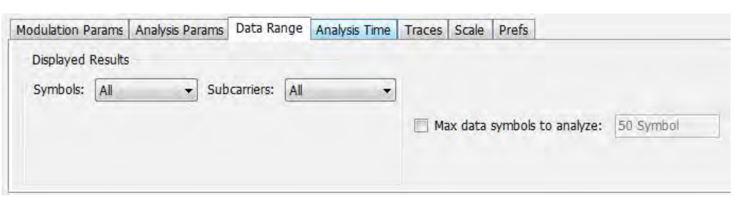
Table continued…

Settings	Description
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.
Enable 1024QAM detection	Check box to enable auto-detection of 1024QAM.
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.

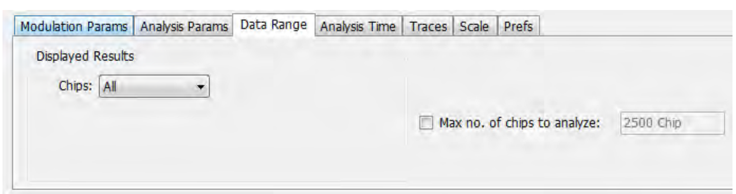


Settings	Description
Symbols	Specifies which symbols are displayed in the graphs.
All	Select All to display all symbols.
Range	Select Range to specify a subset of symbols for display.

Table continued…

Settings	Description
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.

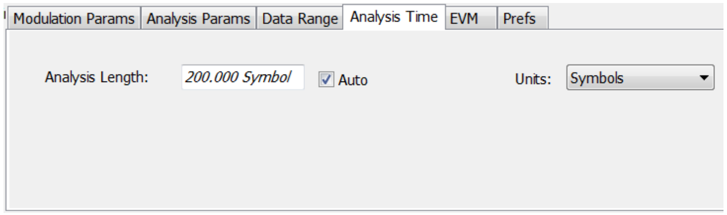
Data Range tab for 802.11b standards.



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

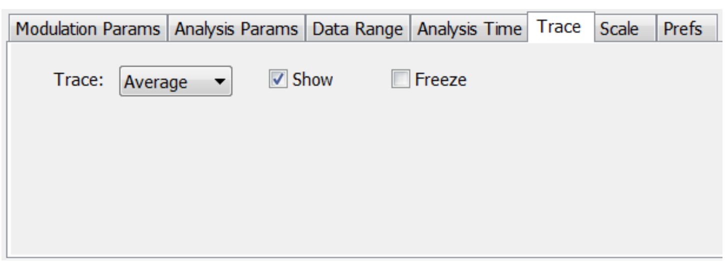
The Analysis Time tab contains parameters that define how the signal is analyzed in the WLAN Analysis displays.



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

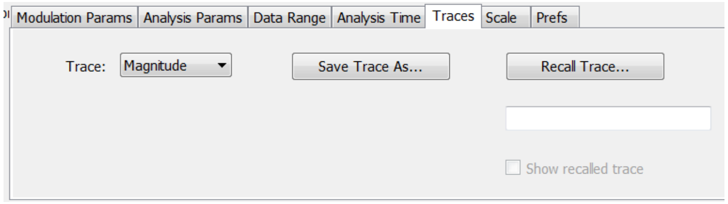
The Trace tab allows you to set the trace display characteristics of the selected display. This tab is not available for all WLAN displays.



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.



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.

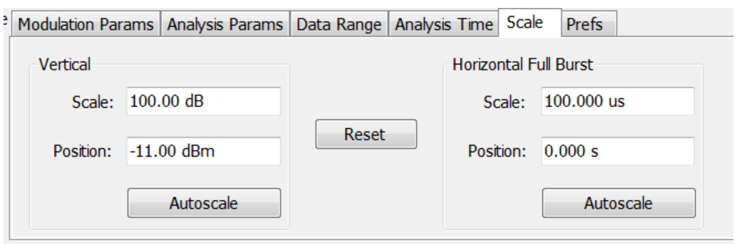


Figure 49: Scale tab for the WLAN Power vs Time display

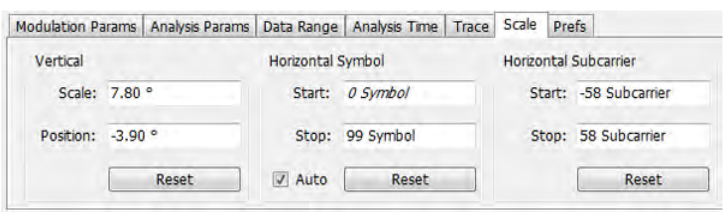


Figure 50: Scale tab for WLAN EVM, Magnitude Error, Phase Error, and Channel Response displays

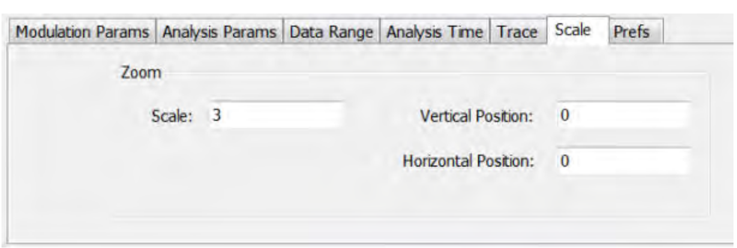


Figure 51: Scale tab for WLAN Constellation display

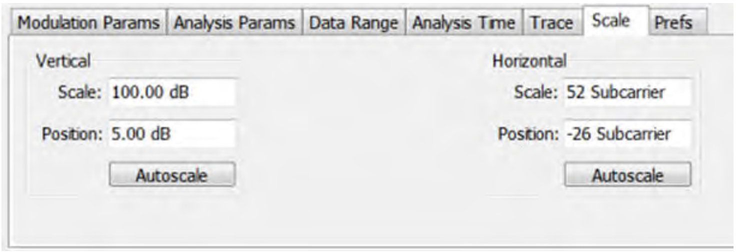
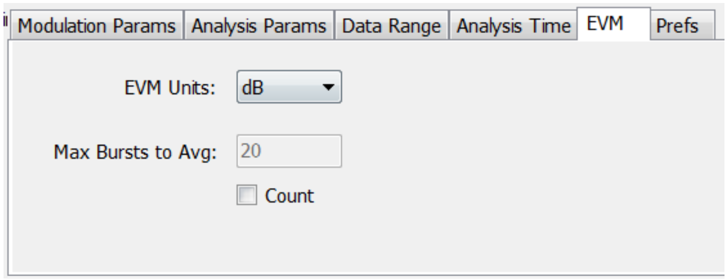


Figure 52: Scale tab for WLAN Spectral Flatness display

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

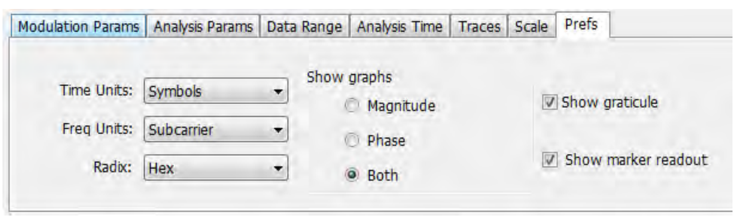
The EVM Tab enables you to chose between dB and percent for the EVM units and to select to set the maximum bursts to average. The EVM Tab is only available for the WLAN Summary display.



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.



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.

OFDM Analysis

OFDM Analysis 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*
- *OFDM Constellation*
- *OFDM EVM*
- *OFDM Spectral Flatness*
- *OFDM Mag Error*
- *OFDM Phase Error*
- *OFDM Power*
- *OFDM Summary*
- *OFDM Symbol Table*

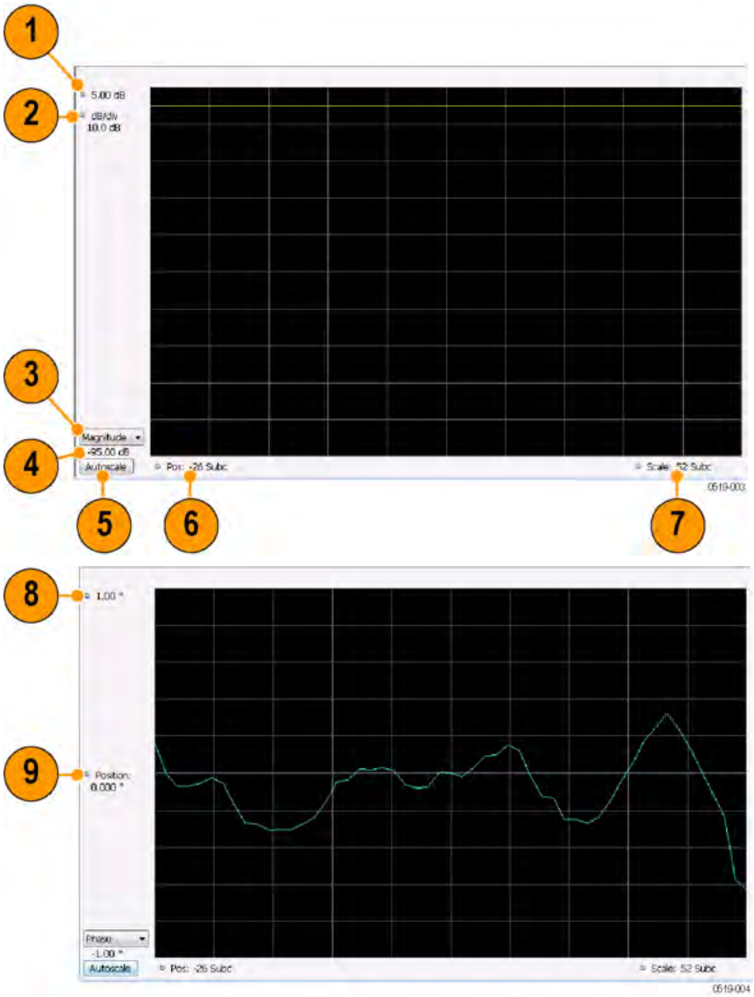
OFDM Channel Response Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Chan Response display.
6. Set the Frequency appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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 (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.

Table continued…

Item	Display element	Description
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	Specifies the input signal standard and additional user-settable signal parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range Tab	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Constellation Display

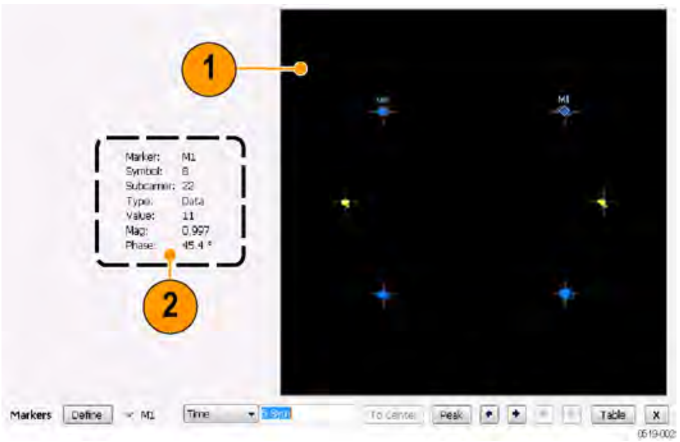
Display shows the OFDM signal subcarriers' amplitude and phase in IQ constellation form.

To show the OFDM Constellation display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Constellation** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Constellation display.
6. Set the **Frequency** appropriate for the signal.

7. Select **Setup** > **Settings** to display the control panel.
8. 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	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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: 

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

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to freeze the display or hide the measurement or average trace.

Table continued…

Settings tab	Description
Scale Tab	Specifies the Zoom scale, and vertical and horizontal positions of the display.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

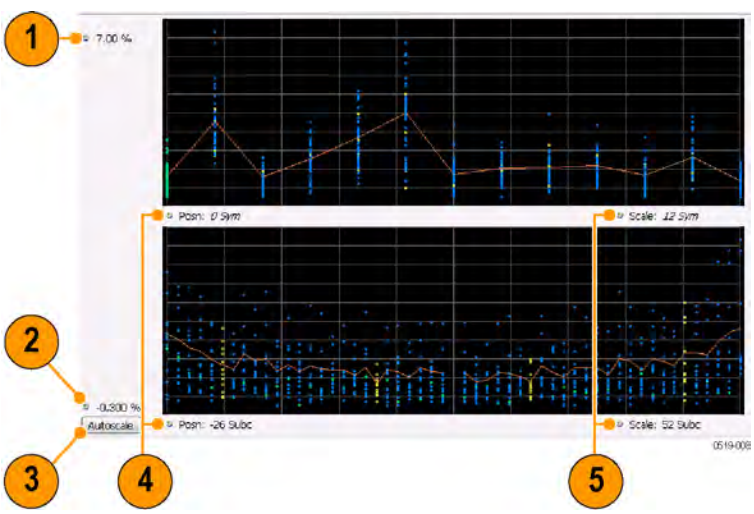
OFDM EVM Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM EVM** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM EVM display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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.

Elements of the Display



Note: There is no carrier assigned to DC.

Item	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.

Table continued…

Item	Display element	Description
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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for OFDM Analysis displays.
Trace	Enables you to freeze the display or hide the measurement or average trace.
Scale	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Spectral Flatness Display

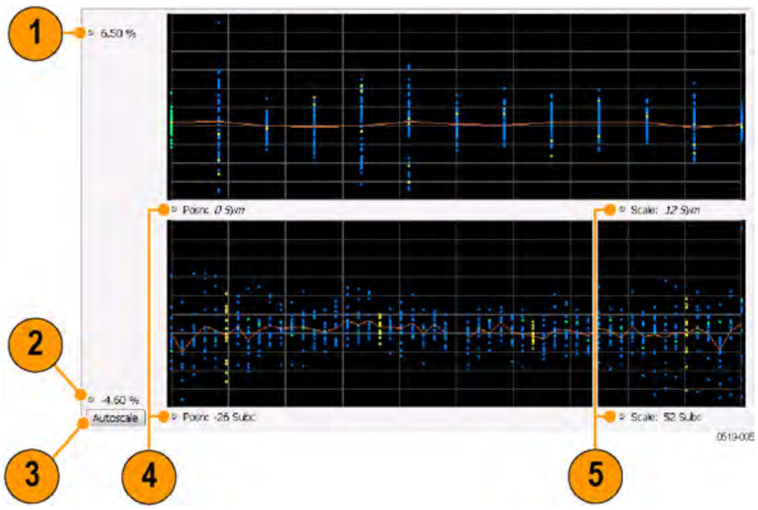
The OFDM Spectral Flatness display shows the average power levels of subcarriers across the signal bandwidth and indicates if they remain within the limits defined for a particular standard.

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Flatness display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval, Subcarrier Spacing and Channel Bandwidth controls as appropriate for the input signal.

Elements of the Display



Item	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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: 

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for WLAN Analysis displays.
Trace	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

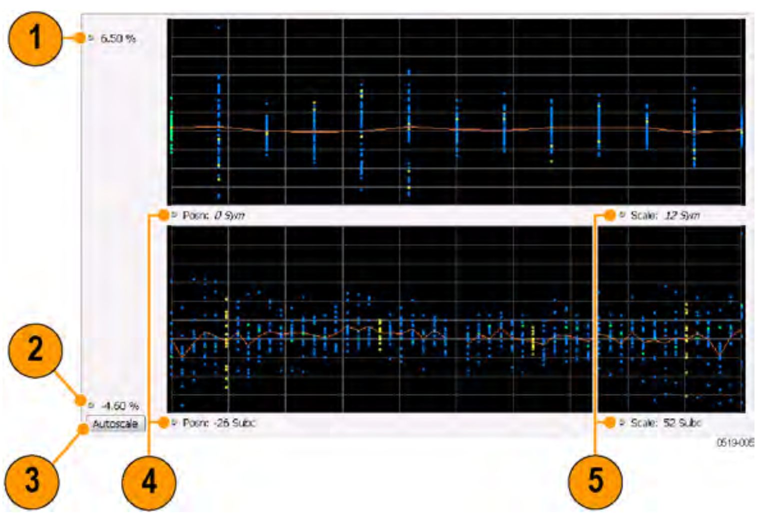
OFDM Magnitude Error Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Mag Error display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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 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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: 

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab	Specifies the units of the display and whether elements of the graphs are displayed.

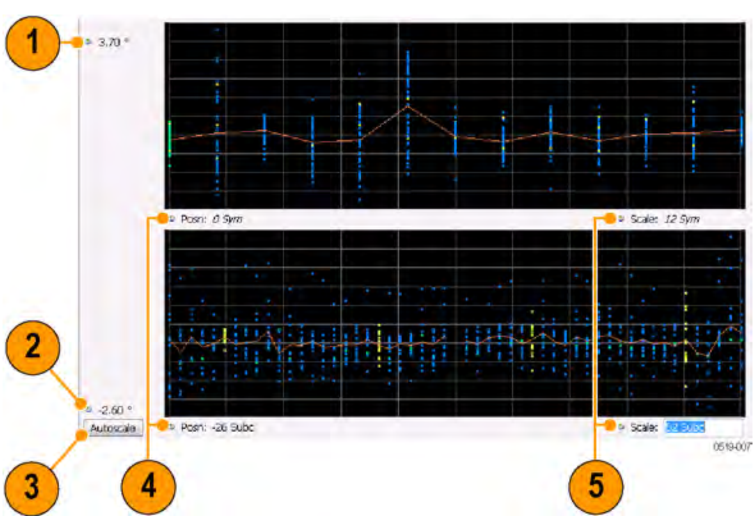
OFDM Phase Error Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Phase Error display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: ⚙

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time Tab	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	Enables you to display or hide the measurement or average trace.
Scale Tab	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs Tab - OFDM on page 269	Specifies the units of the display and whether elements of the graphs are displayed.

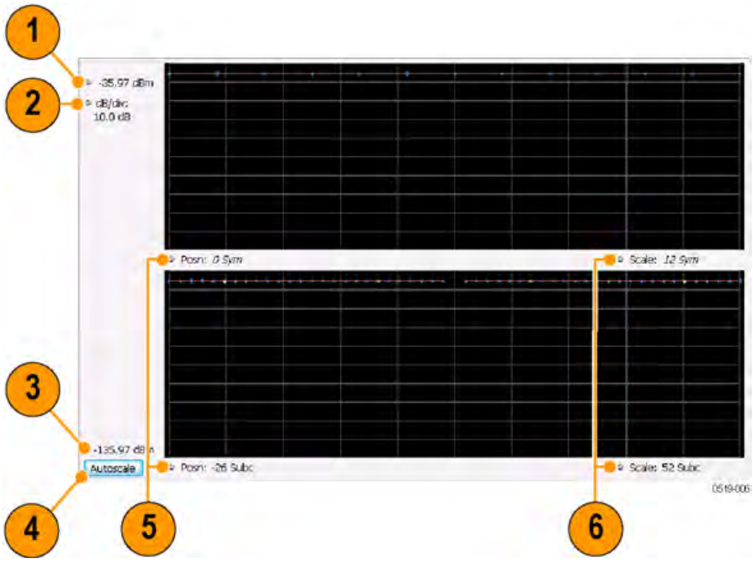
OFDM Power Display

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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Power display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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	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.
(not shown)	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: 

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.

Table continued…

Settings tab	Description
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) for OFDM Analysis displays.
Trace	Enables you to display or hide the measurement or average trace.
Scale	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

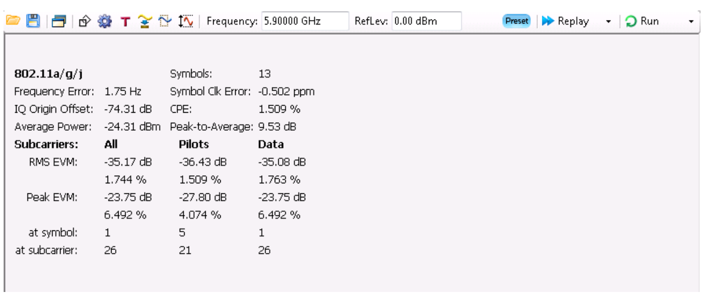
OFDM Summary Display

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

To show the OFDM Summary display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Summary display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. 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



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.

Table continued…

Measurement	Description
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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

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

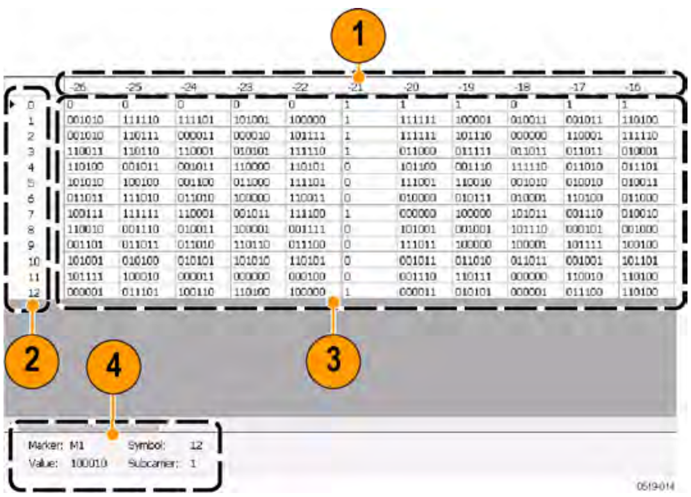
Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
Analysis Time	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) for OFDM Analysis displays.
Prefs	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. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **OFDM Analysis** in the **Measurements** box.
4. 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.
5. Click **OK** to show the OFDM Symbol Table display.
6. Set the **Frequency** appropriate for the signal.
7. Select **Setup** > **Settings** to display the control panel.
8. Select the **Modulation Params** tab. Set the Standard, Guard Interval and Spacing and Bandwidth controls as appropriate for the input signal.



Item	Description
1	Subcarrier identifiers.
2	Symbol identifiers.
3	Subcarrier data values.
4	Marker readout when markers are enabled.

OFDM Symbol Table Settings

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

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

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for OFDM Analysis displays.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

OFDM Analysis Shared Measurement Settings

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

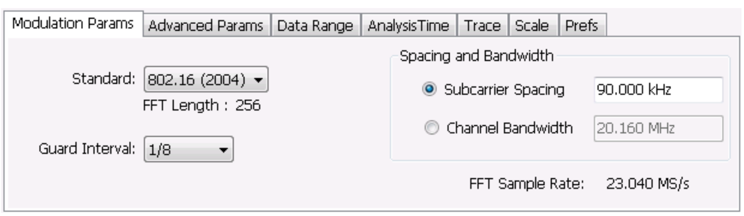
The control panel tabs in this section are shared between the displays in the OFDM Analysis folder (Setup > Displays). Some tabs are shared by all the displays, some tabs are shared by only a couple of displays. The settings available on some tabs change depending on the selected display.

Table 17: Common controls for OFDM analysis displays

Settings tab	Description
Modulation Params	Specifies the type of modulation used for the input signal and other parameters.
Advanced Params	Specifies parameters used by the instrument to analyze the input signal.
Data Range	Specifies which symbols and subcarriers of the signal to display.
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) for OFDM Analysis displays.
Trace	Enables you to display or hide the measurement or average trace.
Scale	Specifies the vertical, subcarrier, and symbols scale and position settings.
Prefs	Specifies the units of the display and whether elements of the graphs are displayed.

Modulation Params Tab - OFDM

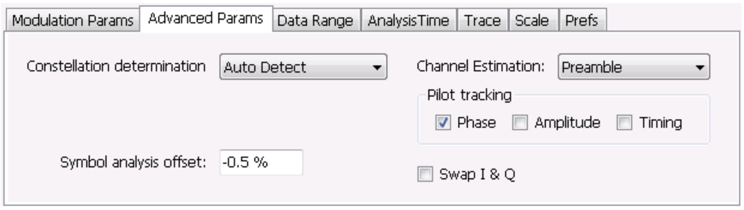
The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that control the demodulation of the input signal.



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

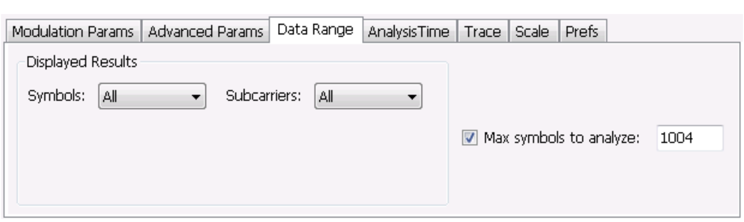
The Advanced Params tab contains parameters that control the analysis of the input signal.



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

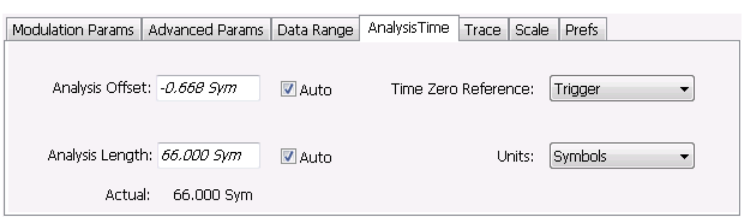
The Data Range tab enables you to control how much signal is analyzed, as well as specify the range of results that are displayed in the Constellation, EVM, Magnitude Error, Phase Error, Power and Symbol Table graphs.



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.



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.

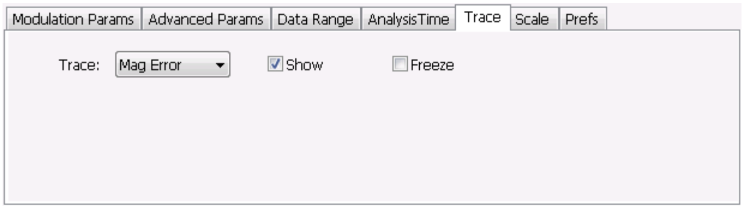
Time Zero Reference

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.



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.

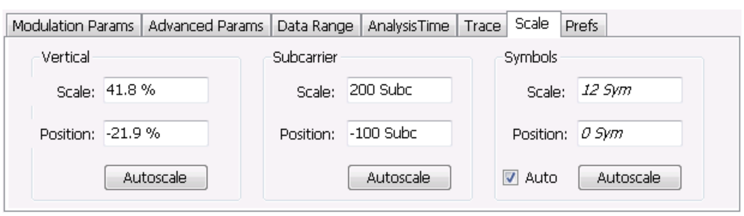


Figure 53: Scale tab for OFDM EVM, OFDM Mag Error, OFDM Phase Error, and OFDM Power displays

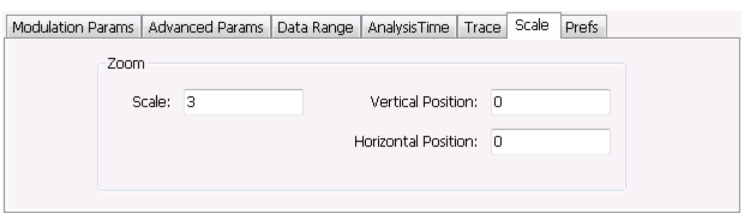


Figure 54: Scale tab for OFDM Constellation display

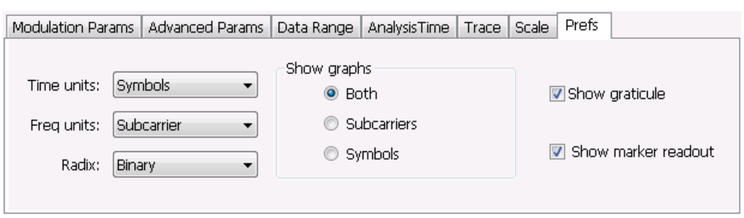
Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale of the graph.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.

Table continued…

Settings	Description
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.

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.



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).

Table continued…

Settings	Description
Show graphs	Specifies which graph types are displayed.
Both	Displays both the Subcarrier and Symbol graphs.
Subcarriers	Displays only the subcarrier graph.
Symbols	Displays only the symbol graph.
Show graticule	Displays or hides the graticule in the graphs.
Show marker readout	Displays or hides the marker readouts in the graphs.

Noise figure and gain measurements

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*
- *Gain*
- *Noise Figure*
- *Noise Table*
- *Uncertainty Calculator*
- *Y Factor*

These measurements allow you to measure the noise contributions of circuit elements to a signal.

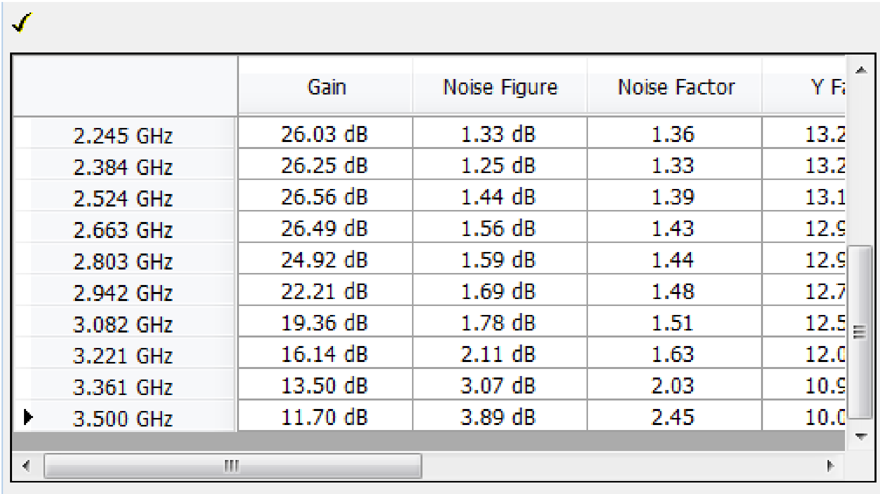
Noise Figure and Gain Measurements

The analyzer takes the following noise measurements: Noise Figure, Noise Temperature, Y Factor, and Gain. See the *Available Measurements* section for brief definitions of each measurement.

Noise table display

Noise table display

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	Y F:
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	12.7
3.082 GHz	19.36 dB	1.78 dB	1.51	12.5
3.221 GHz	16.14 dB	2.11 dB	1.63	12.0
3.361 GHz	13.50 dB	3.07 dB	2.03	10.9
3.500 GHz	11.70 dB	3.89 dB	2.45	10.0

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.

⚠ **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**.

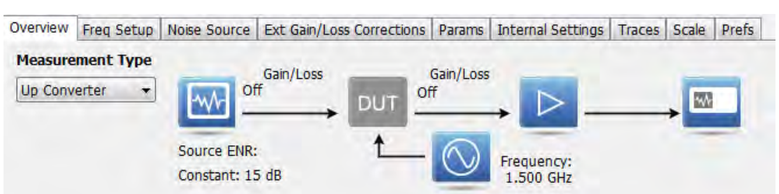
Displaying the Noise Table

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.



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

Front Panel: Settings

Favorites toolbar: 

The Settings control panel tabs for the Noise Table Display are shown in the following table.

Settings tab	Description
Overview	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	Specifies several parameters that control frequency of the test and number of points per measurement.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Prefs	Specifies display preferences such as graticule on/off, number of displayed points and measurement units.

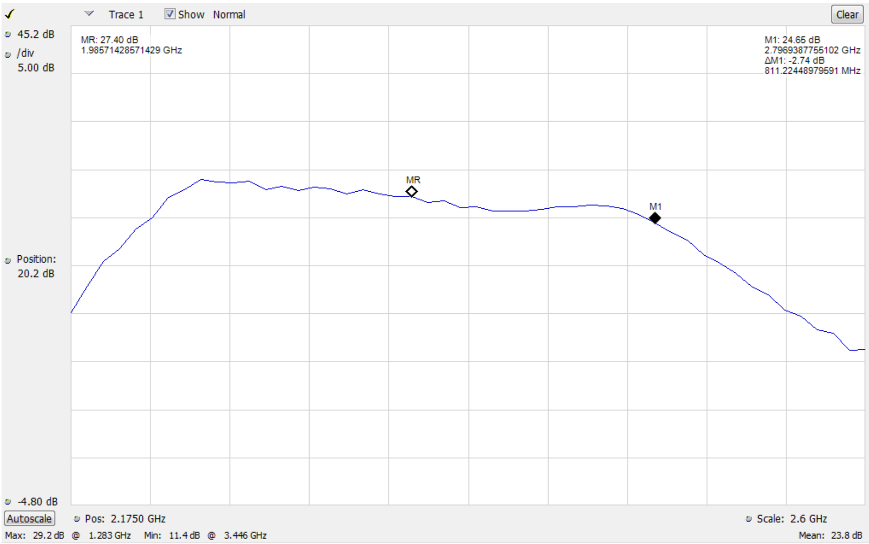
Calibrate. Calibrates the equipment setup prior to measurement.

Gain display

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



Item	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

Front Panel: Settings

The Setup settings for the Gain display are shown in the following table.

Settings tab	Description
Overview	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup	Specifies several parameters that control frequency displayed.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces	Specify the display trace parameters and also allows you to save traces.
Scale	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

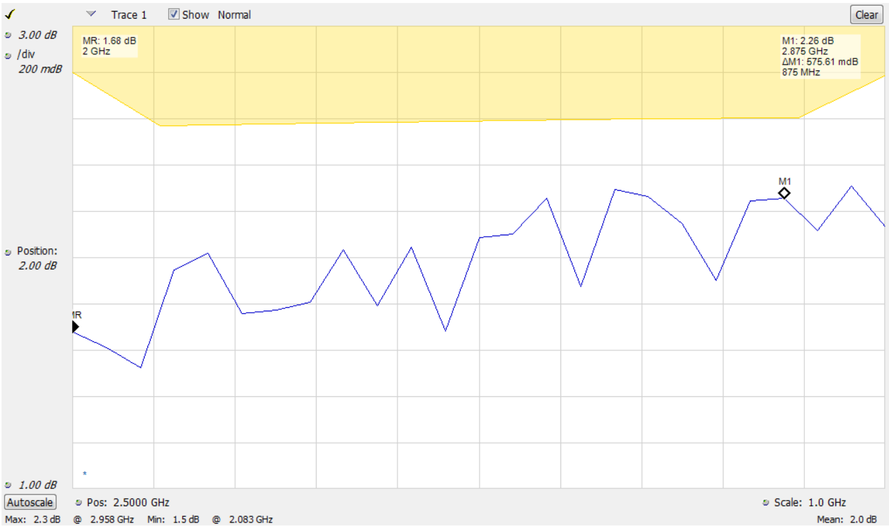
Calibrate. Calibrates the equipment setup prior to measurement.

Noise figure

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).

Elements of the Noise Figure 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 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

Front Panel: Settings

The settings for the Noise Figure Display are shown in the following table.

Settings tab	Description
Overview	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup	Specifies several parameters that control measurement and displayed frequencies.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces	Specify the display trace parameters and also allows you to save traces.
Scale	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

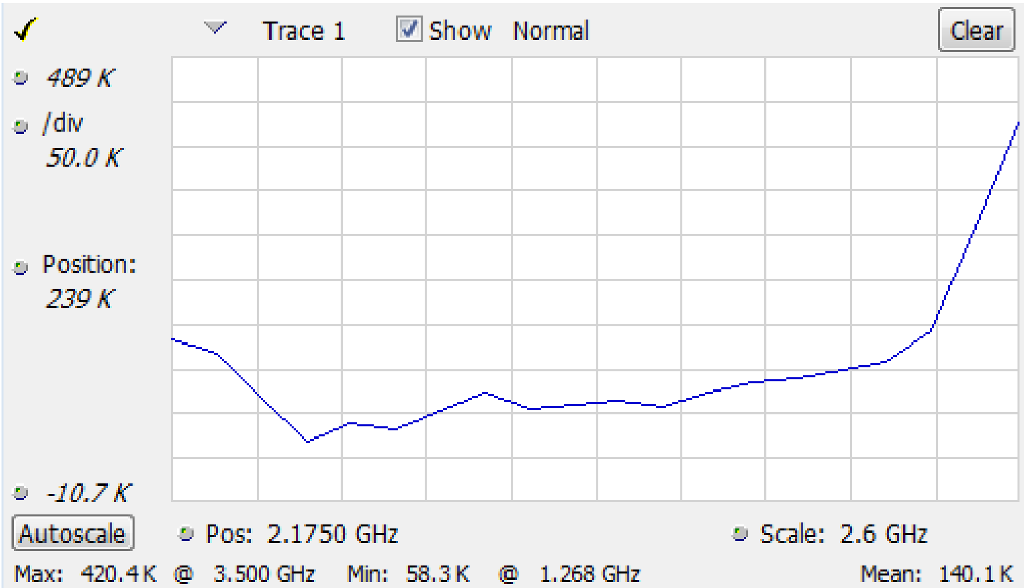
Calibrate. Calibrates the equipment setup prior to measurement.

Noise temperature

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



Item	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

Front Panel: Settings

The settings for the Noise Temperature Display are shown in the following table.

Settings tab	Description
Overview	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup	Specifies several parameters that control measurement and displayed frequencies.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces	Specify the display trace parameters and also allows you to save traces.
Scale	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

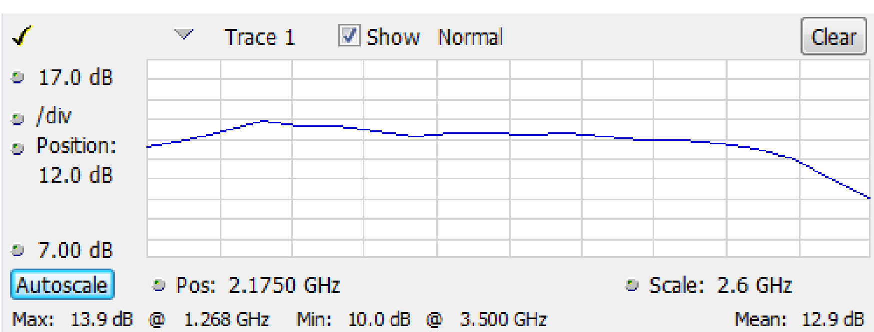
Y factor

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



Item	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 the offset and scale on the horizontal axis.
8	Vertical scale	Sets the vertical scale value.

Y factor settings

Menu Bar: Setup > Settings

Front Panel: Settings

The settings for the Y Factor Display are shown in the following table.

Settings tab	Description
Overview	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup	Specifies several parameters that control measurement and displayed frequencies.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.

Table continued…

Settings tab	Description
Traces	Specify the display trace parameters and also allows you to save traces.
Scale	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs	Specifies preferences such as graticule on/off, number of displayed points and measurement units.

Calibrate. Calibrates the equipment setup prior to measurement.

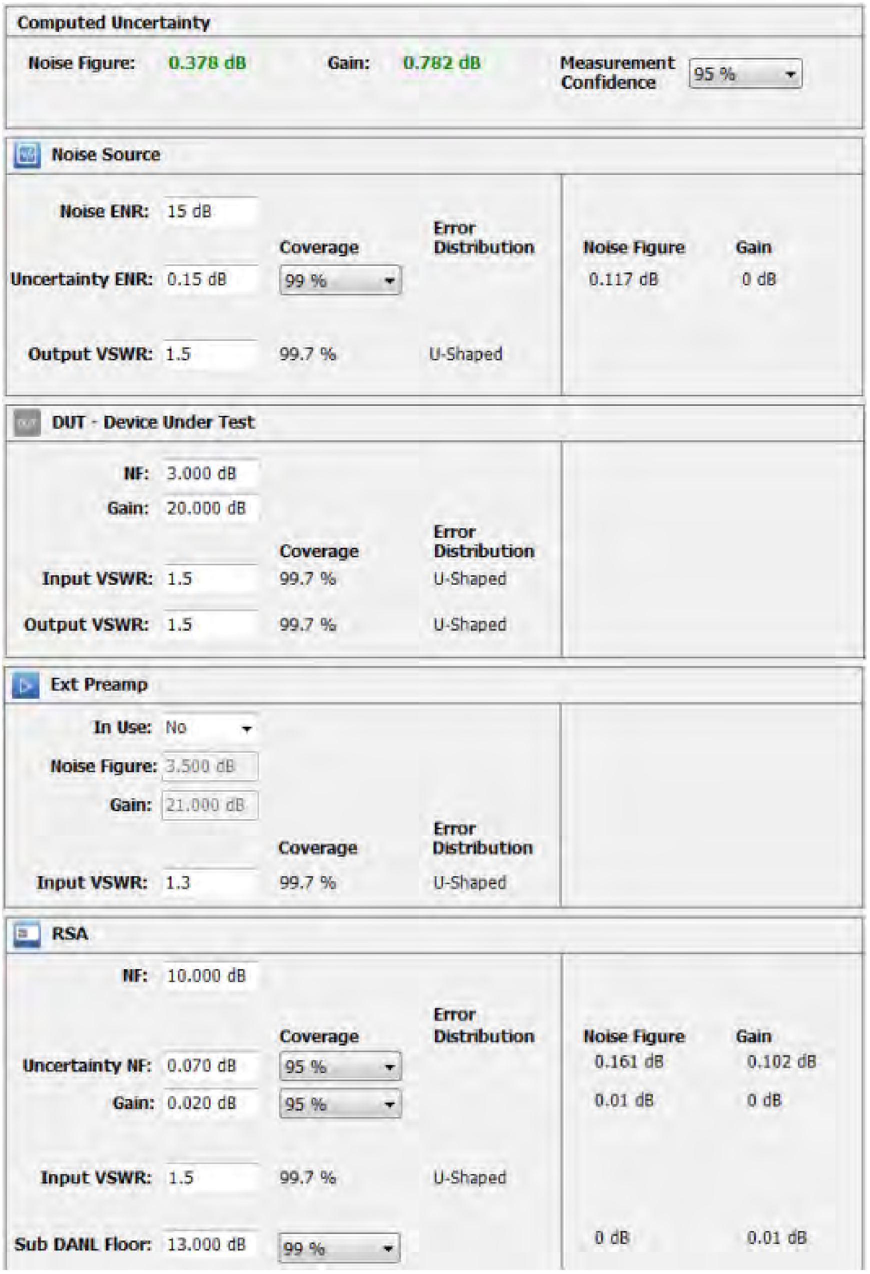
Uncertainty calculator

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



Item	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%).

Table continued…

Item	Display element	Description
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

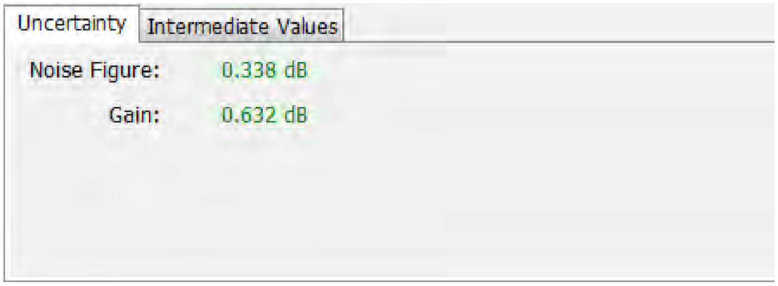
Front Panel: Settings

The settings for the Uncertainty Calculator display are shown in the following table.

Settings tab	Description
Uncertainty	Shows noise figure and gain uncertainty values (dB).
Intermediate Values	Shows standard uncertainties in system.

Uncertainty Tab

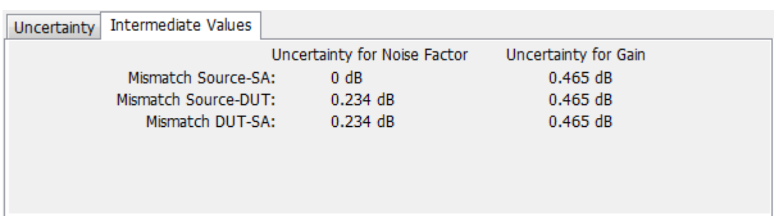
The Uncertainty tab shows the noise figure and gain uncertainty values (dB). These values change based on the noise measurement result and the parameters set in the Uncertainty Calculator display.



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.



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.

Common controls for noise figure and gain displays

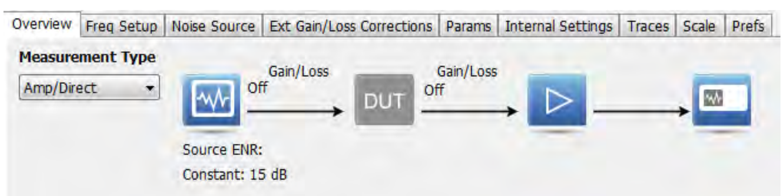
Noise figure and gain measurement settings

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.

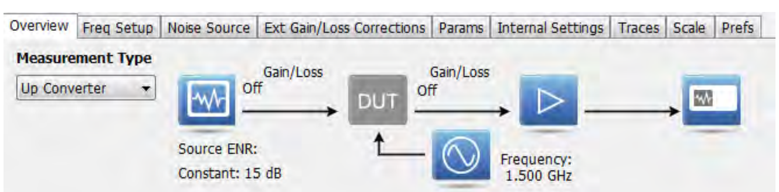
Settings tab	Description
Overview	Specifies the measurement type to be shown in the display. Also allows you to navigate to the related panel tabs.
Freq Setup	Specifies several parameters that control measurement and displayed frequencies.
Noise Source	Specifies ENR and noise source mode (constant or from a table).
Ext Gain/Loss Corrections	Specifies gain and loss values for cables, connectors, and external preamplifiers.
Params	Specifies LO and RSA settings, reference temperature, RBW, and average counts.
Internal Settings	Specifies the reference level (dB), set internal attenuator (manual or auto), optimize RF and IF, and set an internal preamp.
Traces	Specifies the display trace parameters and also allows you to save traces.
Scale	Specifies the scale settings that control how the trace appears on the display but does not change control settings.
Prefs	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**.



The above image shows the Overview tab with Amp/Direct selected.

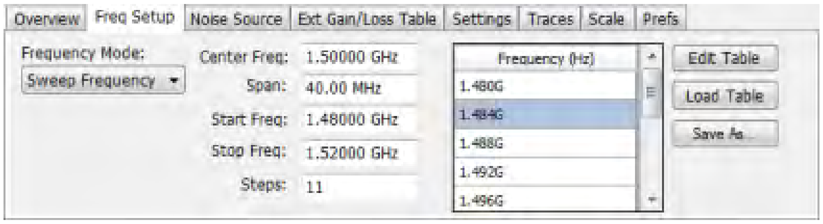


The above image shows the Overview tab with Up Convertor selected.

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

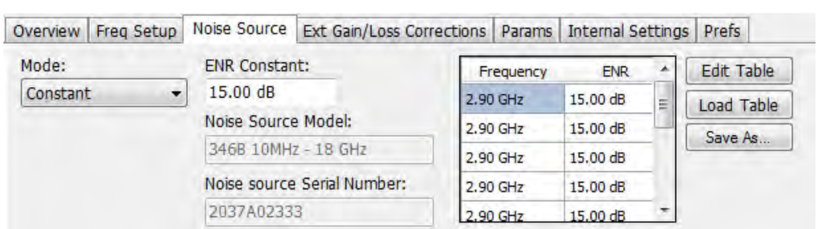
The Freq Setup tab is used to specify the frequency mode (Sweep, Single, or Frequency Table). If you select the Frequency Table, you can edit and load an existing table or save a table.



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.



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

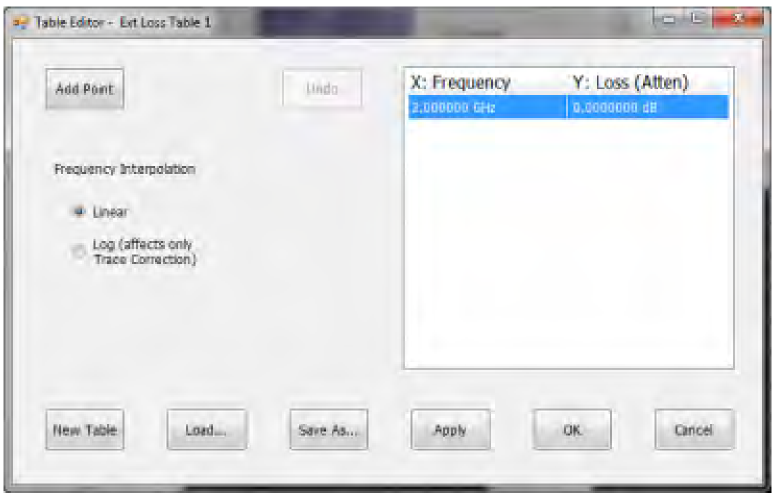
The Ext Gain/Loss Corrections tab is used to specify external gain and loss values. You can set loss values for three common loss scenarios: loss at the DUT input, loss at the DUT output, and loss at calibration. You can also edit directly in an external loss table.

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.

Table continued…

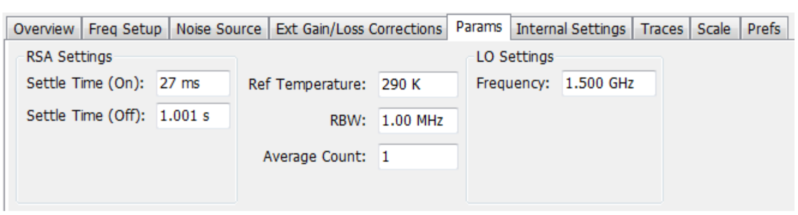
Setting	Description
External Loss Tables	Each loss component (at DUT input, DUT output, and at calibration) can use an External Loss Table for correction of loss versus frequency. When an External Loss Table is selected, the analyzer adjusts the signal according to the values in the table. An external 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*.
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.



Params tab

The Params tab is used to specify the local oscillator (LO) and RSA settings, reference temperature, resolution bandwidth (RBW), and average count.



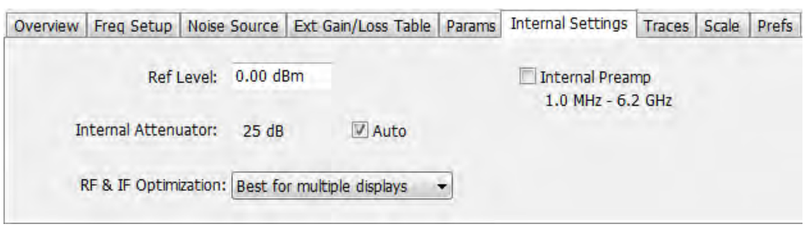
Setting	Description
RSA Settings	The Settle Time sets the time the RSA will pause before measuring after turning the noise source On or Off to assure measurement stability. The required settling time for your measurement setup will vary with the noise source used. The default values have been set for 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.

Table continued…

Setting	Description
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

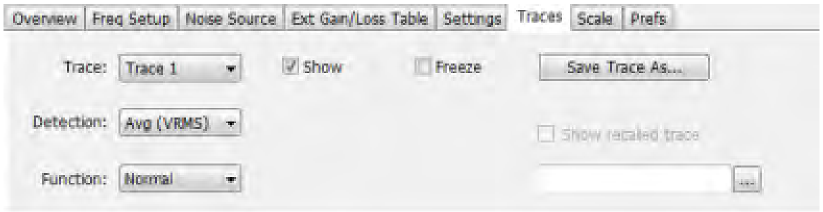
The Internal Settings tab is used to specify the reference level (dB) for the signal analyzer's RF front end, the settings for the internal attenuator, enable/disable the optional internal preamp, and specify the RF & IF Optimization. If you use the application preset for Noise Figure and Gain, these 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.



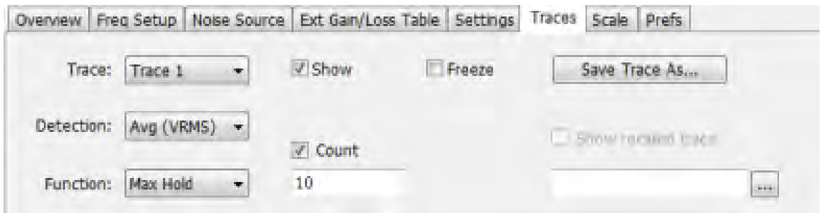
Setting	Description
Ref Level	Specify the reference level (dB) for the signal analyzer's RF front end.
Internal Attenuator	Set to Auto or manual. When Auto mode is enabled, the attenuation setting is displayed but is not adjustable. When Auto is disabled, the attenuator operates in manual mode, allowing 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 and IF stages of the front end). Read about these settings *here*.
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.



This is the Traces tab when Function is set to Normal.

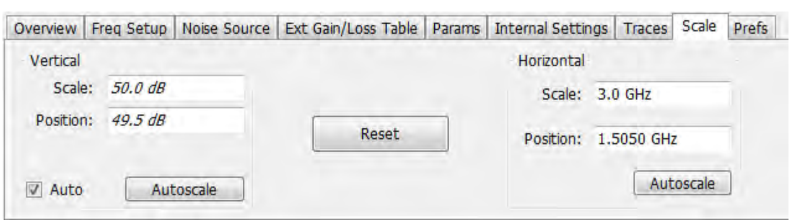


This is the Traces tab when Function is set to .

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 (Only available for Noise Temperature display)	Specify the trace count.

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.



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.

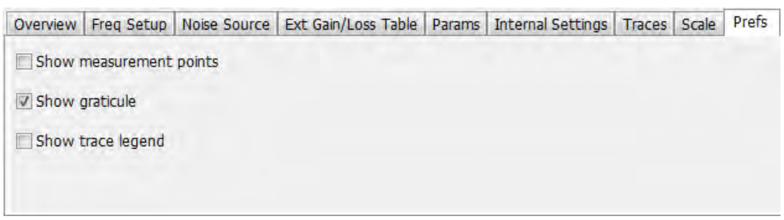
Table continued…

Settings	Description
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.

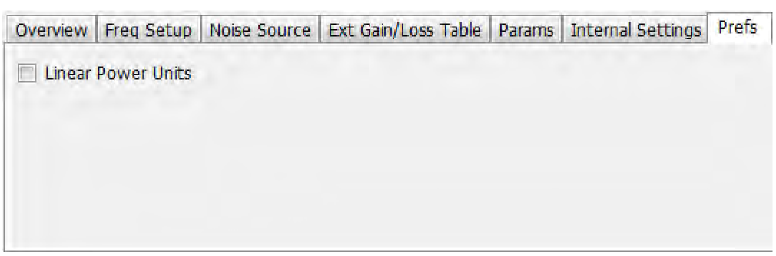
Prefs tab

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.

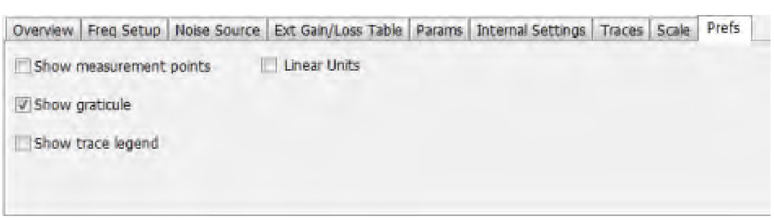
The following image shows the Prefs tab for all of the trace displays.



The following image shows the Prefs tab for the Noise Table display.



The following image shows the Prefs tab for the Noise Figure display.



Pulsed RF

Pulsed RF Overview

The Pulsed RF option (SVP) allows you to take measurements that provide deep insight into pulse train behavior. You can define and analyze unique pulse characteristics in the time and frequency domains and gain additional insight into the performance of Radar or EW subsystems. The Pulse Cumulative Histogram and Pulse Cumulative Statistics Table accumulate results over multiple acquisitions. The remaining Pulse displays show results for the current acquisition. You can use cross-correlated markers to pinpoint events in one display and debug in other displays.

The displays in Pulsed RF (**Setup > Displays > Pulsed RF**) are:

- *Cumulative Histogram*
- *Cumulative Statistics*
- *Pulse-Ogram™*
- *Pulse Statistics*
- *Pulse Table*
- *Pulse Trace*

Pulse Measurements

The analyzer takes the following 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.

Table continued…

Measurement	Description
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 *Ripple* on page 739.
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.
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-ref-Phase Difference	The phase difference between the current 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.
Phase Difference	The time interval by which one wave leads of lags another.
Pulse-ref 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 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.
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.

Table continued…

Measurement	Description
Absolute Frequency	The absolute pulse frequency measured at a point specified by the user. The measurement includes carrier frequency as well. The measurement point should be within the pulse width, starting from the 50% point.
Pulse-Pulse Frequency 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.
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.
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 ±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.

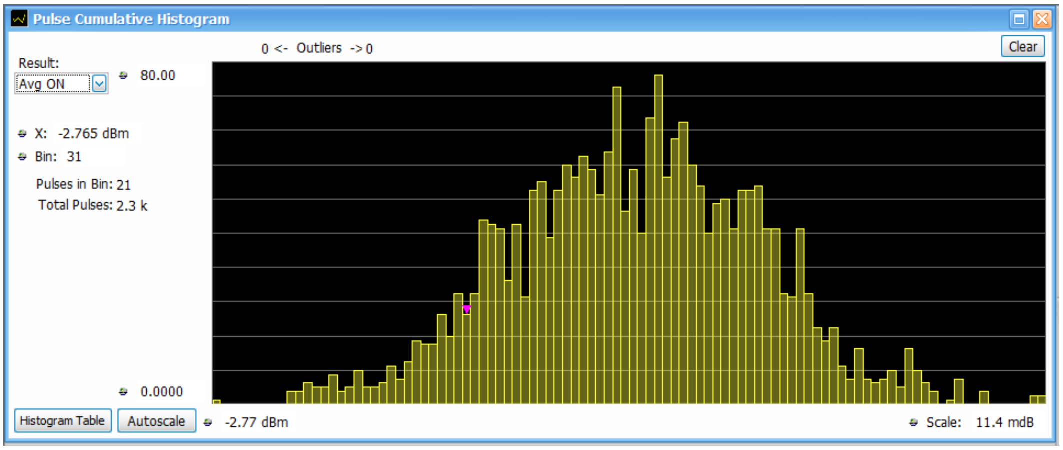
Cumulative Histogram Display

This histogram display shows the numerical distribution of the various pulse measurement results accumulated over multiple frames (in Fast Frame mode) and acquisitions. You can see the pulse count in a chosen bin by choosing the bin number or the X value (of the chosen result). Pulses that do not lie within the chosen Min/Max are shown as outliers.

To show the Cumulative Histogram display:

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the Displays button or select **Setup > Displays**.
3. Press the **Displays** button or select **Setup** > **Displays**.
4. In the **Select Displays** dialog, select **Pulse Analysis** in the **Measurements** box.
5. In the Available displays box, double-click the **Cumulative Histogram** 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.
6. Click **OK** to show the Cumulative Histogram display.
7. If you are analyzing a stored data file, press the **Replay** button to take measurements on the acquisition data file.

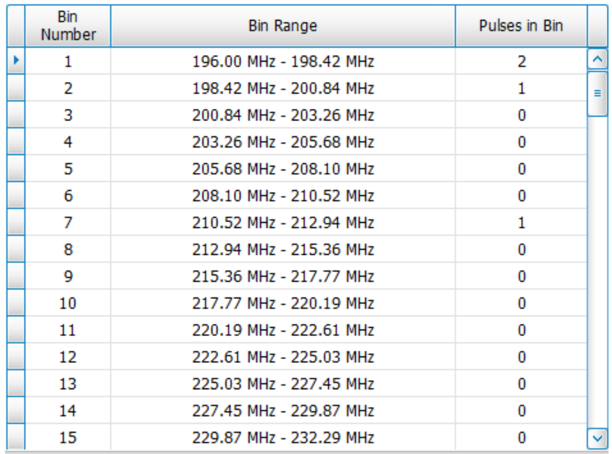
Elements of the display



Item	Display element	Description
1	Result	Drop down list of measurements. The results of the selected measurement in this Cumulative Histogram display will also show in the Pulse Statistics display and be highlighted in the Pulse Table display. All results will be available for view when Auto mode is enabled in the *Cumulative Histogram display settings* on page 296 window. Only selected results will be available for view when Manual mode is enabled in the Histogram Settings window.
2	X	A value of the selected result where the pulse indicator is positioned. Changing X will automatically change the bin number to the one that contains the X value.
3	Bin	Bin number where the indicator is positioned. Changing this number will change the value of X to the middle of the selected bin.
4	Pulses in Bin	Number of pulses in the selected bin.
5	Total Pulses	Total number of pulses analyzed in the current acquisition.
6	Vertical	Sets the vertical range.
7	Autoscale	Sets the axes to values for clear visibility of trace points.
8	Horizontal offset and scale	Controls that specify the offset and scale on the horizontal axis.
9	Clear button	Clears results from the display and starts a new measurement.
10	Outliers	Number of pulses that have measurement values outside of the maximum and minimum values indicates the outliers below the lower limit and those exceeding the upper limit.

Table continued…

Item	Display element	Description
11	Histogram Table button	Contains the Bin number, Bin Range, and Pulses in bin for the chosen measurement.



Bin Number	Bin Range	Pulses in Bin
1	196.00 MHz - 198.42 MHz	2
2	198.42 MHz - 200.84 MHz	1
3	200.84 MHz - 203.26 MHz	0
4	203.26 MHz - 205.68 MHz	0
5	205.68 MHz - 208.10 MHz	0
6	208.10 MHz - 210.52 MHz	0
7	210.52 MHz - 212.94 MHz	1
8	212.94 MHz - 215.36 MHz	0
9	215.36 MHz - 217.77 MHz	0
10	217.77 MHz - 220.19 MHz	0
11	220.19 MHz - 222.61 MHz	0
12	222.61 MHz - 225.03 MHz	0
13	225.03 MHz - 227.45 MHz	0
14	227.45 MHz - 229.87 MHz	0
15	229.87 MHz - 232.29 MHz	0

Cumulative Histogram display settings

Main menu: Setup > Settings

Front Panel: Settings

Favorites Toolbar: 

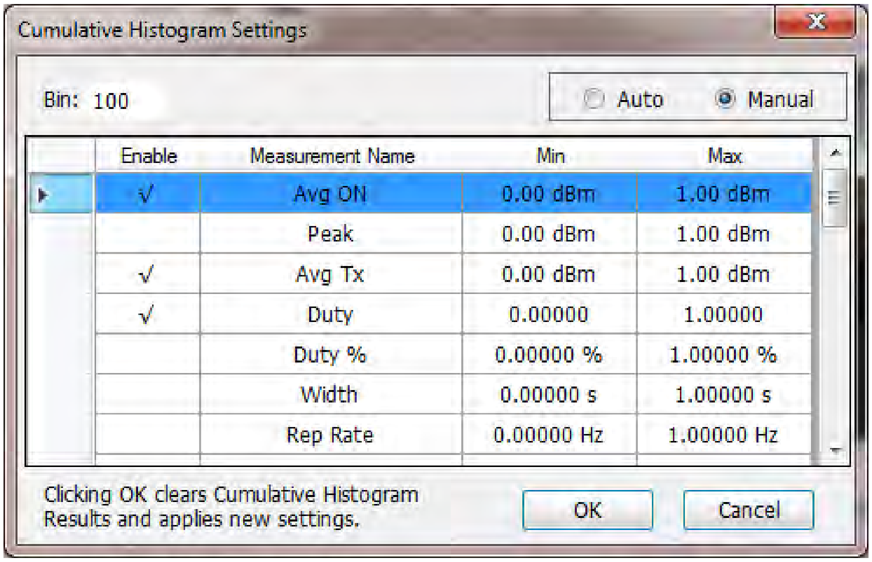
The Settings control panel tabs for the Cumulative Histogram display are shown in the following table.

Settings tab	Description
Params	Specifies several parameters that control how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency error.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether or not certain display elements are shown.

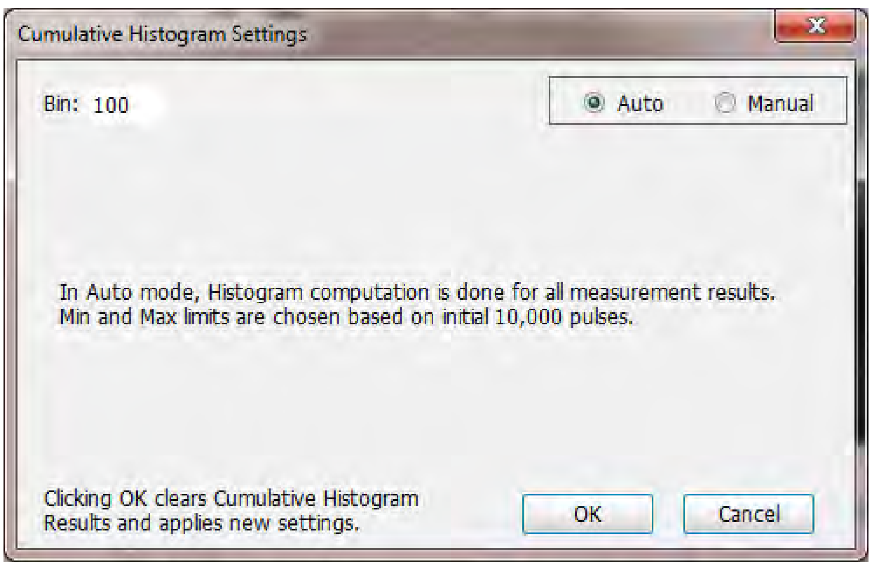
Histogram Settings button

This button is located on the Pulse Cumulative Histogram Settings control panel. Click this button to open a window where you can select which measurement results will be available in the Result drop down menu. You can select to use Auto or Manual mode.

Manual mode for histogram settings. In **Manual** mode, the histogram computation is done for the selected measurement results. You set the maximum and minimum values. The **Bin** field represents the total number of bins used in the histogram.



Auto mode for histogram settings. In **Auto** mode, the histogram computation is done for all measurement results. Minimum and maximum limits are chosen automatically based on the first 10,000 pulses. The **Bin** field represents the total number of bins used in the histogram.



Restore Defaults button

This button is located on the Pulse Cumulative Histogram Settings control panel. Click this button to set the Cumulative Histogram parameters to their default values.

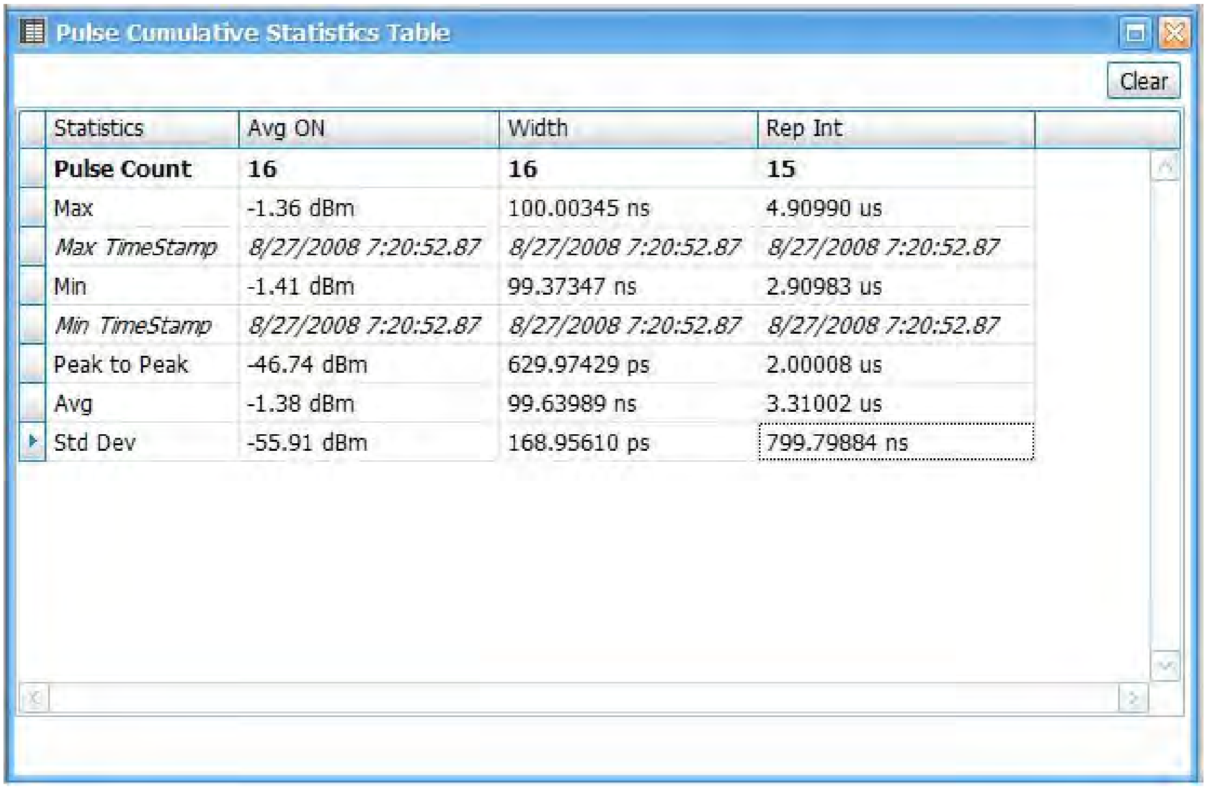
Cumulative Statistics Table display

This display is a statistics table that provides information on Pulse Count, Max, Max TimeStamp, Min, Min TimeStamp, Peak to Peak, Average, and Standard Deviation over different acquisitions.

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **Pulsed RF** in the **Measurements** box.

4. In the Available displays box, double-click the **Cumulative Statistics** 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.
5. Click **OK** to show the Cumulative Statistics display.

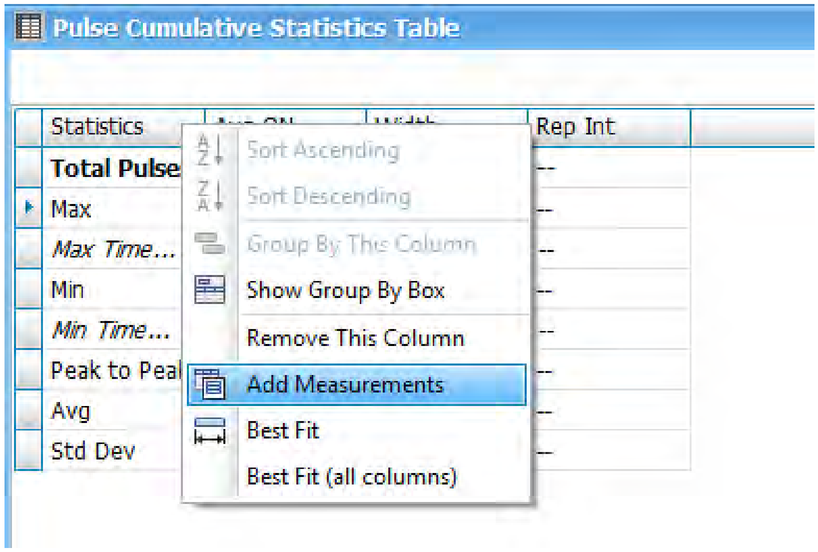
Elements of the display



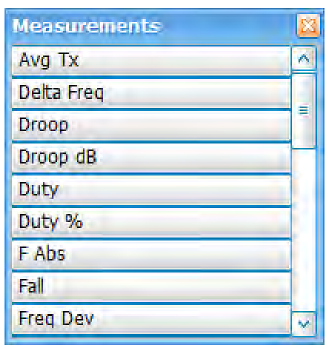
Statistics	Avg ON	Width	Rep Int
Pulse Count	**16**	**16**	**15**
Max	-1.36 dBm	100.00345 ns	4.90990 us
Max TimeStamp	*8/27/2008 7:20:52.87*	*8/27/2008 7:20:52.87*	*8/27/2008 7:20:52.87*
Min	-1.41 dBm	99.37347 ns	2.90983 us
Min TimeStamp	*8/27/2008 7:20:52.87*	*8/27/2008 7:20:52.87*	*8/27/2008 7:20:52.87*
Peak to Peak	-46.74 dBm	629.97429 ps	2.00008 us
Avg	-1.38 dBm	99.63989 ns	3.31002 us
Std Dev	-55.91 dBm	168.95610 ps	799.79884 ns

<table>
<tr><th>Display element</th><th>Description</th></tr>
<tr><td>Measurement</td><td>
The row across the top of the table shows the selected measurement.

You can right click on this row to access this menu to edit the table:



Select Add Measurements to open this window to select measurements:



</td></tr>
<tr><td>Maximum</td><td>Maximum value of the measurement across acquisitions with a time stamp.</td></tr>
<tr><td>Maximum TimeStamp</td><td>This time stamp denotes the time the maximum value of the measurement occurred across acquisitions.</td></tr>
<tr><td>Minimum</td><td>Minimum value of the measurement across acquisitions with a time stamp.</td></tr>
<tr><td>Minimum TimeStamp</td><td>This time stamp denotes the time the minimum value of the measurement occurred across acquisitions.</td></tr>
<tr><td>Average</td><td>Average value of the measurement values accumulated over multiple acquisitions until the current acquisition.</td></tr>
<tr><td>Peak to peak</td><td>This is the difference between Maximum and Minimum value of the measurement</td></tr>
<tr><td>Standard deviation</td><td>Standard deviation of the measurement that has a population equal to the Pulse Count value.</td></tr>
<tr><td>Clear button</td><td>Clear the results and starts a new measurement.</td></tr>
</table>

Note: When analysis is done on only one pulse, the Standard Deviation is zero. Log10 (0) is not defined and thus is reperesented by a "–" when the unit is dB.

Cumulative Statistics Table display settings

Main menu: Setup > Settings

Front Panel: Settings

Favorites Toolbar:

The Settings control panel tabs for the Cumulative Statistics Table display are shown in the following table.

Settings tab	Description
Measurements	Specifies which measurements to show in the table. Click the box(es) next to the measurement(s) you want to show. You can also click the Select All and Clear All buttons.
Params	Specifies how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency error.
Prefs	Specifies whether on not certain display elements are shown.

Restore defaults button

This button is located on the Cumulative Statistics Table Settings control panel. Sets the Cumulative Statistics Table parameters to their default values.

Pulse-Ogram display

The Pulse-Ogram™ display shows a stacked view of radar pulses when the analyzer is using fast-frame mode. The fast-frame captures IQ samples around a pulse when triggered. Each fast frame is configured to capture few IQ samples before rise-time, and after fall-time of a single pulse, and a timestamp associated with that pulse. With this information, the different fast-frame captures are stacked one after the other and displayed as Time v/s Time, and the corresponding spectrum information as Frequency v/s Time. The stacking allows for overlap of adjacent frames. The user can also select the range of frames for viewing in the display. This enables the user to study various aspects of pulse such as pulse width, reflections, rise-time, fall-time, etc.

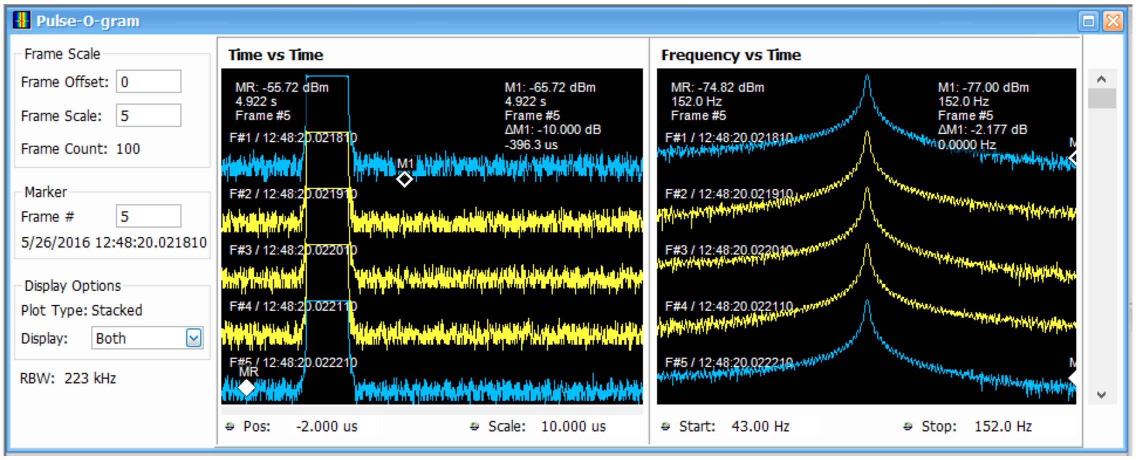
Marker correlation in Pulse-Ogram

At the end of an acquisition, the TOV and Spectrum show the last frame acquired. When we place a marker in Pulse-Ogram, the marker would not move in TOV and Spectrum unless you bring the marker to the last frame in Pulse-Ogram. Similarly, if marker is moved in TOV and Spectrum, then the marker in Pulse-Ogram will move to the last frame automatically.

If you want the marker movement in Pulse-Ogram to change the pulse indicator in the Pulse Table or Pulse Trace display, then you must add the Pulse Statistics display in Time trend mode. Movement of the marker now in the Pulse Statistics display or Pulse-Ogram display will change the pulse indicator position too, and therefore the appropriate pulse will be shown in the Pulse Trace display.

1. If you are analyzing a stored data file, recall the data file now. Otherwise, go to the next step.
2. Press the **Displays** button or select **Setup** > **Displays**.
3. In the **Select Displays** dialog, select **Pulsed RF** in the **Measurements** box.
4. In the Available displays box, double-click the **Pulse-O-gram** 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.
5. Click **OK** to show the Pulse-O-gram display.

Elements of the display



Display element	Description
Time vs Time	This view has the IQ data captured in the fast frames in a stacked view (with overlap).
Frequency vs Time	This view has the corresponding spectrum of the signal captured.
Frame offset	Controls the number of frames that are offset in the display. The starting frame will be frame offset + 1.
Frame scale	Controls the number of frames that can be seen in the display.
Frame count	Total number of fast frames in the acquisition.
Frame #	Indicates the frame number in which the marker is present. This option will only appear when the marker is added.
Plot type	Shows Stacked and is not selectable.
Display	Select to view Time vs Time or Frequency vs Time or Both.
RBW	Shows the resolution bandwidth for the Frequency vs Time view.

Pulse-Ogram display settings

Main menu: Setup > Settings

Front Panel: Settings

Favorites Toolbar: 

The Settings control panel tabs for the Pulse-Ogram display are shown in the following table.

Settings tab	Description
Analysis	Specifies settings related to analysis of the signal.
Traces	Specifies the display characteristics of displayed traces.
Scale	Specifies the parameters related to fast frame.
Prefs	Specifies marker readout options.

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.

Freq Error: -4.208 kHz (Auto)   Freq: 999.9957918 MHz

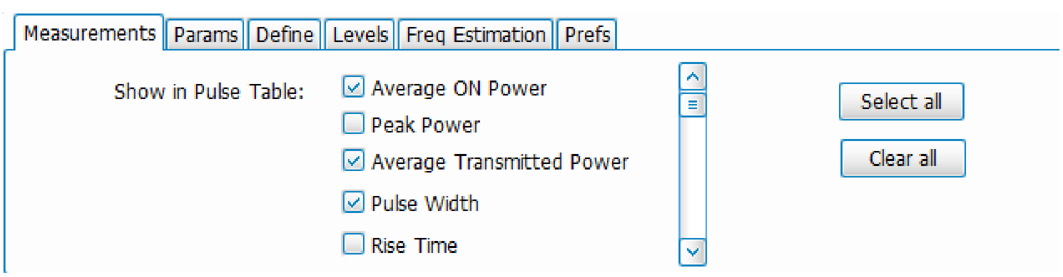
Pulse #	Avg ON	Width	Rise	Rep Int	RMS Ø Err	Peak	Avg Tx
1	-1.40 dBm	100.00345 ns	7.99554 ns	4.90948 us	802.20618 °	-0.85 dBm	-18.32 dBm
2	-1.38 dBm	99.52590 ns	7.83859 ns	2.91027 us	278.82507 °	-0.84 dBm	-16.10 dBm
3	-1.37 dBm	99.73721 ns	7.80641 ns	2.91002 us	280.49780 °	-0.70 dBm	-16.10 dBm
4	-1.36 dBm	99.85104 ns	7.68201 ns	2.91014 us	284.17639 °	-0.62 dBm	-16.08 dBm
5	-1.37 dBm	99.50647 ns	7.98586 ns	2.91022 us	287.90259 °	-0.64 dBm	-16.08 dBm
6	-1.40 dBm	99.67329 ns	8.03208 ns	4.90946 us	806.15570 °	-0.73 dBm	-18.32 dBm
7	-1.36 dBm	99.91533 ns	7.84547 ns	2.91045 us	272.54922 °	-0.62 dBm	-16.08 dBm
8	-1.36 dBm	99.55097 ns	7.48575 ns	2.90986 us	276.32895 °	-0.78 dBm	-16.08 dBm
9	-1.39 dBm	99.41364 ns	7.65567 ns	2.91011 us	280.42859 °	-0.87 dBm	-16.11 dBm
10	-1.36 dBm	99.56028 ns	7.80557 ns	2.91018 us	284.14838 °	-0.74 dBm	-16.07 dBm
11	-1.40 dBm	99.63683 ns	8.02328 ns	4.90990 us	810.08453 °	-0.86 dBm	-18.31 dBm
12	-1.38 dBm	99.55033 ns	7.95047 ns	2.91008 us	268.64148 °	-0.74 dBm	-16.10 dBm
13	-1.37 dBm	99.37347 ns	7.73742 ns	2.90983 us	272.31412 °	-0.68 dBm	-16.09 dBm
14	-1.36 dBm	99.58830 ns	7.79934 ns	2.91000 us	275.92587 °	-0.77 dBm	-16.08 dBm
15	-1.37 dBm	99.59512 ns	7.74599 ns	2.91024 us	279.55917 °	-0.53 dBm	-16.08 dBm
16	-1.41 dBm	99.75660 ns	8.28168 ns	-- s	814.49548 °	-0.90 dBm	-- dBm

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.



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

Pulse Table display settings

Main menu bar: Setup > Settings

Front Panel: Settings

Favorites Toolbar: ⚙

The Settings control panel tabs for the Pulse Table Display are shown in the following table.

Settings tab	Description
Measurements	Selects the measurements to be show in the Pulse Table.

Table continued…

Settings tab	Description
Params	Specifies several parameters that control how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency errors.

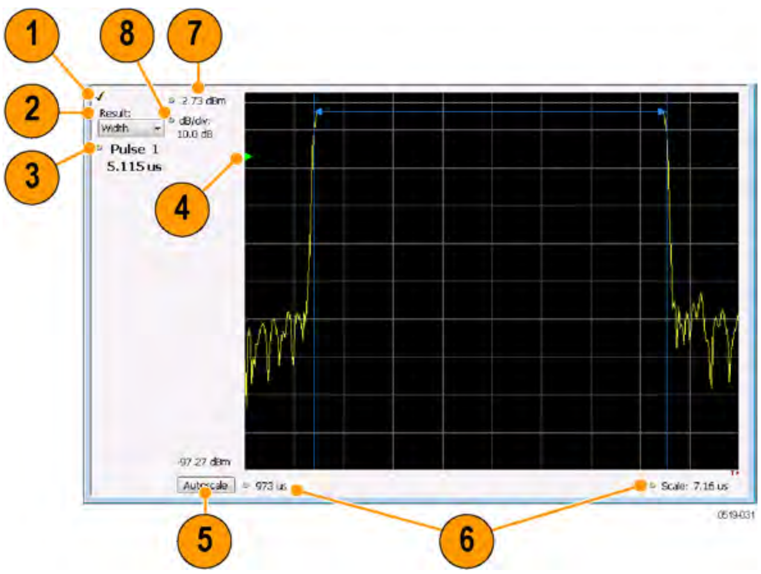
Restore defaults button

This button is located on the Pulse Table Settings control panel. Sets the Pulse Table parameters to their default values.

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.

Elements of the Pulse Trace 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 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.

Table continued…

Item	Display element	Description
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.
(not shown)	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
8	Vertical scale	Sets the vertical scale value.

Changing the Pulse Trace Display Settings

Pulse Trace display settings

Main menu: Setup > Settings

Front Panel: Settings

Favorites Toolbar:

The Setup settings for the Pulse Trace display are shown in the following table.

Settings tab	Description
Params	Specifies several parameters that control how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency error.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether on not certain display elements are shown.

Restore defaults button

This button is located on the Pulse Trace Settings control panel. Sets the Pulse Trace display parameters to their default values.

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 Pulse Count, Max, Min, Peak to Peak, Average, and Standard Deviation in this display summarize results for the selected pulse measurement.

Elements of the Pulse Statistics Display

The following images show the display when different plot types are selected. The table following these images explains the elements of these displays.

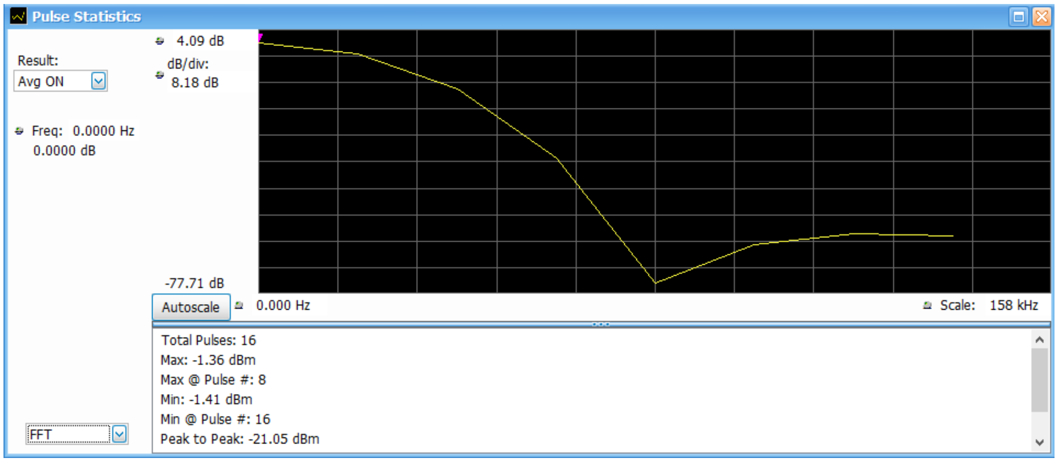


Figure 55: The above image shows an FFT plot.

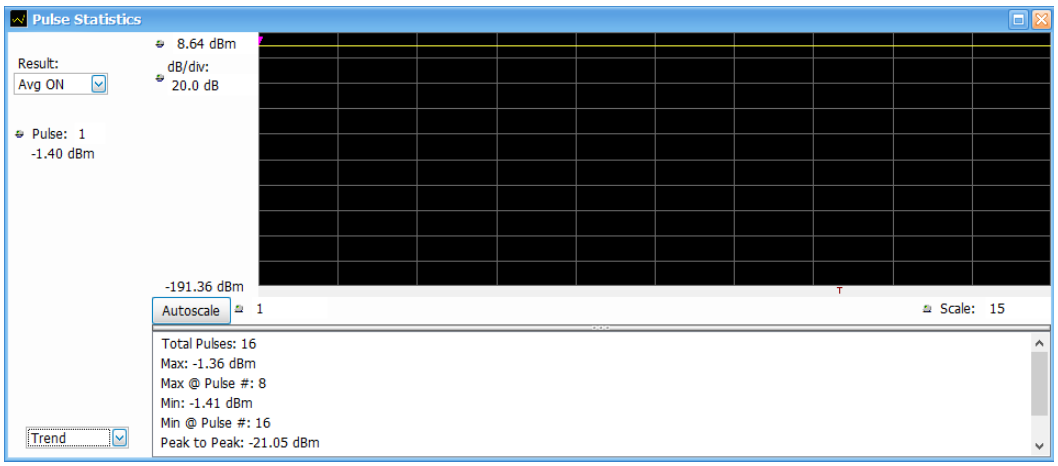


Figure 56: The above image shows a Trend plot.

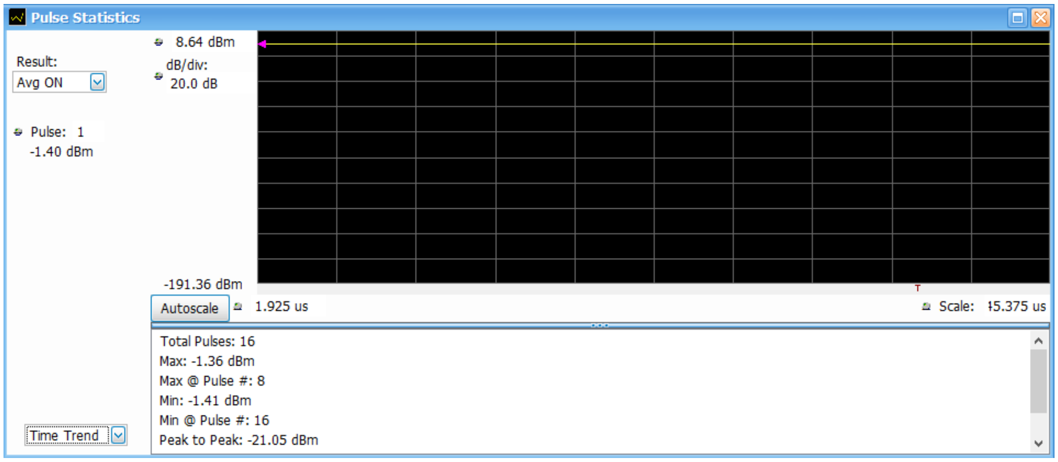


Figure 57: The above image shows a Time Trend plot.

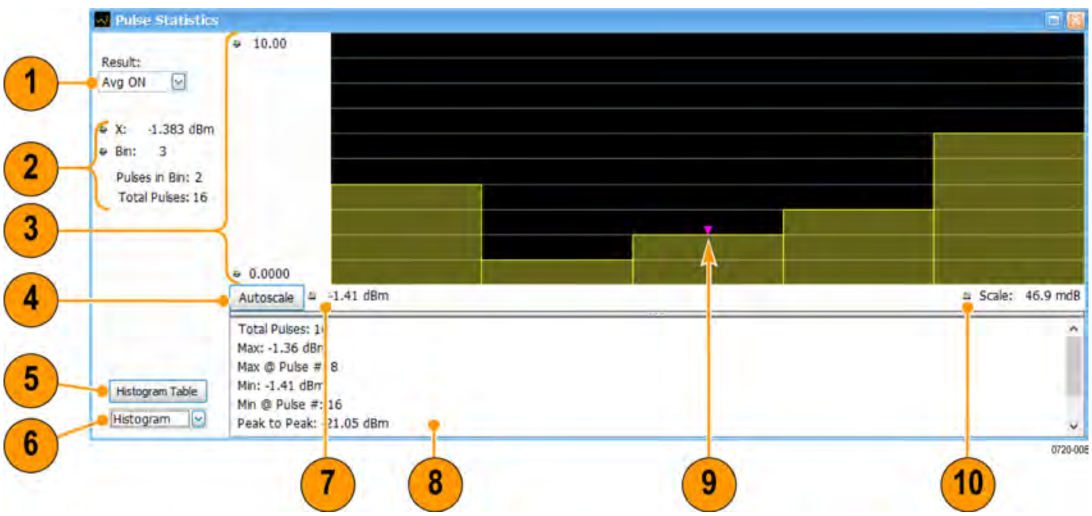


Figure 58: The above image shows a Histogram plot.

Item	Display element	Description
1	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.
2	Results indicators (The indicators shown depend on the plot type selection. The values shown are plot indicator (Item 9) values.)	
	Pulse	Pulse indicator for Trend or Time Trend plots that indicates the pulse selected by the Pulse setting.
	Freq	Pulse indicator for FFT plots that marks the trace point at the selected frequency.

Table continued…

<table>
<tr><th>Item</th><th>Display element</th><th>Description</th></tr>
<tr><td></td><td>X</td><td>For Histogram plots: A value of the selected result where the pulse indicator is positioned. Changing X will automatically change the bin number to the one that contains the X value.</td></tr>
<tr><td></td><td>Bin</td><td>For Histogram plots: Bin number where the indicator is positioned. Changing this number will change the value of X to the middle of the selected bin.</td></tr>
<tr><td></td><td>Pulses in Bin</td><td>For Histogram plots: Number of pulses in the selected bin.</td></tr>
<tr><td></td><td>Total Pulses</td><td>For Histogram plots: Total number of pulses analyzed in the current acquisition.</td></tr>
<tr><td>3</td><td>Vertical</td><td>Sets the vertical range.</td></tr>
<tr><td>4</td><td>Autoscale</td><td>Sets the axes to values for clear visibility of trace points.</td></tr>
<tr><td>5</td><td>Histogram Table button</td><td>Contains the Bin number, Bin range, and Pulses in bin for the chosen measurement.
<table>
<tr><th>Bin Number</th><th>Bin Range</th><th>Pulses in Bin</th></tr>
<tr><td>1</td><td>196.00 MHz - 198.42 MHz</td><td>2</td></tr>
<tr><td>2</td><td>198.42 MHz - 200.84 MHz</td><td>1</td></tr>
<tr><td>3</td><td>200.84 MHz - 203.26 MHz</td><td>0</td></tr>
<tr><td>4</td><td>203.26 MHz - 205.68 MHz</td><td>0</td></tr>
<tr><td>5</td><td>205.68 MHz - 208.10 MHz</td><td>0</td></tr>
<tr><td>6</td><td>208.10 MHz - 210.52 MHz</td><td>0</td></tr>
<tr><td>7</td><td>210.52 MHz - 212.94 MHz</td><td>1</td></tr>
<tr><td>8</td><td>212.94 MHz - 215.36 MHz</td><td>0</td></tr>
<tr><td>9</td><td>215.36 MHz - 217.77 MHz</td><td>0</td></tr>
<tr><td>10</td><td>217.77 MHz - 220.19 MHz</td><td>0</td></tr>
<tr><td>11</td><td>220.19 MHz - 222.61 MHz</td><td>0</td></tr>
<tr><td>12</td><td>222.61 MHz - 225.03 MHz</td><td>0</td></tr>
<tr><td>13</td><td>225.03 MHz - 227.45 MHz</td><td>0</td></tr>
<tr><td>14</td><td>227.45 MHz - 229.87 MHz</td><td>0</td></tr>
<tr><td>15</td><td>229.87 MHz - 232.29 MHz</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Plot type selector</td><td>Select Trend, Time Trend, FFT, or Histogram as plot type.</td></tr>
<tr><td>7</td><td>Horizontal offset</td><td>Adjusts the horizontal offset.</td></tr>
<tr><td>8</td><td>Statistics summary</td><td>Display of measurement statistics for the selected result.</td></tr>
<tr><td>9</td><td>Pulse indicator</td><td>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.</td></tr>
<tr><td>10</td><td>Scale</td><td>Adjusts the horizontal scale.</td></tr>
</table>

Changing the Pulse Statistics Display Settings

Pulse Statistics settings

Main menu bar: Setup > Settings

Front Panel: Settings

Favorites Toolbar:

The settings for the Pulse Statistics display are shown in the following table.

Settings tab	Description
Params	Specifies several parameters that control how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency errors.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether or not certain elements of the display are shown.

Restore defaults button

This button is located on the Pulse Statistics Settings control panel. Sets the Pulse Statistics display parameters to their default values.

Pulsed RF Measurement Settings

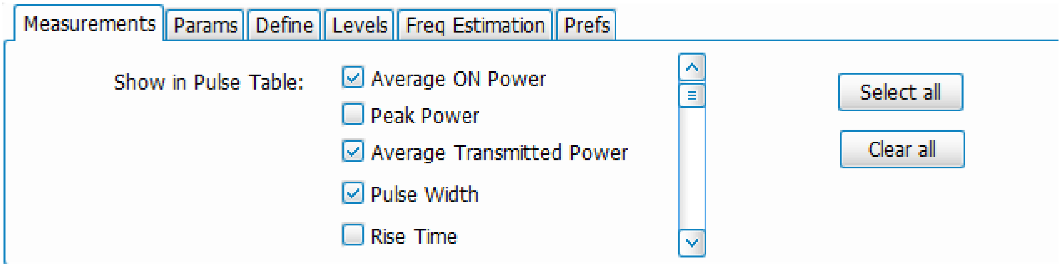
Some of the control panel tabs are shared by the Pulsed RF displays (Setup > Displays). Changing a setting in a shared tab changes that setting for all the Pulsed RF displays. The other control panel tabs are unique for each display. The following information explains both types.

Table 18: Common controls for pulsed RF displays

Settings tab	Description
Measurements	Specifies which measurement results appear in the Cumulative Statistics Table and Pulse Table displays.
Params	Specifies several parameters that control how pulses are counted and defined.
Define	Specifies parameters that control where measurements are taken on a pulse.
Analysis (Only Available for the Pulse-Ogram display)	Specifies parameters related to analysis of the signal.
Levels	Specifies parameters that control the method and levels used to calculate some pulse values.
Freq Estimation	Specifies the reference used for computing frequency errors.
Traces (Only available for the Pulse-Ogram display)	Specifies the smooth points for the Time vs Time view and the detection method for the Frequency vs Time view.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Specifies whether or not certain elements of the display are shown.

Measurements Tab

The Measurements tab is used to specify the measurements that appear in the Cumulative Statistics Table display and the Pulse Table display.



Show in Cumulative Statistics Table

Checked measurements appear in the table.

Select all

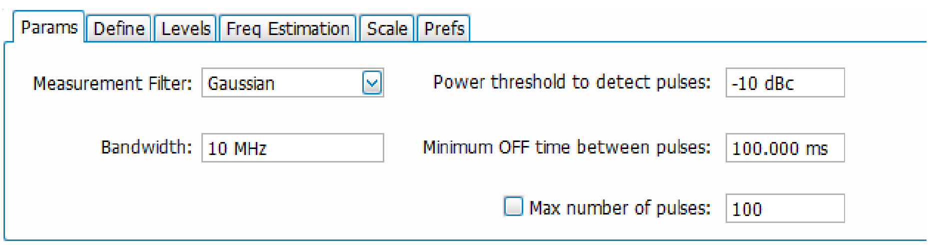
Click **Select all** to choose all measurements for display in the table.

Clear all

Click **Clear all** to remove all measurements from the table display.

Params Tab

The Params tab enables you to adjust several measurement parameters for Pulsed RF displays. Not all parameters show for all displays.



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. *(Only available for the Pulse Statistics, Pulse Trace, and Pulse Table displays.)*

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 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.

Minimum OFF time between pulses

Specifies the time the signal must fall below the power threshold for two pulses to be considered separate pulses. The minimum value for this setting is 1.000 ns.

Max Number of Pulses

Only available for the Pulse Statistics, Pulse Trace, and Pulse Table displays.

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 setting resolution is: 1. If this setting is not checked, the analyzer will measure all pulses within the Analysis Time.

To determine the maximum number of pulses that can be analyzed, use the following equation:

$$\text{Maxnumberofpulses thatcan analyzed} = \text{PulseRate} \times \text{capacity}$$

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).

The Pulse Cumulative Statistics display provides statistics of pulses like Average, Standard Deviation, and Peak to Peak. Pulse Count does not have an upper limit for Pulse Cumulative Statistics. The Pulse Cumulative Histogram display provides information about the trend of the Pulse characteristics and outliers. This display does not support any upper limit or lower limit.

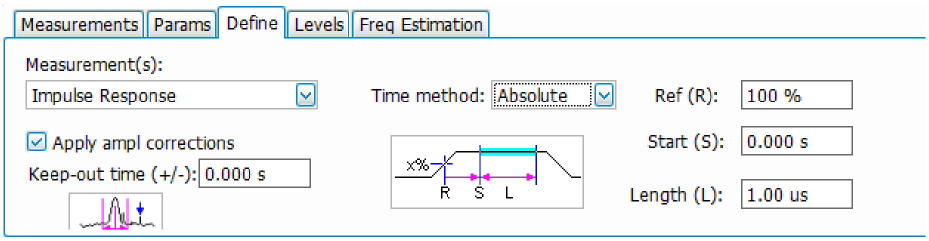
Note: In Fast Save mode, Pulse /Frame Count can go up to 200,000. This count also depends on the hard disk drive (HDD) capacity to store acquisitions.

The asterik (*) around a pulse number indicates that it is a Fast Frame.

All Pulse Analysis displays except the Pulse-Ogram update results only after analysis of all fast frames.

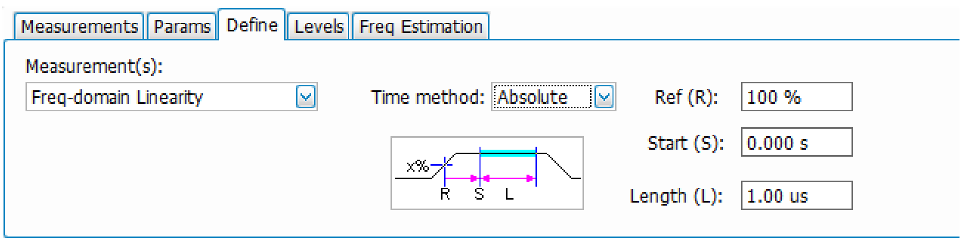
Define Tab

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. This tab is not available for the Pulse-Ogram display.



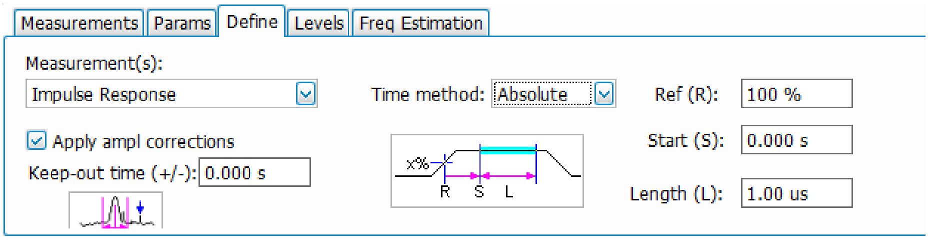
The settings that appear on the Define tab are described below. They may vary according to the Measurement(s) selection.

Freq-Domain Linearity



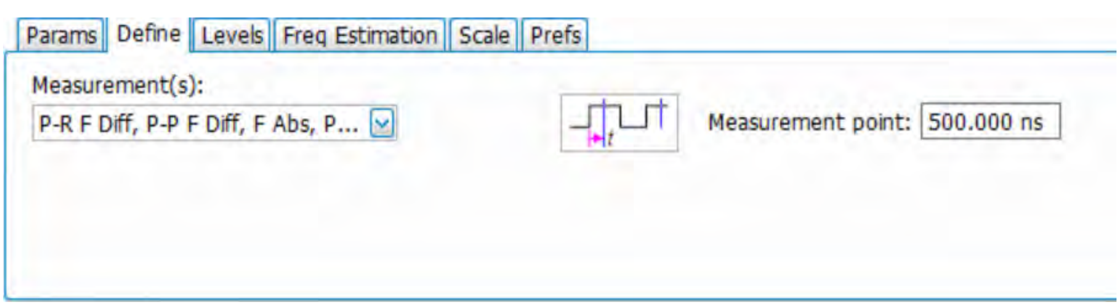
Setting	Description
Time method	Specifies how the measurement's duration is determined. The choices are Absolute and Relative.
Absolute time method	
Ref (R)	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 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



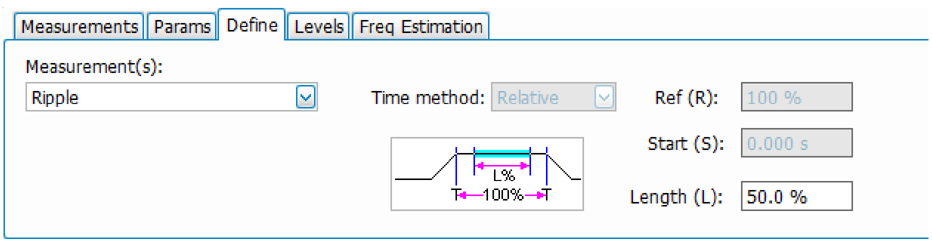
Setting	Description
Apply ampl corrections	Enable/disable corrections that remove errors due to the window function and to the time offset of the side lobe.
Keep-out time (+/-)	The Keep-out time specifies a region that is ignored when the trace is analyzed for side lobes. The setting defines a region 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.

P-R F Diff, P-P F Diff, F Abs, P-R ø Diff, P-P ø Diff



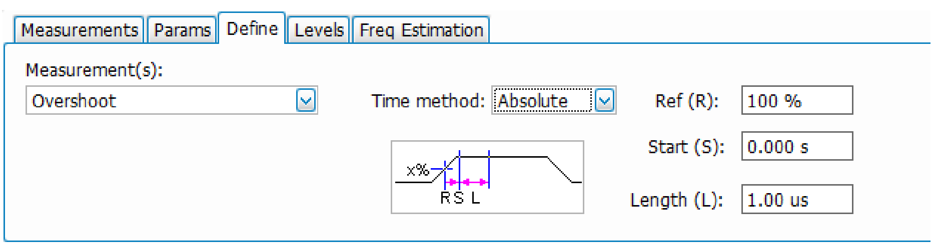
Setting	Description
Measurement point	Specifies the period in time after the 50% rising edge at which frequency and phase difference measurements are made.

Ripple



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



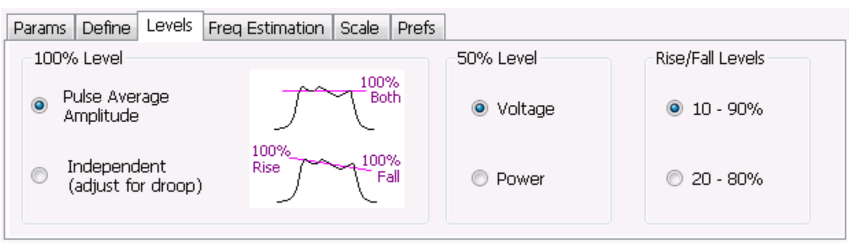
Setting	Description
Time method	Specifies how measurement parameters are determined. The choices are Absolute and Relative.
Absolute time method	
Ref (R)	Ref specifies the level along the pulse rising edge that is defined as the point from which Start time is counted. Choices: 50%, 60%, 70%, 80%, 90% 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

Table continued…

Setting	Description
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.



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.

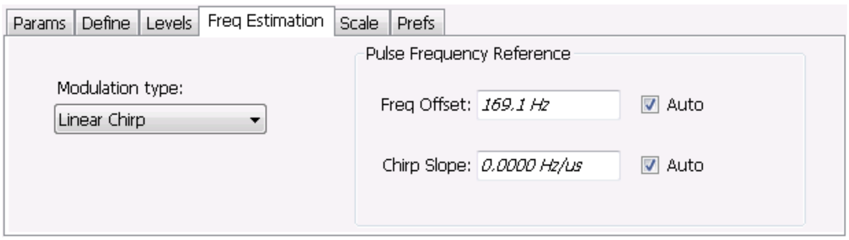
Because some RF pulse types have droop (a height difference between the beginning and ending points of the pulse top), the 100% percent level on the rising edge may not be equal to the 100% level on the falling edge. The Independent method of pulse point location is designed for pulses with different 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. This tab is not available for the Pulse-Ogram display.



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:

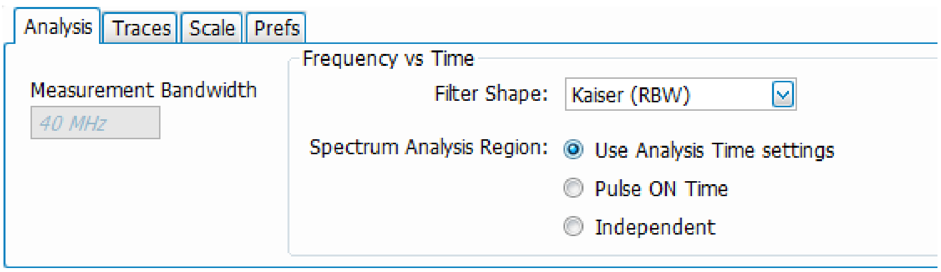
- CW (constant phase): The signal is not designed to change in either frequency or phase during the measured pulse train.
- CW (changing phase): The signal does not change the carrier phase within each pulse, although it could change the phase from one pulse to another pulse. The signal is not designed 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.

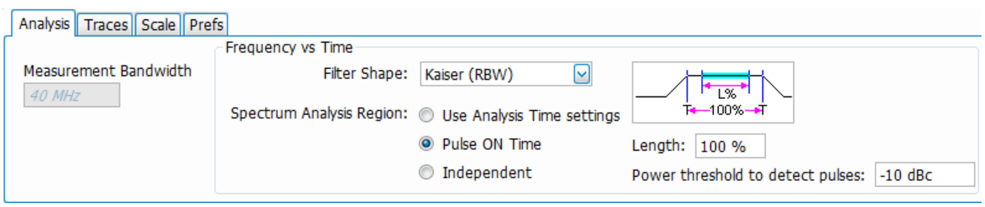
The following table maps the appropriate signal type selection with the signal characteristics.

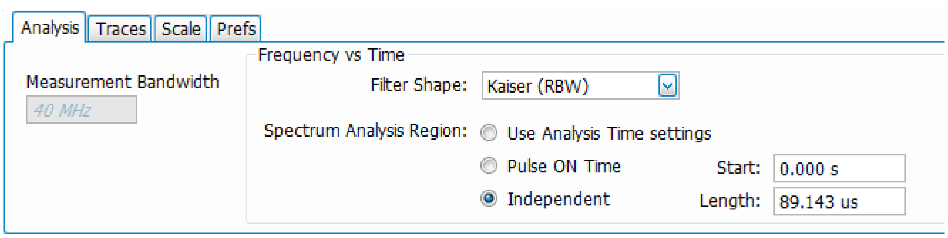
Signature	Phase offset from one pulse to another	
	Zero	Any (unknown)
CW	CW Constant Phase	CW Changing Phase
LFM	Linear Chirp	N/A

Analysis Tab

The Analysis tab is only available for the Pulse-Ogram display. It allows you to set parameters related to analysis of the signal. The settings vary depending on which spectrum analysis region you select.







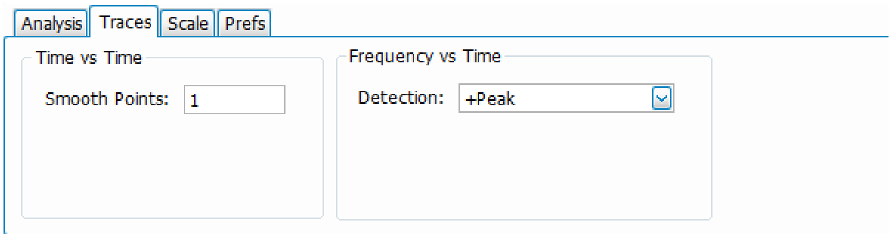
Setting	Description
Measurement bandwidth	Specifies the frequency range used by the measurement. This control is linked to the Bandwidth control of other Pulsed RF Displays. If **No Filter – Max BW** is selected in other displays, the control setting is disabled, but shows the maximum value possible. If **No Filter** or **Gaussian** is selected in other displays, then the Bandwidth control is also enabled in the Pulse-Ogram display.
Filter shape	Spectrum of the signal is windowed by the desired filter shape.
Use analysis time settings	Provides the complete analysis length as displayed in Time Overview.
Pulse on time	Analysis is done in the ON period of the data.
Length	Specifies the analysis length.

Table continued…

Setting	Description
Power threshold to detect pulses	Specifies the level used for locating pulses in the data.
Independent	In Manual option, you can choose the analysis length of the desired type for the Freq vs Time view in the display.
Start	Specify the analysis offset. The default value is the offset in Time Overview.
Length	Specify the analysis length. The default value is the length in Time Overview.

Traces Tab

The Traces tab is only available for the Pulse-Ogram display. It allows you to set the trace characteristics for the display.



Setting	Description
Smooth points	Shows the number of filter coefficients used for smoothening the noisy region for visual clarity.
Detection	Trace Detection is used to reduce the results of a measurement to the desired number of trace points.

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 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.
- **Avg (VRMS)**: 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.
- **Sample**: The first value is selected from the set of results to be compressed into a trace point.

Scale Tab

The Scale tab is only available for trace displays. It 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. Each display has different settings, as shown below.

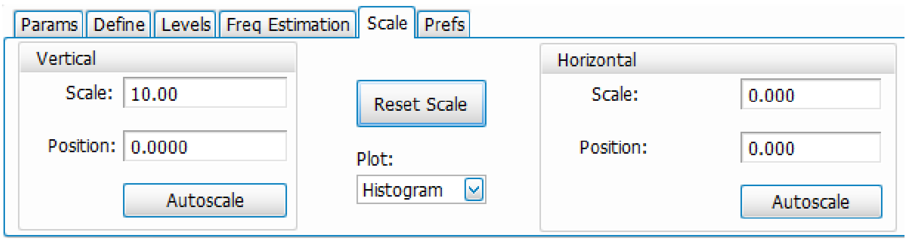


Figure 59: The above image shows the Scale tab for the Pulse Statistics display.

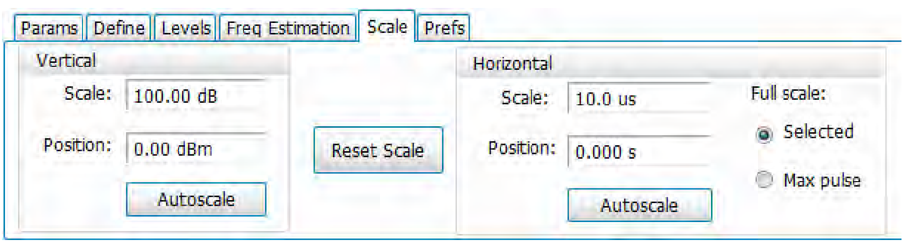


Figure 60: The above image shows the Scale tab for the Pulse Trace display.

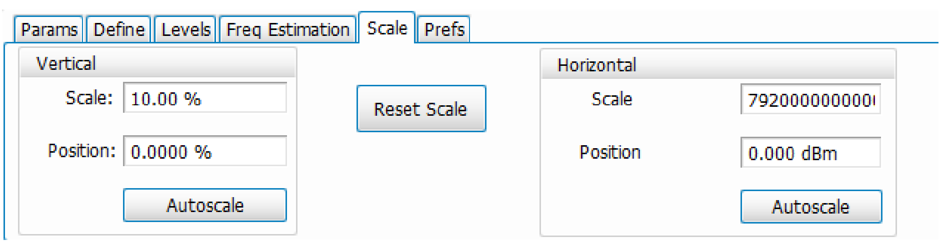


Figure 61: The above image shows the Scale tab for the Pulse Cumulative Statistics display.

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.

Table continued…

Setting	Description
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.

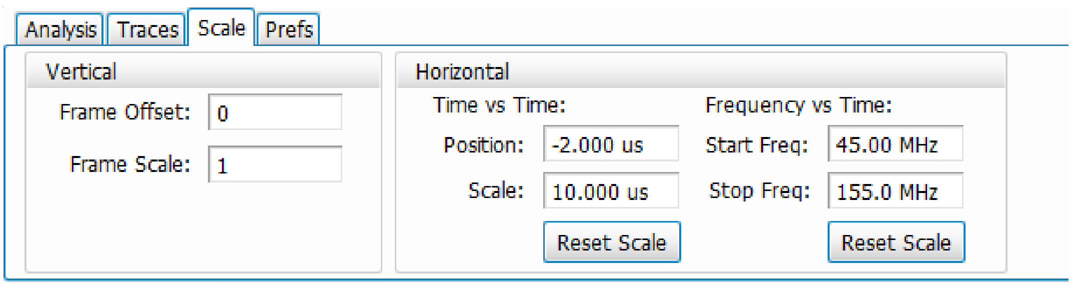


Figure 62: The above image shows the Scale tab for the Pulse-Ogram display.

Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Frame Offset	Display will start after the indicated frame number.
Frame Scale	Shows how many frames are displayed in both Time vs Time and Frequency vs Time views.
Horizontal (Time vs Time view)	Controls the span of the Time vs Time trace display and position of the trace.
Position	Allows you to pan a zoomed trace. The default value matches the offset of the acquisition.
Scale	Allows you to change the span. The default value matches the length of the acquisition.
Reset Scale	Restores the position and scale settings to default value.
Horizontal (Frequency vs Time view)	Controls the span of the Frequency vs Time trace display and position of the trace.
Start Freq	Allows you to set the starting frequency shown in the graph without changing analysis. The default value matches the highest frequency of the span.

Table continued…

Setting	Description
Stop Freq	Allows you to set the stop frequency shown in the graph without changing analysis. The default value matches the highest frequency of the span.
Reset Scale	Restores the start frequency and stop frequency to default values.

Prefs Tab

The Prefs tab is only available for Pulsed RF trace displays. It is not available for the table displays. It enables you to change parameters of the measurement display. Available parameters vary depending on the selected display.

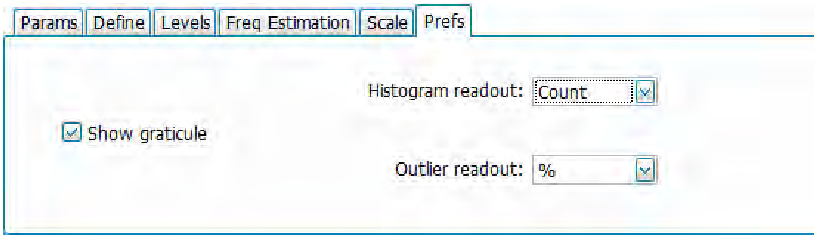


Figure 63: The above image shows the Prefs tab for the Pulse Cumulative Histogram display.

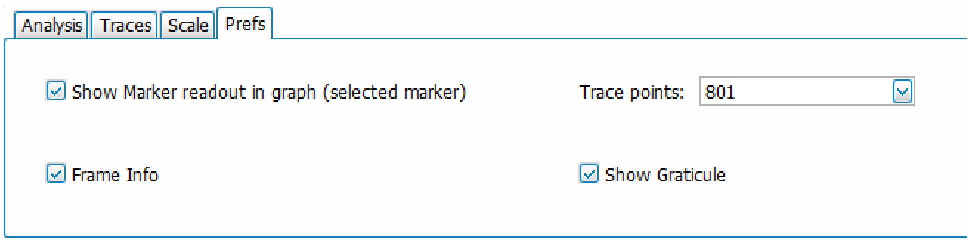


Figure 64: The above image shows the Prefs tab for the Pulse-Ogram display.

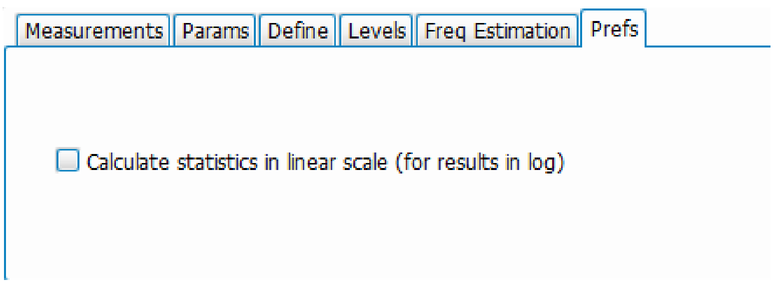


Figure 65: The above image shows the Prefs tab for the Pulse Cumulative Statistics display.

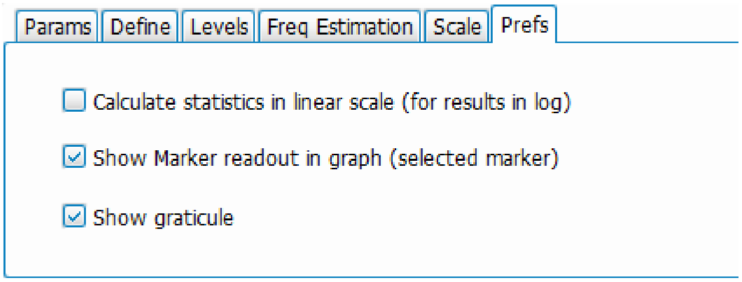


Figure 66: The above image shows the Prefs tab for the Pulse Statistics display when Time Trend is the selected plot type. Trend and FFT plot types do not show the Show Marker readout selection.

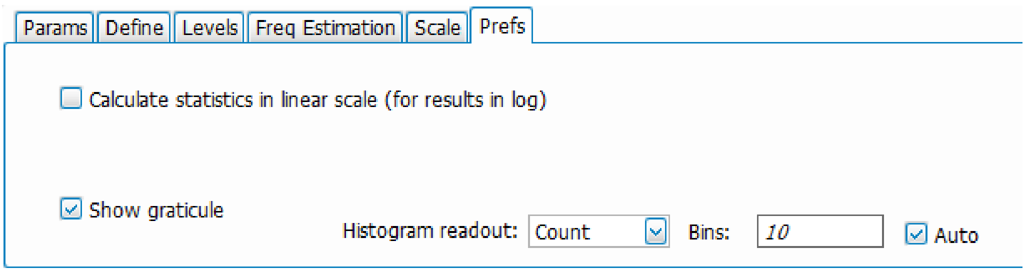


Figure 67: The above image shows the Prefs tab for the Pulse Statistics display when Histogram is the selected plot type.

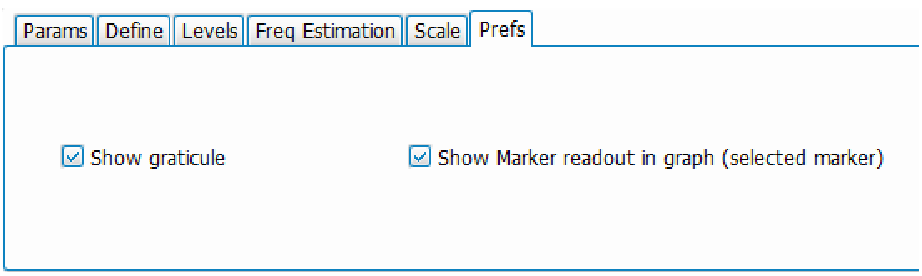


Figure 68: The above image shows the Prefs tab for the Pulse Trace display.

Setting	Description
Show graticule	Displays or hides the graticule in the trace display.
Show Marker readout in graph *(Only available for Pulse Trace and Pulse-Ogram displays.)*	When a marker is enabled, this setting displays or hides the maker readout, but not the maker itself, on Time Trend plots.
Histogram readout *(Only available for Cumulative Histogram display and the Pulse Statistics display when Histogram is the 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.

Table continued…

Setting	Description
Calculate statistics in linear scale (for results in log) *(Only available for Pulse Statistics display.)*	Checking this box allows for calculation of statistics in the linear domain (for example, the Power values in dB are converted to Watts (linear scale) and statistics are computed in Watts and then converted back to dB scale). This measurement will be observed only when this box is selected. This selection only appears in the Pulse Statistics display for these measurements: Average ON Power, Average Transmitted Power, Peak Power, Impulse Response Amplitude, Droop dB, Overshoot dB, and Ripple dB.
Bins *(Only available for Pulse Statistics display when Histogram is the plot type.)*	Specifies how many "bins" or histogram bars the results are distributed into.
Auto *(Only available for Pulse Statistics display when Histogram is the plot type.)*	Sets the bin number to automatic default, which is 10.
Outlier readout *(Only available for Cumulative Histogram display)*	Controls the parameters Outlier readout and Bins. Outlier 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.
Trace points *(Only available for the Pulse-Ogram display.)*	Sets the number of trace points used for marker measurements and for results export.
Frame Info *(Only available for the Pulse-Ogram display.)*	Displays or hides the frame information in the display.

The statistics can be calculated in the linear domain as well the log

Average ON Power, Average Transmitted Power, Peak Power, Impulse Response Amplitude, Droop dB, Overshoot dB, Ripple dB, the statistics can be calculated in linear domain as well, i.e. the Power values in dB are converted to watts (linear scale) and statistics are computed in watts and then converted back to dB scale. This measurement will be observed only when the Calculate statistics in linear scale (for results in log) is selected.

EMC Accessories

Overview

Tektronix has accessories for EMC pre-compliance testing available to you. The following topics are presented to assist you with using these accessories to perform tests.

- *Radiated tests introduction*
- Antennas and radiated test accessories
  - *EMI-BICON-ANT biconical antenna*
  - *EMI-CLP-ANT Log Periodic Dipole Array antenna*
  - *EMI-PREAMP preamplifier*
  - *EMI-TRIPOD antenna tripod*
- How to set up a radiated pre-compliance test for
  - *30 MHz to 300 MHz*
  - *300 MHz to 1 GHz*
- *Conducted tests introduction*
- Conducted test accessories
  - *EMI-LISN50UH-US*
  - *EMI-LISN50UH-GB*
  - *EMI-LISN50UH-EU*
- *How to set up a conducted pre-compliance test with LISN*
- Other accessories
  - *CABLE-1M, CABLE-3M, CABLE-5M*
  - *EMI-LISN5UH*
  - *EMI-NF-AMP*
  - *EMI-NF-PROBE*
  - *EMI-TRANS-LIMIT*
- *Accounting for accessories contributions in the EMCVu software*

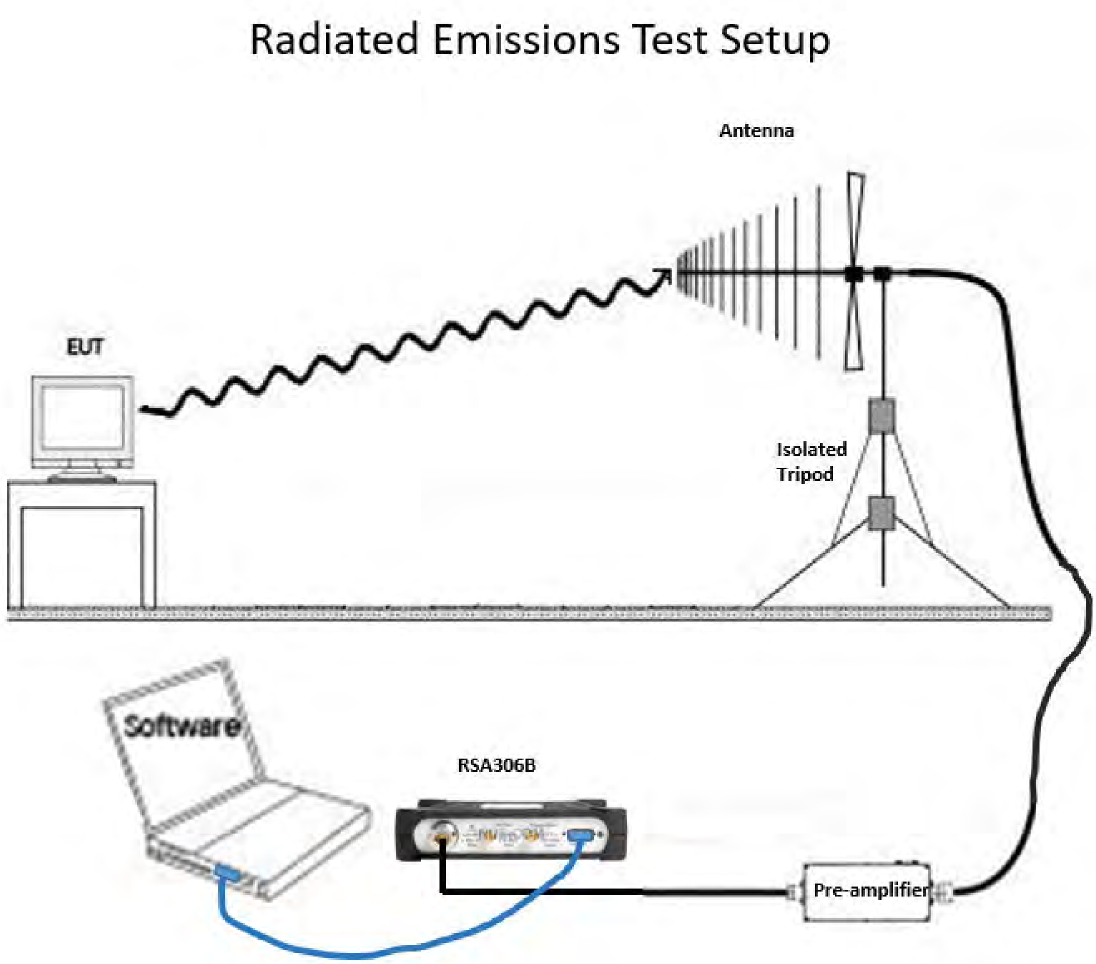
Tip: View the topics in the *EMC Analysis* section of this Help for information about using the EMC Analysis software.

Radiated tests introduction

Radiated emissions testing is about measuring the electromagnetic field strength of the emissions that are unintentionally generated by your product. Emissions are integral to the switching voltages and currents within any digital circuit; however, it is important that they comply emission limits.

The actual setup for Compliance tests is clearly specified in the standard document as applicable to the different types of products. You should refer to these standards for details about the actual setup. There are several challenges in the actual Radiated test setup. The electromagnetic waves don't extend out from your product in a nice spherical pattern. The emissions tend to be directional, so a test lab would typically vary the height of the receiving antenna between 1 and 4 meters as well as rotate a turntable. The receiving antenna picks up both the signal direct from the EUT, as well as a bounce off the ground. To increase measurement accuracy, the ground is covered with an electromagnetically reflective surface (aluminum, steel, wire mesh etc..) and this ground plane must be relatively flat. The EUT will be scanned in the frequency band of interest and you will look for emissions that are close to the limits.

Pre-compliance can help you find out emission issues early or troubleshoot emissions issues reported by a test house. A Radiated Emission Pre-Compliance test setup diagram is shown below with the equipment under test (EUT), ground plane, antenna mounted on a tripod, a pre-amplifier, and a spectrum analyzer. The radiation from the EUT is picked up by the antenna, the output of which is amplified by a pre-amplifier for better sensitivity. The output of the pre-amplifier The output of the pre-amplifier is connected to the input of the analyzer that acquires the signal and analyzes it with the help of the software (EMCVu).

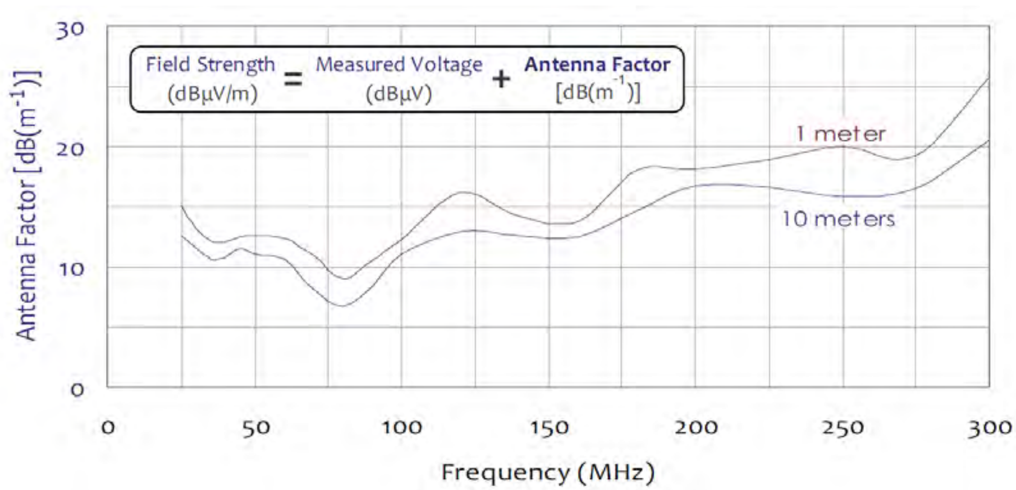


EMI-BICON-ANT (ABF-900A biconical antenna)

The EMI-BICON-ANT (Com-Power ABF-900A) is a broadband, linearly polarized Biconical Dipole Antenna with collapsible elements, operating over the frequency range of 25 MHz to 300 MHz. Each full-size biconical element (54 cm cage diameter) collapses to a maximum diameter of 5 cm for easy transport/storage.

The ABF-900A biconical antenna is intended for use as an EMI test antenna for qualification-level regulatory compliance measurements (FCC, CE, Mil-Std, RTCA DO-160, FDA, SAE Automotive, etc.).

ABF 900 has the following characteristics (Antenna factor).



These factors can be loaded into the EMCVu Accessories tab (located in the EMC Settings control panel or the EMC Project Setup Wizard). The file will be available to you in *C:\SignvalVu-PCFiles\EMC_Accessories*.

Tip: See the *Radiated tests introduction* topic for more information and to view a connections diagram.

EMI-TRIPOD (AT-812 antenna tripod)

The recommended support structure for the Com-Power ABF-900A is the Com-Power AT-812 Antenna Tripod. One of the standard AT-812 accessories is the Com-Power ATHP-812 Antenna Pipe Holder, which clamps securely around the one-inch diameter feed tube of the ABF-900A. The ATHP-812 is then secured to a tripod or mast via its 1/4” x 20 thread mounting hole.

Figure 69: The above image shows the tripod.

Figure 70: The above image shows the mounted antenna with the pipe holder.

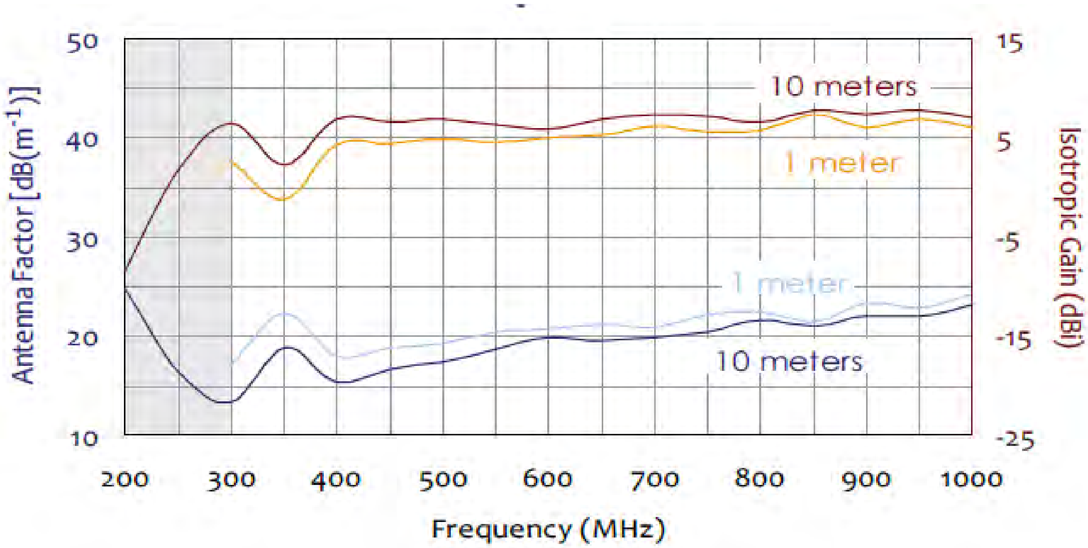
Tip: See the *Radiated test introduction* topic for more information and to view a connections diagram.

EMI-CLP-ANT (ALC-100 Log Periodic Dipole Array (antenna)

The Com-Power ALC-100 is a broadband, linearly polarized Log Periodic Dipole Array (LPDA) antenna, operating over the frequency range of 200 MHz to 1 GHz and with excellent efficiency between 300 MHz and 1 GHz.

The ALC-100 Compact Log Periodic Antenna is intended for use as an EMI test antenna for qualification-level regulatory compliance measurements (FCC, CE, RTCA DO-160, FDA, SAE Automotive, etc.).

The ALC-100 can also be mounted using the AT-812 tripod (which is a part of the accessories given by Tektronix).



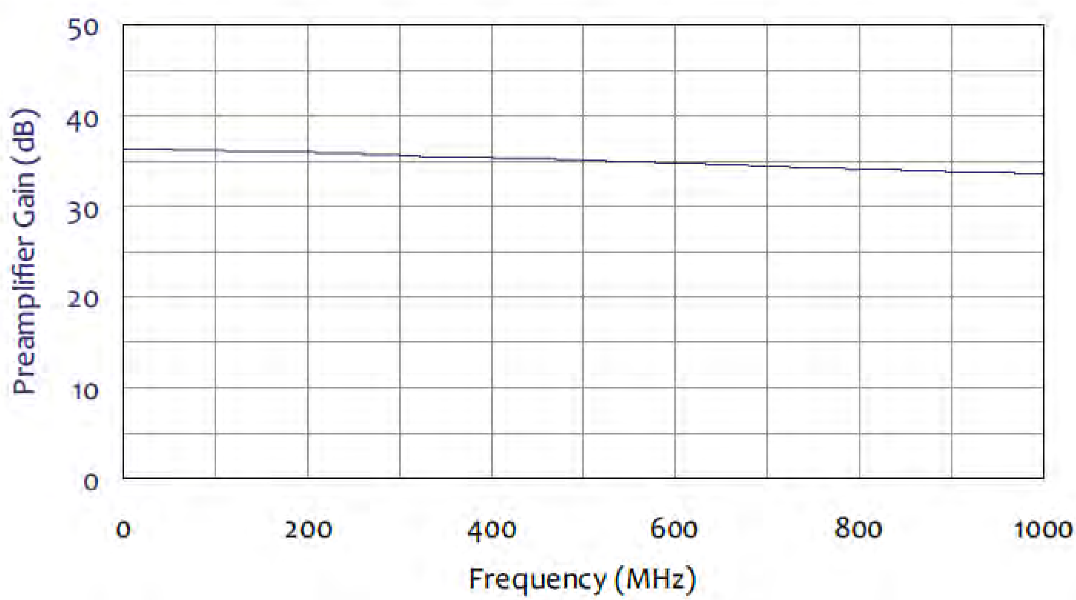
Tip: See the *Radiated tests introduction* topic for more information and to view a connections diagram.

EMI-PREAMP (PAM-103 preamplifier)

The Com-Power PAM-103 is a broadband, high gain, low-noise preamplifier operating over the frequency range of 1 MHz to 1 GHz. Its high gain (33 dB ±3 dB) and low noise figure (<3.3 dB) make the PAM-103 preamplifier the ideal choice for optimizing your EMI measurement system, whether it be a test chamber, open area test site, or tem-cell.

The PAM-103 can be powered by its internal, rechargeable battery packs, or by its AC to DC power adapter/battery charger. On a full charge, the preamp will operate on battery power for over 13 hours. The battery low indicator light will let you know when it is time to plug it in and the charging indicator light will let you know that it is charging. If you are unable to plug it in, you can feel confident in continuing your test, because the PAM-103 will turn itself off before the battery voltage reaches the point at which the gain could become unstable. Whether it is operating on battery power or external power, if the amp is on, the output should be stable and the gain should remain constant.

Nearly all measurement systems for radiated EMI tests require preamplification to achieve the necessary sensitivity.

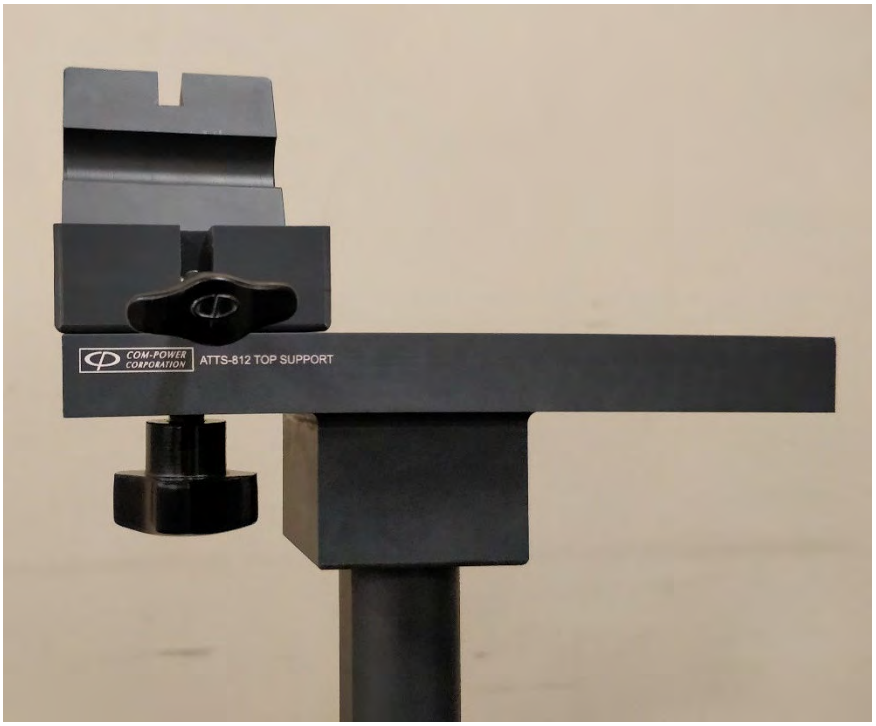


Tip: See the *Radiated tests introduction* topic for more information and to view a connections diagram.

Radiated pre-compliance test setup (30 MHz to 300 MHz)

A simple pre-compliance setup is shown below using a ABF-900 antenna, a preamplifier, and an RSA306B real-time spectrum analyzer.

1. Mount the antenna pipe holder ATHP-812 on the top support (ATTS-812) of the tripod (AT-812).



2. Mount the antenna pipe AB-900A on the antenna pipe holder (ATHP-812).

3. Fix the biconical antenna (ABF-900) to the antenna pipe (AB-900A).

4. Connect the output of the antenna pipe to a pre-amplifier through a Tektronix *cable*.
5. Connect the output of the pre-amplifier to a Tektronix USB spectrum analyzer or a RSA5100B series spectrum analyzer.

Tip: See the *Radiated tests introduction* on page 323 topic for more information and to view a connections diagram.

Radiated pre-compliance test setup (300 MHz to 1 GHz)

A pre-compliance setup is shown below using the ALC-100 antenna, a preamplifier, and an RSA306B real-time spectrum analyzer.

1. Clamp the accessory to the top support (ATTS-812) of the tripod (AT-812).

2. Mount the antenna (ALC-100) to the accessory connected in the previous step.

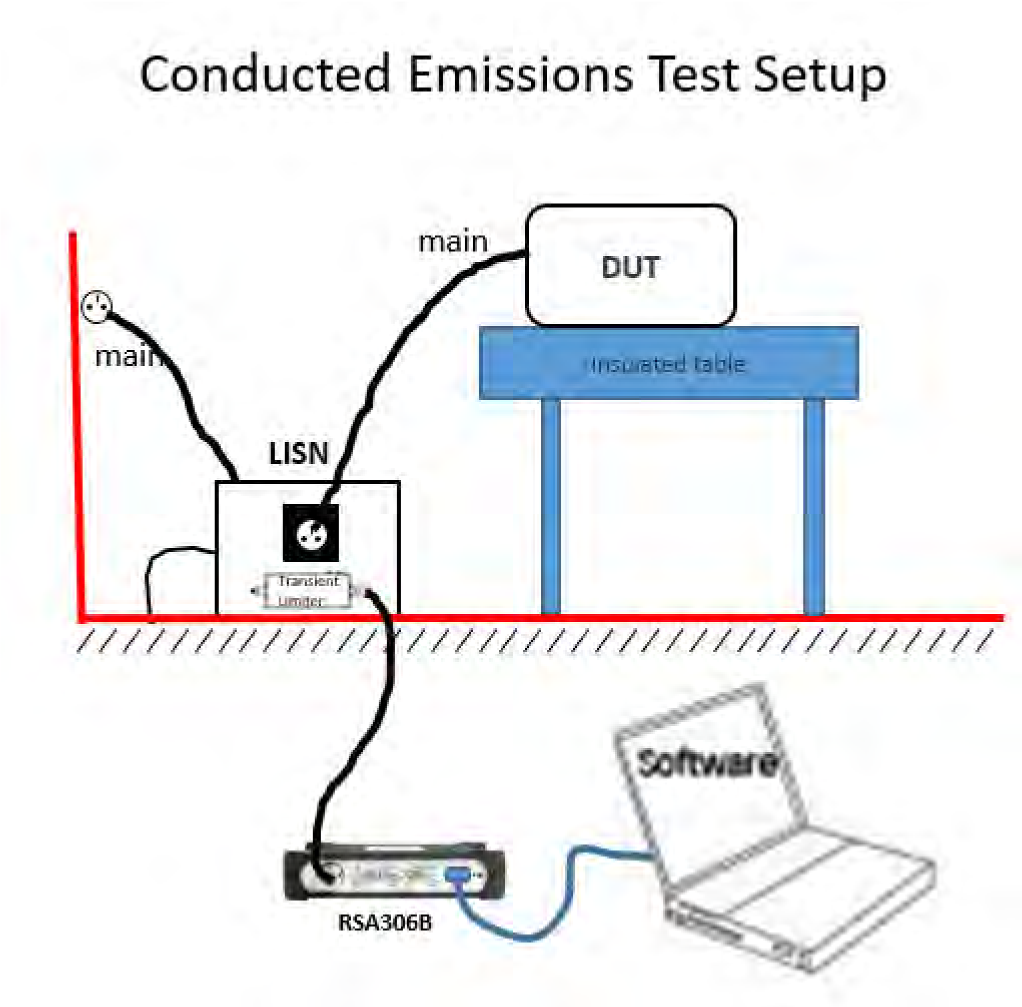
3. Connect the output of the antenna to a pre-amplifier through a Tektronix *cable*.
4. Connect the output of the pre-amplifier to a Tektronix USB spectrum analyzer or an RSA5100B series spectrum analyzer.

Tip: See the *Radiated tests introduction* on page 323 topic for more information and to view a connections diagram.

Conducted tests introduction

Conducted emission tests are about testing the portion of electromagnetic energy created by your device that is conducted onto the power supply cord. To restrict the amount of interference your device can couple back onto a power supply, test labs measure these emissions (usually from 150 kHz - 30 MHz) and verify that they comply with specified limits.

This helps to ensure that the local power supply remains relatively clean and nearby devices will not be affected by your device. Conducted emissions testing is usually performed on devices that connect to an AC power supply. For some standards, there are also limits placed on devices that operate from a DC power supply.



LISN is one of the key accessories required for doing a conducted test.

EMI-LISN50UH (TBLC08 Line Impedance Stabilization Network)

The following models are available:

- EMI-LISN50UH-US: This model supports DUT devices with US main power.
- EMI-LISN50UH-GB: This model supports DUT devices with GB main power.
- EMI-LISN50UH-EU: This model supports DUT devices with EU main power.

The 50 µh AC line Tekbox TBLC08 is a Line Impedance Stabilization Network (LISN) for the measurement of line-conducted interference within the range of 9 kHz to 30 MHz, as per the CISPR16 standard. The device is designed for testing single phase, AC-powered equipment with supply voltages up to maximum 260 V. Conducted noise can be measured on the phase and on the neutral conductor. The TBLC08 is equipped with a switchable limiter/attenuator.

The LISN provides for stabilization and lets you measure what amount of energy is fed back to the power line. The LISN is powered and the front-end power socket lets you power your equipment under test (EUT). The emissions that is fed back to the power line is available at RF out for a receiver or spectrum analyzer to measure.

The LISN is connected to the AC power supply and provides power to the EUT. The spectrum analyzer is connected to the RF out of the LISN. TBLC08 has an built-in limiter that can be switched ON to avoid transients. The emission that is usually fed back to the power line is made available at RF OUT by the stabilization network.

Tip: See the *Conducted tests introduction* topic for more information and to view a connections diagram.

CABLE (coaxial Type N to Type N)

The following cables for EMI testing are available from Tektronix:

- CABLE-1M: 1 meter RF coaxial Type N to Type N cable
- CABLE-3M: 3 meter RF coaxial Type N to Type N cable
- CABLE-5M: 5 meter RF coaxial Type N to Type N cable

EMI-LISN5UH (TBOH01 Line Impedance Stabilization Network)

The 5 µh DC line Tekbox TBOH01 is a Line Impedance Stabilization Network (LISN) for the measurement of line-conducted interference within the range of 150 kHz to 110 MHz. It is inserted into the supply line of the DUT.

Tip: See the *Conducted tests introduction* on page 334 topic for more information and to view a connections diagram.

EMI-TRANS-LIMIT (LIT-153A transient limiter)

The Com-Power LIT-153A is a transient limiter that protects the EMI receiver input via the LISN from any short transients (a few microseconds or less) on the power supply lines.

Tip: See the *Conducted tests introduction* on page 334 topic for more information and to view a connections diagram.

EMI-NF-AMP (TBWA2 amplifier)

The TekBox TBWA2 is a 20 dB or 40 dB wideband amplifier for use with the TBPS01 probes.

Tip: See the *EMI-NF-PROBE* accessory topic.

See the *Radiated tests introduction* topic for more information and to view a connections diagram.

EMI-NF-PROBE (TBPS01 near field probe set)

The TekBox TBPS01 is a near field probe set.

Tip: See the *EMI-NF-AMP* accessory topic.

See the *Radiated tests introduction* on page 323 topic for more information and to view a connections diagram.

Accounting for accessories contributions in EMCVu software

Each accessory has its own Gain/Loss (antenna factor in the case of antennas) that must be accounted for to get an accurate emission measurement. The measured reading must be corrected for the Gain/Loss/ Factor contribution due to the accessories.

The EMCVu software allows you to correct for the accessory contributions. You can either use the Setup Wizard – Accessories tab or the Accessories tab in the Settings control panel to account for these contributions. You can view the Combined Impact of all the accessories in a graph, too.

The typical values of Gains/Losses/Factors of each of the Tektronix provided accessories is available for you to easy load. You can either use the “Load Tektronix provided Accessories Gains/Losses” from the Setup Wizard or you can load individual accessory files using “Configure Accessories > Edit > Load”. The individual .csv files are available in *C:\SignalVu-PC Files\EMC Accessories*.

Tip: See the *How to perform an EMC pre-compliance test* on page 343 topic for more information of how you can perform an emission measurement. See the *Combined impact of gains/losses* on page 384 to read more about contributions.

EMC Analysis

Introduction to EMC Analysis

The Electro Magnetic Compatibility (EMC) Analysis option (Option 32) allows you to perform pre-compliance emissions tests for your devices and troubleshoot emission issues. A separate EMCVu icon is loaded to your Desktop for quick access to the EMC displays, setups, and standards. These same displays, setups, and standards can also be accessed from the analyzer.

EMC is a measure of the capability of a device to operate as expected in its operating environment. A device should not affect the capability of other equipment in a certain proximity to operate as expected. EMI can be defined as electromagnetic energy that affects the functioning of an electronic device. Sources of EMI are predominantly from electronic devices or electrical systems. While EMI can be generated from any electronic device, certain equipment and components, such as cell phones, welders, motors, and LED screens, are more likely to create disturbances than others. Measuring the amount of EMI generated by the internal systems of devices is a process known as emissions testing. The RF range is generally split into a Conducted range and a Radiated range.

Several consequences, including safety risks and product failures, can result if you fail to properly anticipate the EMC of a device. Tektronix's EMC solution helps you find the emission problems in your device and troubleshoot them.

EMC standards

The EMC standards bring a common approach to every member state to EMC/EMI testing. It is important to purchase the standards document to do these tests because it lays out a clear procedure for test setup and methodologies. The CISPR standards usually define test procedures for commercial products.

The various standards set down limits for conducted and radiated EMI emissions. Typically, limit lines are defined separately for residential areas and industrial areas. These two areas are represented by two classes of limits: class A represents the industrial environment; class B defines the limits for residential areas.

The following are standards for which limit lines can be easily loaded in this application. Complete information about setup and testing can be found in the standard document.

Available standards under Europe are:

- EN55011: Industrial, scientific and medical (ISM) equipment containing a radio-frequency generator
- EN55012: Vehicles, motor boats and internal combustion engines - protection of off-board receivers
- EN55013: Sound / television broadcast receivers and associated equipment
- EN55014: Household appliances, portable electrical tools and similar apparatus, parts
- EN55015: Electrical lighting and similar equipment, for example fluorescent lamps
- EN55025: Vehicles, motor boats and internal combustion engines- protection of on-board receivers
- EN55032: Multimedia equipment (replaces CISPR 13 and CISPR 22 from 2017)
- EN60601: Medical Electrical equipment
- DEF STAN: Defense Standard for equipment and sub systems

Available standards under US are:

- FCC Part 15
- FCC Part 18
- MIL-STD 4161G

Key features

EMC testing with Tektronix provides you the following suite of pre-compliance and troubleshooting tools and displays to help you debug problems faster.

Pre-compliance **on page 342**

- *EMC Project Setup Wizard* on page 346: Use the EMC Project Setup Wizard to include contributions due to accessories, load ranges and limits based on standards recommendations, choose between measurement types, and include information for reports.
- *Measure ambient* on page 357: Measure emission not contributed by the Equipment under Test (EUT) and compare it with results obtained when the EUT is turned on.
- *Re-measure spot* on page 358: Identify emission results from a scan and re-measure on the selected spot (frequencies that have failed Threshold/Limit lines) with detectors recommended by the standard or detectors defined by you.
- *Reports* on page 356: Include measurement results and settings in a report. Include multiple measurement results in a report.

Troubleshooting

- *Harmonic Markers* on page 364: Allows you to place markers at selected harmonic factors of a known fundamental frequency to find if the emissions are caused by known design issues.
- *Inspect Suspect Frequencies*: Inspect a set of suspect frequencies in discrete mode or a set of harmonics of as many as 3 fundamental frequencies. You can use this tool with a near field probe set to see from where the suspect emission frequencies come.
- *Level Target* on page 367: Place a level target in the display and compare scans against the target visually.
- *Compare Traces* on page 368: Compare different scan traces, save traces, recall traces, and compare against limit lines. Compare Ambient traces and use the Math function (the difference of two traces) to create a Math trace.
- *Persistence Display* on page 370: Troubleshoot intermittently occurring emissions using the persistence tool with the DPX display.

Displays

- *EMC-EMI*
- *DPX*
- *Spectrogram*
- *Spectrum Display*

How to open EMCVu

You can start the EMC Analysis tool one of the following ways:

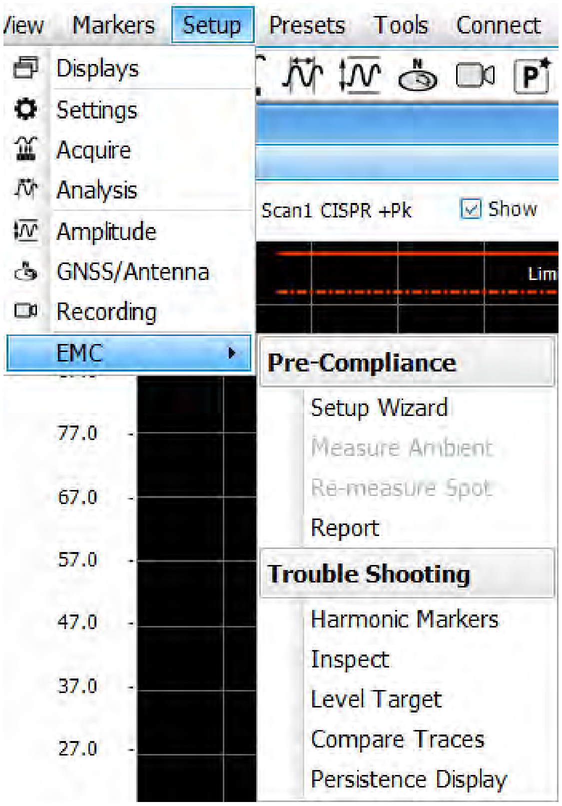
1. Double click 

 on the Desktop. This EMCVu icon will open the analyzer defaulted to the EMC Analysis display with the Setup Wizard open.

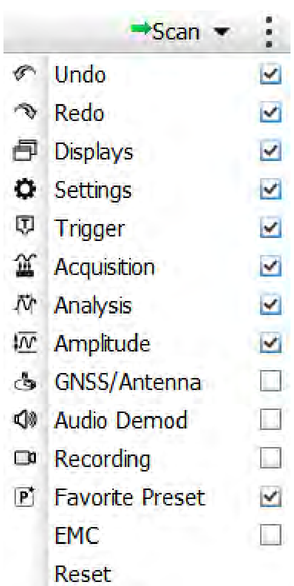
   Tip: EMCVu is best viewed in 1920x1080 or 1920x1200 resolution.

2. Double click the RSA icon on the Desktop. This icon will open the analyzer.

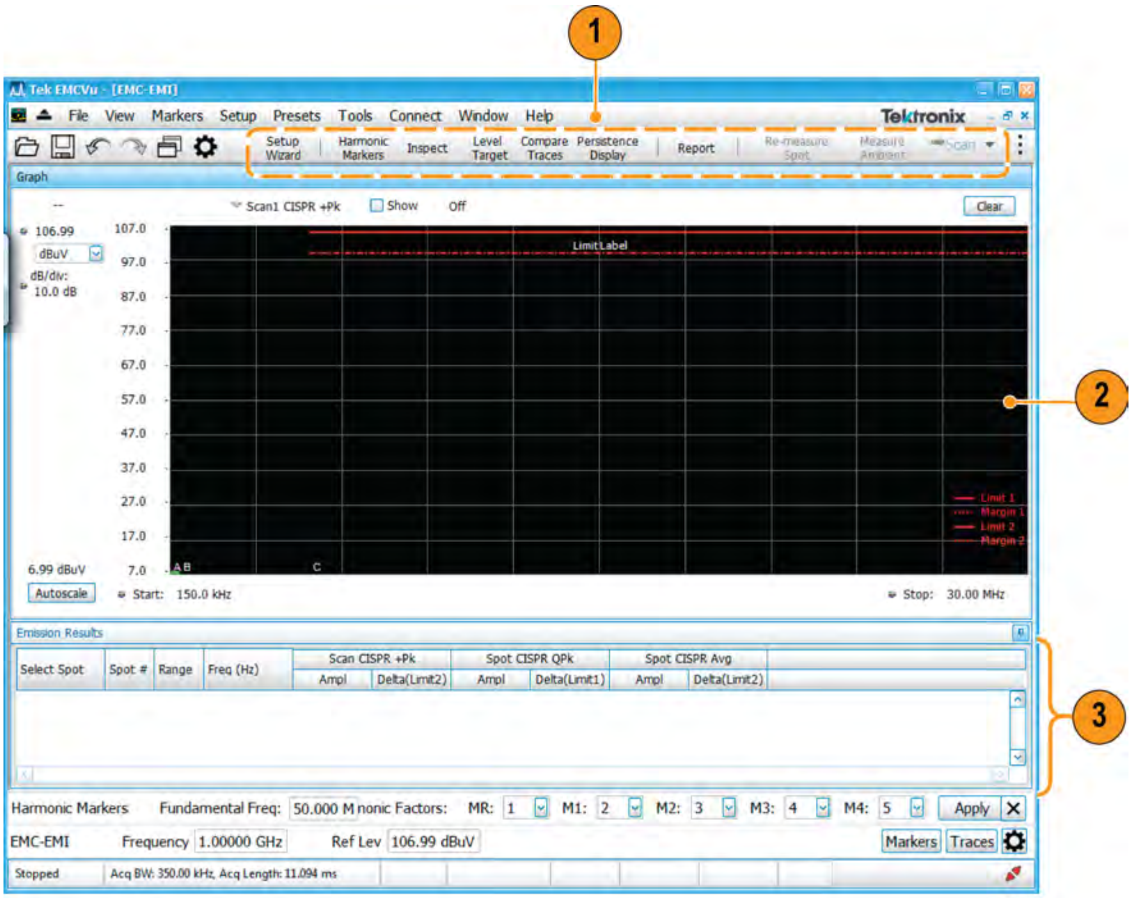
   a. Select **Setup** from the Main menu bar and select EMC. This allows you to access various EMC functions. To get started with an EMC pre-compliance test, select **Setup Wizard**. You can read more about the EMC Project Setup Wizard *here*.



b. Click the icon ⋮ on the *Favorites bar* and check the box next to EMC. This will place the EMC menu options on the Favorites bar for quick access.



Elements of the EMC Analysis window



0720-016

Element	Description
1	These menu items on the Favorites bar are EMC Analysis specific. You can add or remove these items from the *Favorites bar* by clicking the ⋮ icon (located at the far right end of the bar) and then checking or unchecking the box next to **EMC**.
2	The graph of the currently selected display appears here.
3	Emissions results will appear here.

Pre-compliance

The Tektronix EMC analysis option allows you to perform pre-compliance testing of your equipment to detect possible emissions at an early stage, reducing the chances of failure at the test house. The EMC software can be accessed through the analyzer application interface or though the EMCVu icon on your Desktop. This analysis option provides the following four key features to perform pre-compliance testing.

1. *Quick start* guide on how to perform a pre-compliance test.
2. *Setup Wizard*
    - *Accessories tab*
    - *Ranges & Limits tab*
3. *Measure ambient* on page 357

4. *Re-measure spot* on page 358
5. *Reports* on page 356

CISPR (International Special Committee on Radio Interference) detectors are needed when performing EMC testing of electronic devices. Specifically, levels of EMI need to be under a reference while being measured with a specified CISPR detector. These detectors are defined in Publication 16 of CISPR. Option SVQPNL-PC and SVPQFL-PC adds these CISPR detectors and filters so you can perform the required EMI measurements needed for your DUT (Device Under Test). These detectors can be invoked in the Spectrum display or in the EMC–EMI display. Note that these detectors process the signal over a long period of time (2 seconds), so it is expected that the user interface may seem less responsive during that time.

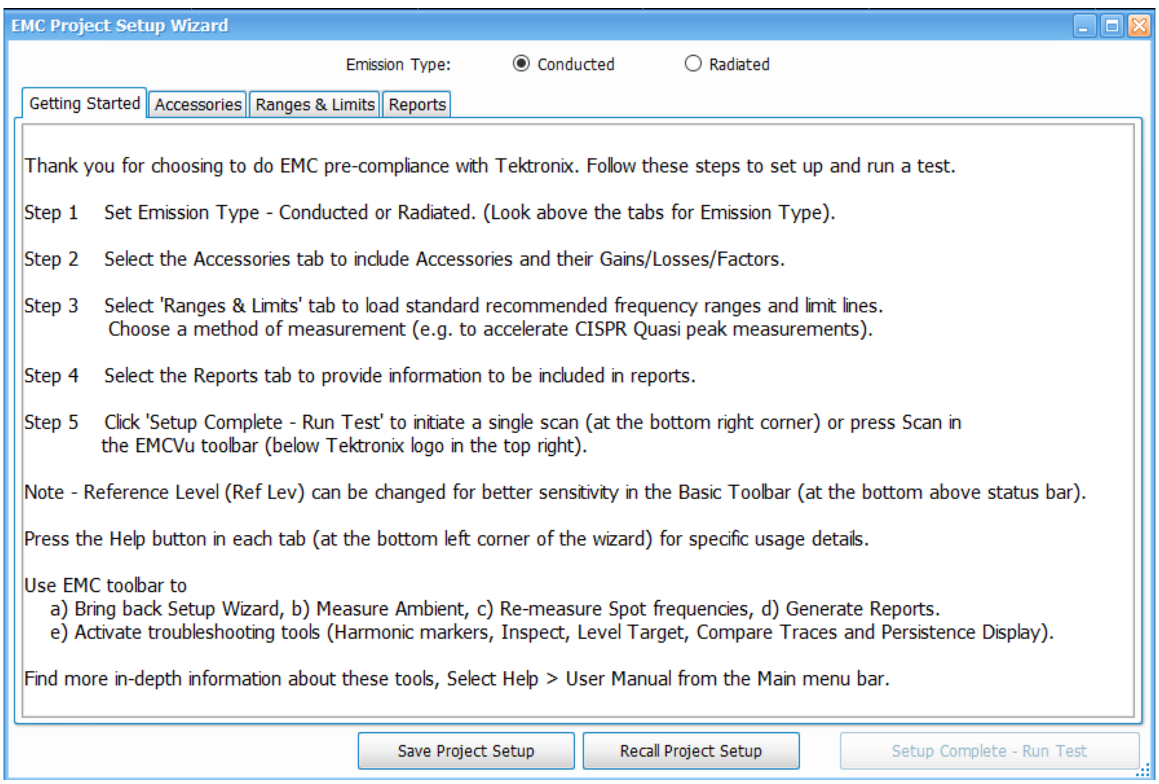
Tip: Click here to see *How to open EMCVu* on page 340 (EMC Analysis).

Tip: The EMC Project Setup Wizard contains a subset of available EMC settings. See the *EMC-EMI settings* on page 376 topic for information about those additional settings.

How to perform an EMC pre-compliance test

1. Double click 

on the Desktop. This EMCVu icon will open the analyzer application defaulted to the EMC Analysis view with the Setup Wizard open on the Getting Started tab.

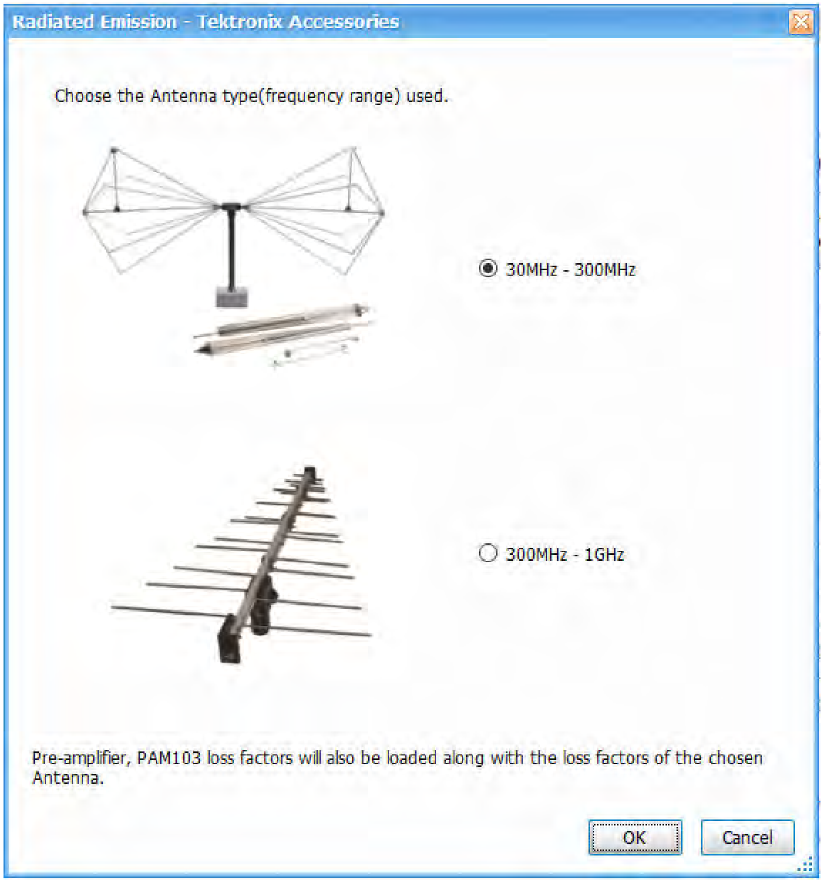


2. Select **Conducted** or **Radiated** as the Emission Type. This selection is located at the top of the Setup Wizard window.
3. Select the Accessories tab.

4. Click the **Load Tektronix Provided Accessories Gains/Losses** button.
5. If you selected **Conducted** emissions, a window will appear prompting you to turn on the limiter in LISN. When you have done this, click **OK** to continue.

LISN and cable will be loaded for the conducted pre-compliance setup. If you need to add other accessories, do so now. View the *Add/edit individual accessories* or *Load accessories from a saved file* on page 351 topics for detailed instructions.

6. If you selected **Radiated** emissions, a window will appear prompting you to select the frequency range of the antenna. When you have done this, click **OK** to continue.



Antenna, Cable, Pre-Amplifier, and Cable will be loaded for the radiated pre-compliance setup. If you need to add other accessories, do so now. View the *Add and/or edit individual accessories* on page 349 or *Load accessories from a saved file* on page 351 topics for detailed instructions.

7. Select the **Ranges & Limits** tab. View the *Load from Standard* on page 352 and *Choose a measurement method* on page 353 topics to read about how to use this tab.
8. Select the **Reports** tab and select the information to be contained in the report. View the *Reports* on page 356 topic for details about how to do this.
9. Click the **Setup Complete– Run Test** button to initiate a single scan.
10. If desired, you can change the Reference Level for better sensitivity. In general, you can set the reference level based on the largest signal of interest.

    For example, for a 50 dBuV reference level, the maximum emission level that can be measured is 55 dBuV (5 dB over-scale). If the signal of interest is lower, then the reference level can be adjusted accordingly. Emission levels that are approximately 10 dB higher than the noise level can be measured accurately.

    The noise level can be easily measured by terminating the input to the LISN/Antenna or removing the EUT and other sources of EMI from the test setup. The noise floor has to be measured with the same RBW that is used to measure emission level (recommended by the standard). For example, if the noise floor is measured at -5 dBuV for 120 kHz RBW, then emission levels at 5 dBuV or higher can be accurately measured.

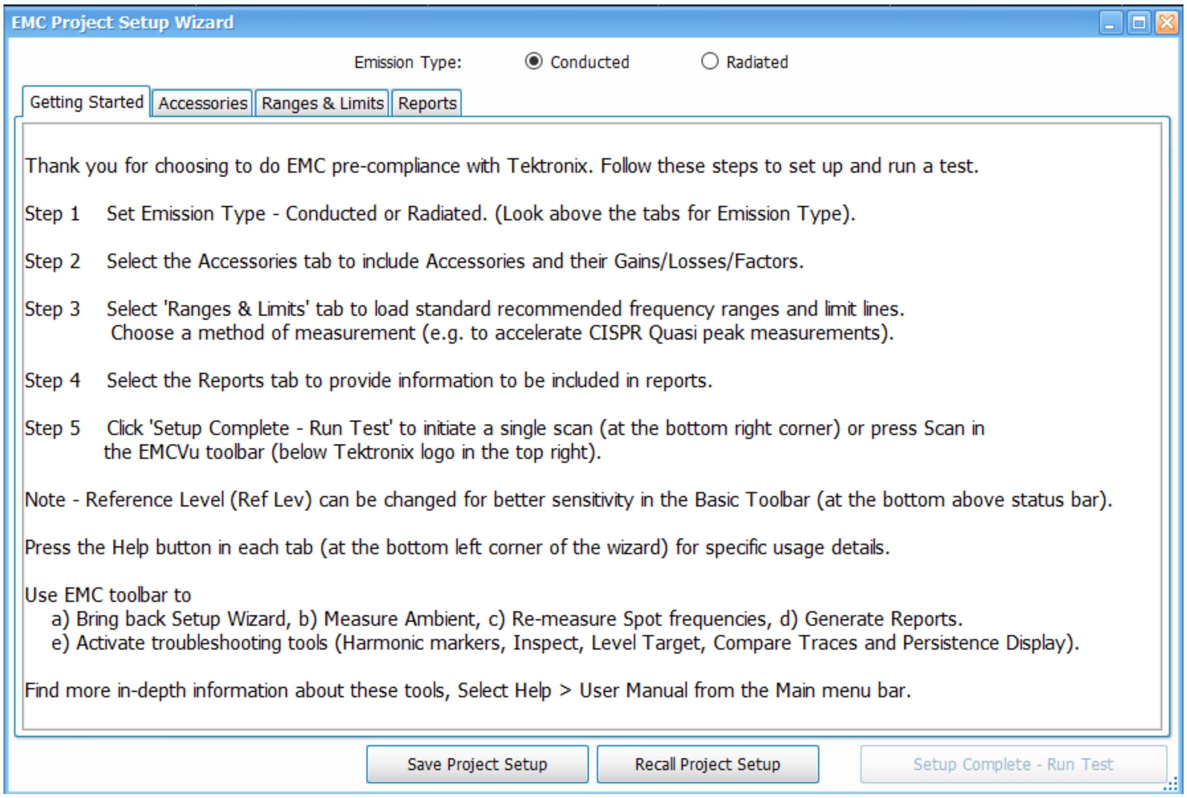
Tip: Read about troubleshooting tools and displays in the *Troubleshooting* topic.

Tip: To access more *EMC settings*, click the icon or select **Setup > Settings** from the Main menu bar when the *EMC-EMI display* on page 371 is selected.

Tip: The EMC Project Setup Wizard contains a subset of available EMC settings. See the *EMC-EMI settings* on page 376 topic for information about those additional settings.

EMC Project Setup Wizard

The EMC Project Setup Wizard opens on the Getting Started tab. The content on the Getting Started tab leads you through a series of well-defined steps to set up and perform an EMC pre-compliance test. The other tabs, buttons, and settings of the Setup Wizard allow you to select accessories, set ranges and limits, create reports, and perform other tasks, as shown in the following table.



Tip: EMCVu is best viewed in 1920x1080 or 1920x1200 resolution.

Tip: The EMC Project Setup Wizard contains a subset of available EMC settings. See the *EMC-EMI display settings* topic for information about those additional settings.

Setting/Tab	Description
Emission Type	Allows you to select the emission type: Conducted or Radiated.
Getting Started	Guides you through a pre-compliance test.
Accessories	Allows you to specify accessory related settings.
Ranges and Limits tab on page 351	Allows you to specify range and limit related settings for comparison, choose measurement modes, and load standard recommended values.
Reports on page 356	Allows you to specify the details to be included in the test report.

Table continued…

Setting/Tab	Description
Help	All of the Setup Wizard tabs, except Getting Started, have a Help button. Clicking this button opens a Help file with information related to the currently active tab. For more in-depth information about the EMC Analysis displays, settings, and functionality, select Help > User Manual from the Main menu bar in the analyzer application.
Setup Complete — Run Test	Allows you to begin a scan, initiating the test run.
Save Project Setup	Allows you to save all of the Setup Wizard settings as an EMC project setup file.
Recall Project Setup	Allows you to recall a saved EMC project setup.

Tip: The Setup Wizard will open every time the EMC-EMI display is launched. This behavior can be suppressed from the Prefs tab in the EMC Settings control panel by disabling **Show Setup Wizard on EMC-EMI display startup**.

Accessories tab

This tab in the EMC Project Setup Wizard lists, and allows you to set up, the accessories required for the test. You can also view a graph showing the combined impact of accessories gains and losses. The final measurement reading is corrected based on these accessory contributions before it is shown in the display. The correction is calculated by negating the combined impact of all of the accessory gains/losses you entered.

Tip: The EMC Project Setup Wizard contains a subset of available EMC settings. See the *EMC-EMI settings* on page 376 topic for information about those additional settings.

Tip: Read more about the plot on this tab in the *Combined impact of gains/losses (view in plot)* topic.

You can load accessories one of the following ways:

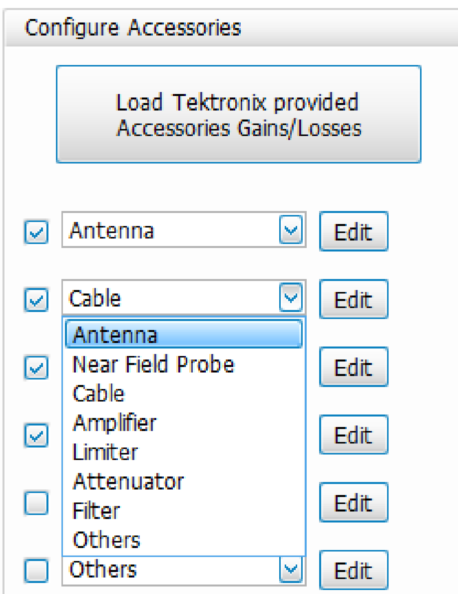
- Use the *Load Tektronix provided Accessories Gains/Losses* button.
- Manually *Add and/or edit individual accessory details*.
- Use the *Load All Accessories* button.

More topics about setting up accessories and related information:

- *Accessories setup*
- *Combined impact of gains/losses* on page 384
- *Calculation of combined impact of accessories gains/losses* on page 386
- *Edit accessory contributions*
- *External correction in DPX*
- *Loading accessories from a file*
- *Available accessories in the drop-down lists*
- *Two types of mismatch issues when recalling the csv file*
- *Changing accessory details*

Load Tektronix provided accessories gains/losses

1. Select either **Conducted** or **Radiated** as the Emission Type (top of window, above the tab headings).
2. Click the **Load Tektronix Provided Accessories Gains/Losses** button.



3. For Conducted emissions:

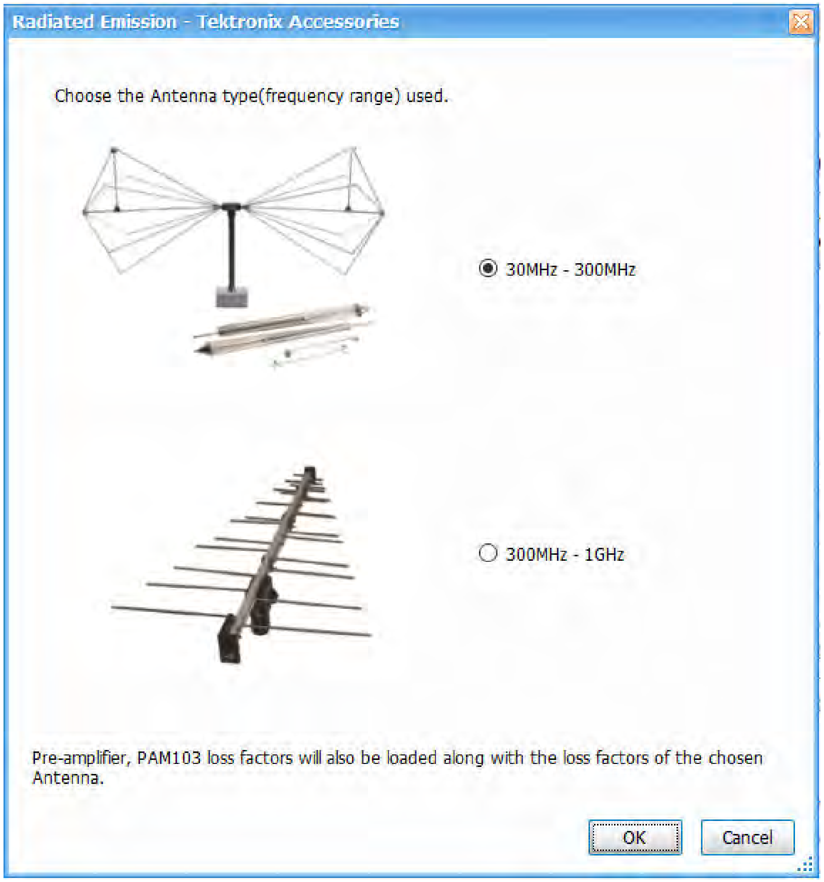
   You will be prompted to turn on the limiter in LISN. The default contributions loaded for the conducted pre-compliance setup are LISN and cable. However, you can add any other accessories as needed.

4. For Radiated emissions:

   The default contributions loaded for the radiated pre-compliance setup are Antenna, Cable, Pre-Amplifier, and Cable. However, you can add any other accessories as needed.

You will also be prompted to choose the antenna that is being used for the test. The biconical antenna is used for tests between 30 MHz and 300 MHz. The log periodic antenna is used for tests between 300 MHz and 1 GHz. Depending on the range of the test, you can make the choice and the contribution due to those set of accessories will be loaded.

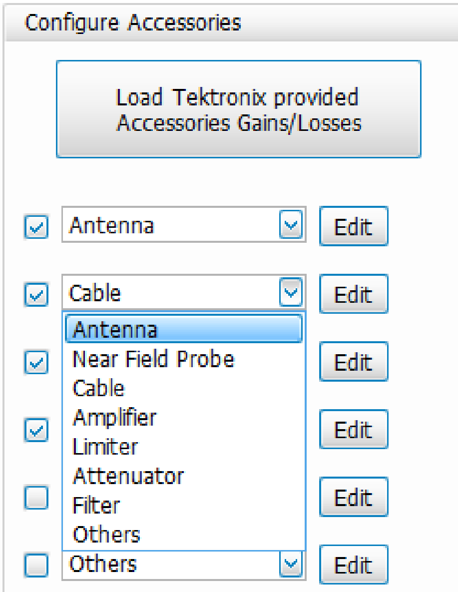
The parameters loaded for Cable are those of the *CABLE-1M* (1 meter) cable. If you are using a 3 m or 5 m cable, please load the appropriate file from the *C:\RSA5100B Files\EMC Accessories* folder.



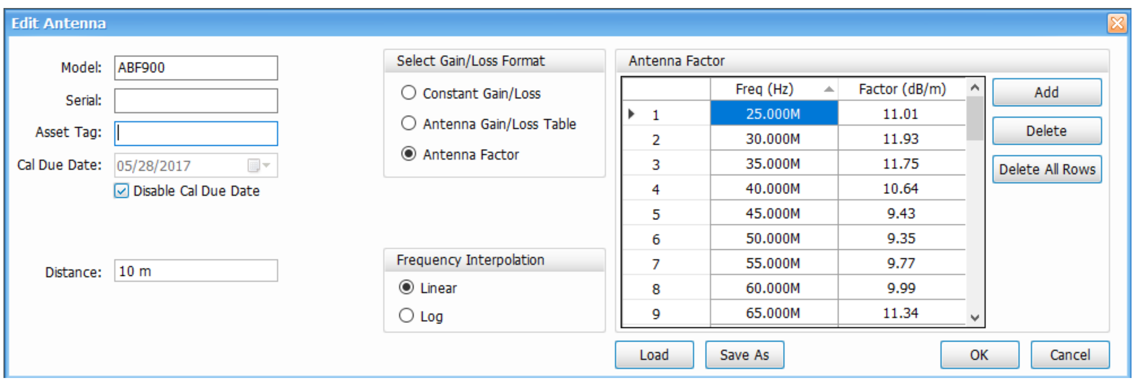
Tip: Read more about editing accessories in the *Accessories tab* and *Accessories setup* topics.

Add and/or edit individual accessories

1. To add an accessory, click on the arrow next to an accessory field and select from the drop down list. The list is dependent on the selected emission type (Conducted or Radiated).



2. To edit the details of an accessory, click the **Edit** button next the accessory you want to edit. A window will appear containing the parameters of the accessory.



3. Edit the desired parameters. You can edit the following:
   - Model number
   - Serial number
   - Asset tag
   - Calibration due date
   - Distance (for Antenna)
   - Gain/Loss format
     - Constant gain/loss[2]
     - Antenna gain/loss table[2]
     - Antenna factor
   - Frequency interpolation (Linear or Log)
4. Click the **OK** button to close the edit window and go to another accessory.
5. Edit any other accessories, if needed.

[2] Values are entered in dB with gain represented as positive values and loss as negative. For antennas, either isotropic gain information is entered in dBi or antenna factors in dB/m.

6. Click the **Save All Accessories** button to save the updated details of all edited accessories to a file.
7. Click the **Load All Accessories** button to load the updated accessories to the current setup.

Tip: Read more about editing accessories in the *Accessories tab* and *Accessories setup* on page 378 topics.

Load accessories from a saved file

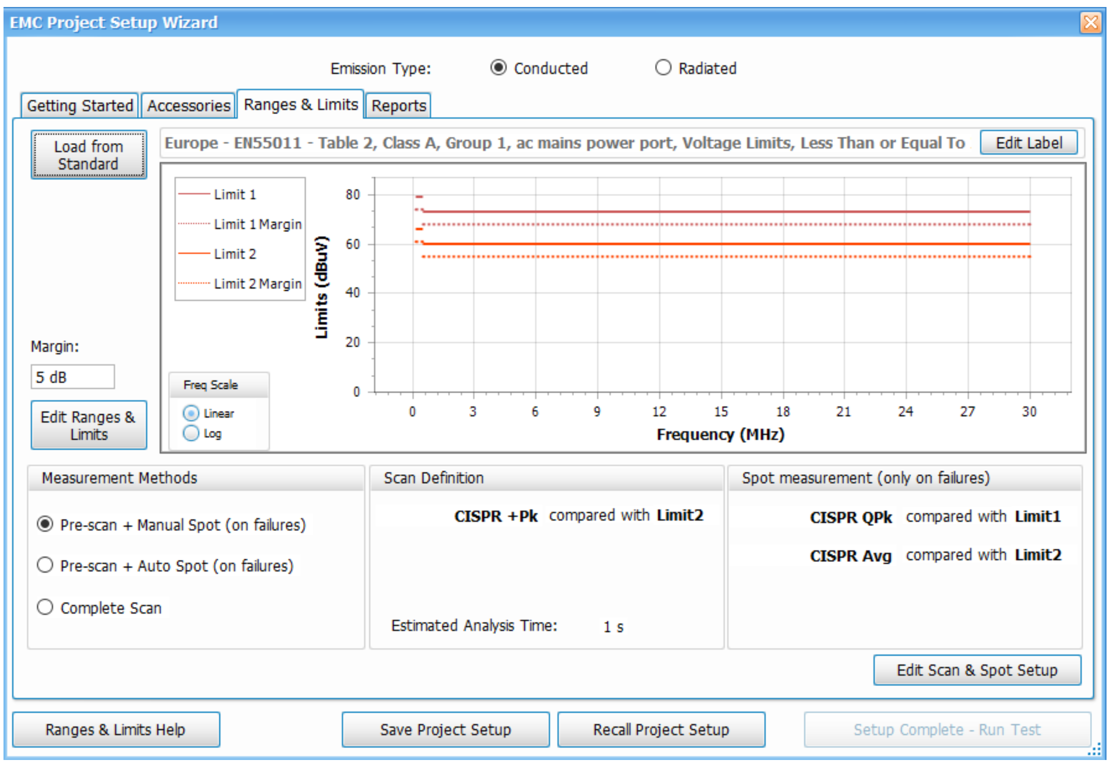
1. Click the **Load All Accessories** button to load accessories from a saved setup file.

Note: The parameters loaded for Cable are those of the *CABLE-1M* (1 meter) cable. If you are using a 3 m or 5 m cable, please load the appropriate file from the C:\RSA5100B Files\EMC Accessories folder.

Tip: Read about the combined impact of accessories and accessories setup information in the *Accessories setup* on page 378 topic.

Ranges and Limits tab

The Ranges and Limits tab of the EMC Project Setup Wizard allows you to specify the parameters that control the EMC-EMI measurement. You can:

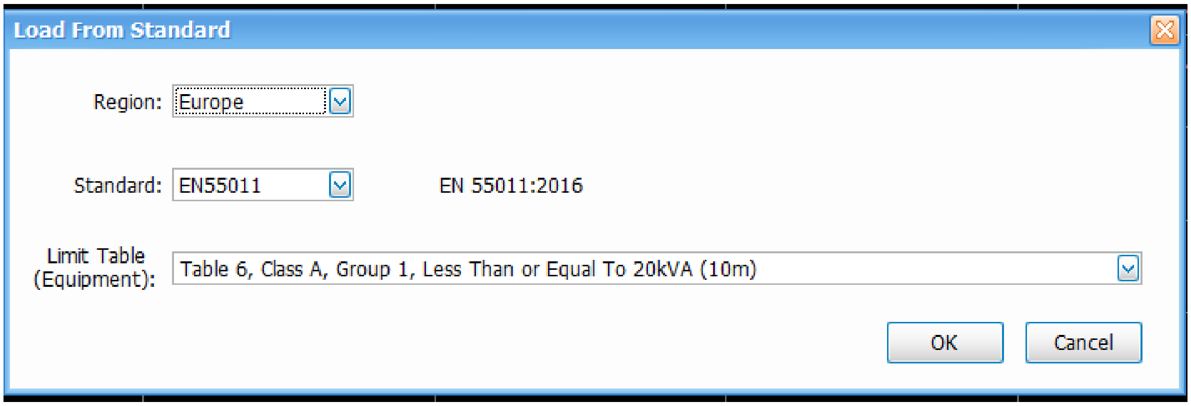


- *Load from Standard*
- *View Ranges and Limits plot and edit label*
- *Edit Ranges and Limits* on page 352
- *Choose a measurement method* on page 353
- *Edit Scan and Spot Setup* on page 355

Tip: The EMC Project Setup Wizard contains a subset of available EMC settings. See the *EMC-EMI settings* on page 376 topic for information about those additional settings.

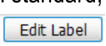
Load from Standard

Click the **Load from Standard** button on the Ranges and Limits tab in the EMC Project Setup Wizard to load from a standard based on the region selected. The following window will appear from which you can make selections.



- This window allows you to choose the region for which your product is intended and then a standard from a list of standards in that region. You will need a copy of the standard document (the version number of the standard is mentioned as you make a choice of the standard from the drop down).
- The various frequency ranges / limit line tables provided from the standard will be listed in a drop down for selection.
- Once the appropriate standard is loaded, you will see the ranges and limits recommended by the standard in a plot. The detector choice recommended by the standard is also shown in the Scan Definition and Spot Setup below the plot. The limit line against which the detector results will be compared is also shown as a mapping against each detector choice.
- A margin also can be set (shown by the dotted line) and this is applicable to all limit lines. The Margin setting is located to the left of the plot.
- Some tables in standards recommend separate limit lines for each detector choice and all of them will be loaded.

View Ranges and Limits plot and edit label

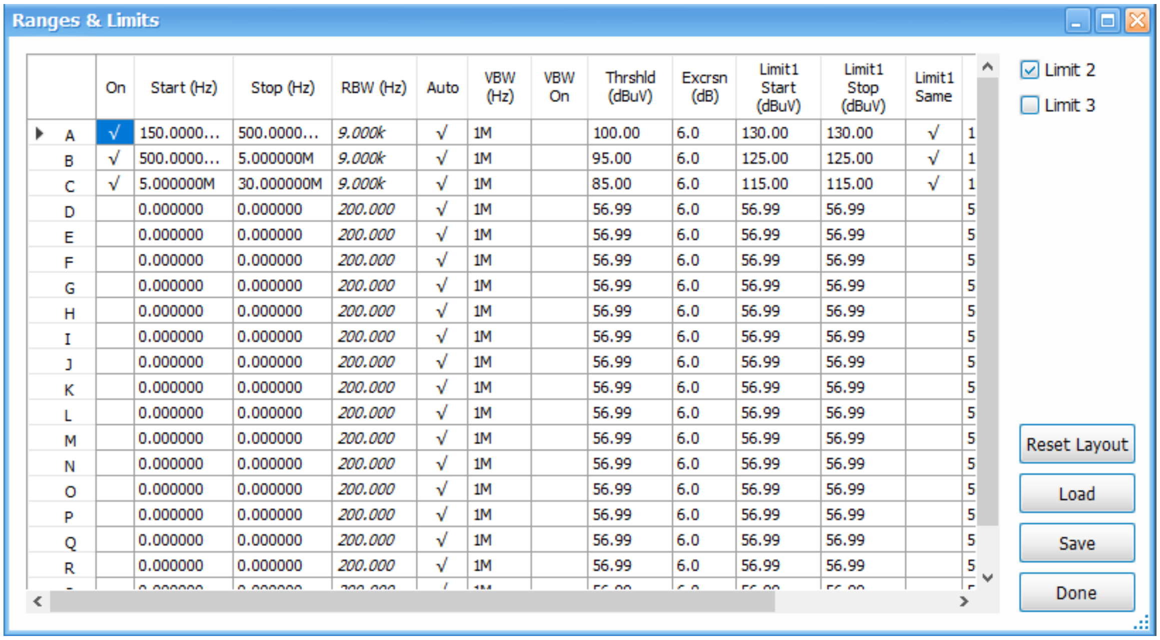
- The Ranges and Limits loaded from standard can be seen in the plot in the Ranges & Limits tab of the EMC Project Setup Wizard.
- When loaded from standard, the limit label is set appropriately based on the standard and limit table choice. However, this can be edited by clicking 

 (Edit Label button).
- The Limits are shown in different colors when more than one limit line is selected. This is indicated in the Limit legends.
- Margin for every limit line is shown in dotted form for every limit in the respective color.
- Frequency scale can be viewed in Linear or Log.

Edit Ranges and Limits

Ranges and limits can be customized from the Ranges & Limits tab of the EMC Project Setup Wizard. If you want to customize the limit lines loaded from a standard or you want to create your own limit lines, do as follows.

1. Click the **Edit Ranges and Limits** button to left of the plot. The following expanded table will appear.



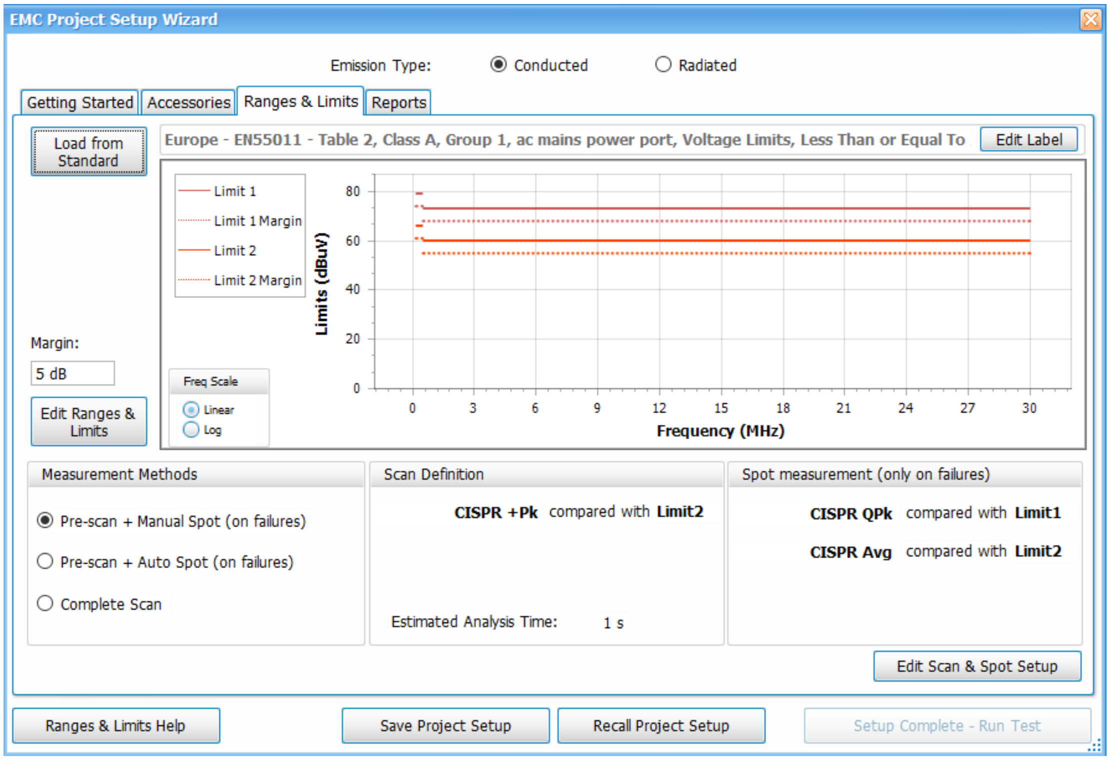
	On	Start (Hz)	Stop (Hz)	RBW (Hz)	Auto	VBW (Hz)	VBW On	Thrshld (dBuV)	Excrsn (dB)	Limit1 Start (dBuV)	Limit1 Stop (dBuV)	Limit1 Same	
A	√	150.0000...	500.0000...	*9.000k*	√	1M		100.00	6.0	130.00	130.00	√	1
B	√	500.0000...	5.000000M	*9.000k*	√	1M		95.00	6.0	125.00	125.00	√	1
C	√	5.000000M	30.000000M	*9.000k*	√	1M		85.00	6.0	115.00	115.00	√	1
D		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
E		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
F		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
G		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
H		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
I		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
J		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
K		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
L		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
M		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
N		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
O		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
P		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
Q		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5
R		0.000000	0.000000	*200.000*	√	1M		56.99	6.0	56.99	56.99		5

2. Edit the start and stop frequencies, RBW and VBW settings, and limit values.

   As many as 3 limit lines can be included. The limit lines will be shown with individual color codes and the corresponding margin lines shown in same color but in dotted form. The margin control is only one control applied in common to all limit lines.
3. Check to see that the customized limit lines appear in the plot.
4. Save frequency ranges and limit lines by clicking the **Save** button. You can also load from these saved files later.

Choose a measurement method

Once the desired ranges and limits are loaded, you can decide to do the measurement in one of the following three measurement methods, which are available for most standards.



- **Pre-scan + Manual Spot**: A quick pre-scan followed by choosing spots from results table and re-measuring them with detectors recommended by the standard (or that of your choice).
- **Pre-scan + Auto Spot**: A pre-scan followed by an Automated re-measurement for a chosen number of spots.
- **Complete Scan**: A complete scan with detectors recommended by the standard - could be time consuming if detectors such as CISPR Quasi Peak or CISPR Avg are chosen.

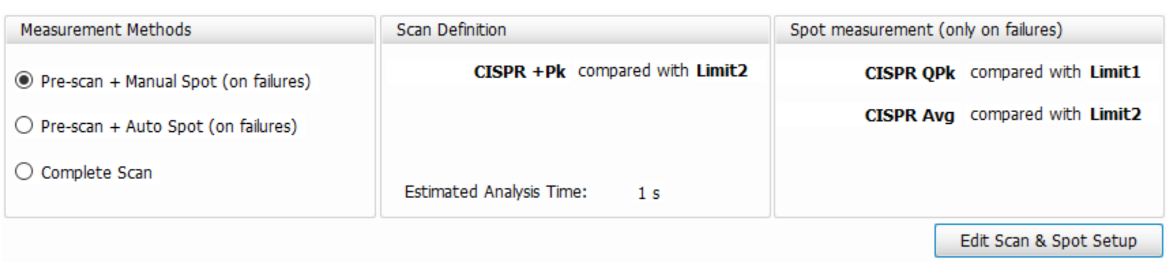
⚠ **Tip:** You can read more about measurement methods and how they can be set from the Ranges & Limits tab in the EMC Settings control panel in the *Measurements* on page 393 topic.

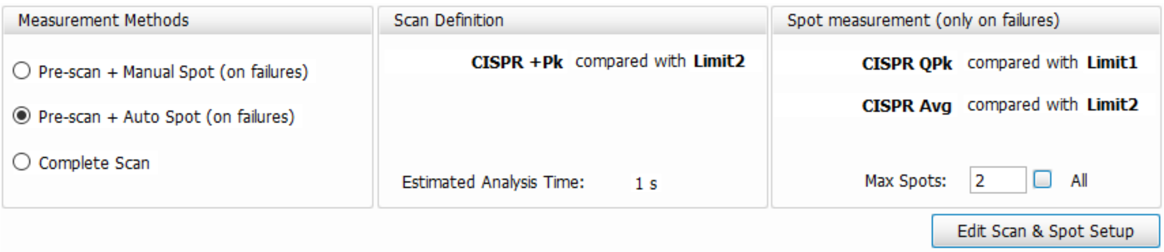
The mapping of limit lines to the detectors is also shown under Scan Definition and Spot measurement. This tells you which detector will be used for Scan and Spot measurements and which limit line will the Scan or Spot results be compared against.

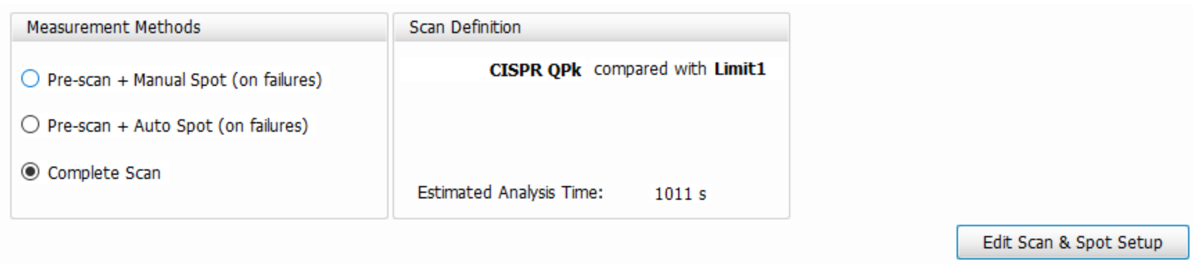
The Estimated Analysis Time is shown to give an idea of how much time the Scan is expected to take for the detectors chosen. This Estimated time is based out of the choice of detectors and the span of the actual scan measurement and is calculated under ideal conditions for a machine with 16 GB RAM. Actual time taken for measurement could vary.

This estimated analysis time could be higher if detectors such as CISPR Quasi Peak are used for a larger span range.

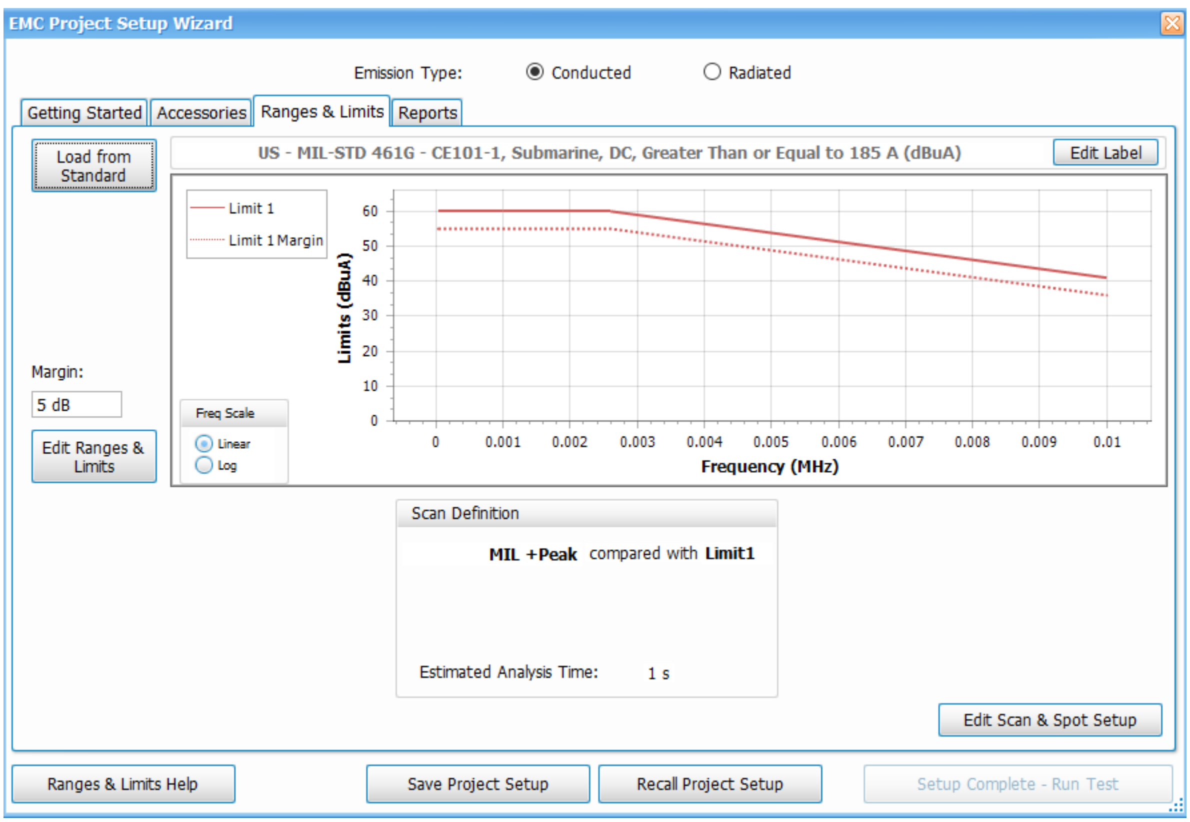
The following three images show how the Scan Definition and Spot Measurement information may vary depending on the selected measurement method.







The three measurement methods might not be shown for some standards if they do not recommend detectors such as CISPR Quasi Peak (for example, Mil/Gov 461G and DEF STAN). This is because the scan itself is done with CISPR Peak detector which can be done faster and there is no need for a Pre-scan followed by spot measurements in such a case.

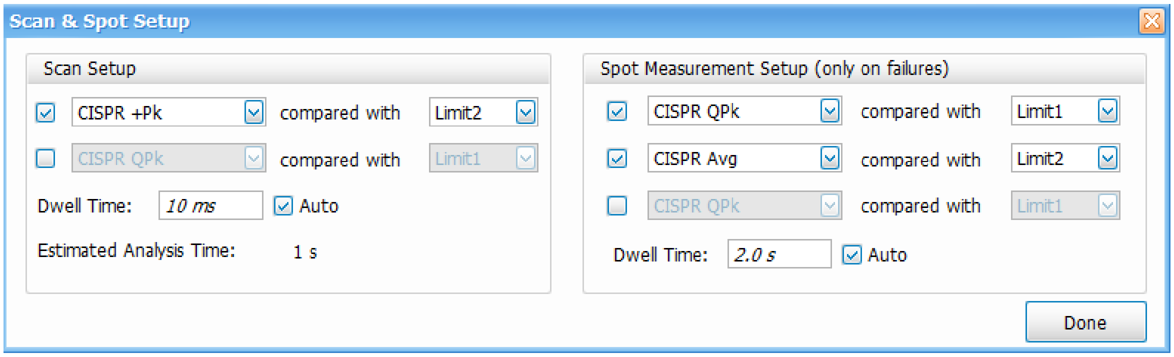


Edit Scan and Spot Setup

Edit Scan and Spot Setup allows you to modify any detector choice or dwell time. You can also do the limit mapping appropriately.

- Choose the appropriate detector for scan and spot re-measurement
- Set dwell time
- Choose the limit line mapping

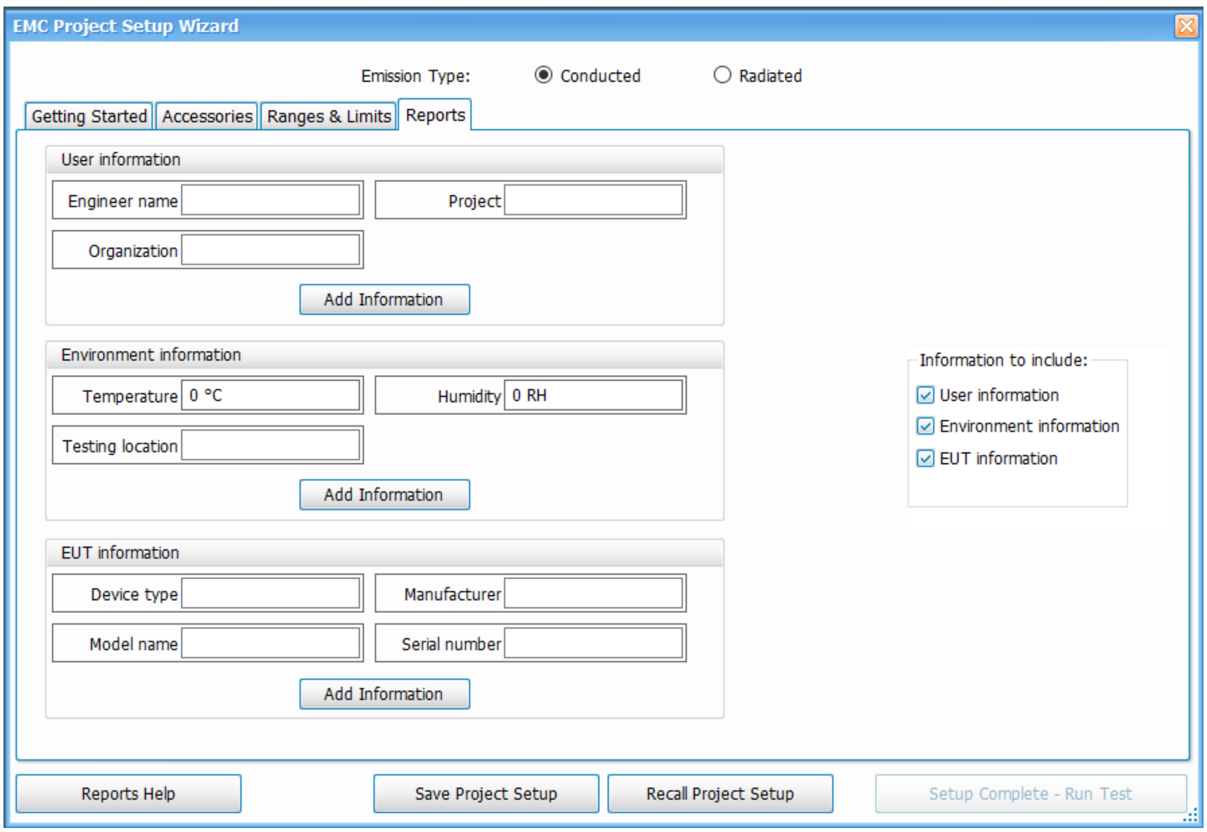
By default, the standard recommended limit line is mapped to appropriate detectors.



Tip: You can read more about scan and spot setup in the *Edit Scan and Spot Setup* on page 355 topic.

Reports

The Reports tab in the EMC Project Setup Wizard allows you to select the information you want to include in a report.

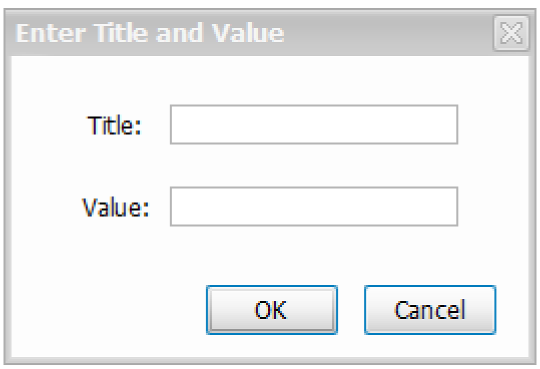


Item	Description
User information	Includes user information in the report: Engineer name, Project name, and Organization name. Empty fields will not be included in the report. If you do not want to include a default field, you can leave it empty.

Table continued…

Item	Description
Environment information	Includes environment information in the report: Temperature, Humidity, and Testing location. Empty fields will not be included in the report. If you do not want to include a default field, you can leave it empty.
EUT information	Includes equipment under test (EUT) information in the report: Device type, Model Name, Manufacturer name, and Serial number. Empty fields will not be included in the report. If you do not want to include a default field, you can leave it empty.
Add Information	New information details can be added to any of the three information areas by clicking an Add Information button in the associated area. You can then providing details such as title and value of the new item in the Add Information window.
Information to include	Select which information areas to include in a report from this list. Check a box to include the associated information. Uncheck a box to leave out the associated information.

1. Check the boxes in the **Information to include:** area of the Reports tab that are next to the information you want included in the report.
2. Edit the information fields in the User, Environment, and EUT (equipment under test) areas, as needed.
3. If needed, click the **Add Information** button in the desired information area to add an additional field to the selected information area.



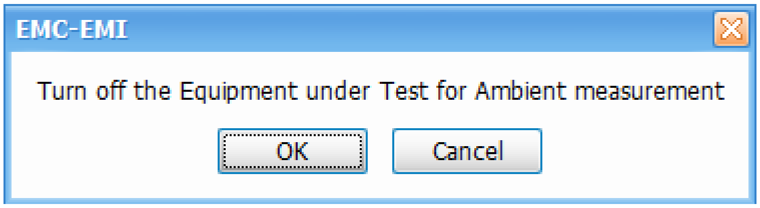
Tip: Read the *Generating and saving reports* on page 359 topic for detailed information about saving, generating, viewing, and exporting reports.

Tip: The Setup Wizard will open every time the EMC-EMI display is launched. This behavior can be suppressed from the *Prefs tab* in the EMC Settings control panel by disabling **Show Setup Wizard on EMC-EMI display startup**.

Measure ambient

An Ambient scan analysis can be done to quickly check if the Spots (emission at specific frequencies) obtained are due to ambient emissions or the actual equipment. Perform this ambient scan analysis procedure to quickly check if the listed Spots are due to ambient interference or the equipment.

1. Select **Setup > EMC > Measure Ambient** or click **Measure Ambient** from the EMC related items on the *Favorites toolbar*. Alternatively, you can recall a trace saved from the Ambient tab in the EMC Settings control panel.
2. Follow the prompt that appears and turn off the Equipment under Test (EUT) or completely remove it from the setup.



3. Click the Ambient tab in the EMC Settings control panel and set Detector, Dwell Time, and Delta Threshold appropriately.
4. Return the EUT to the setup, if removed, and turn it on.
5. Perform a scan with the same detector set in the Measurement Type tab.
6. View the Ambient trace in the graph.

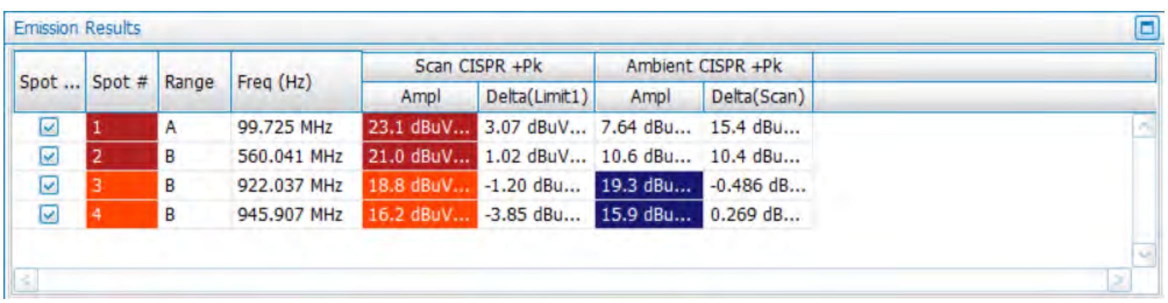
Tip: Read about comparing ambient scan results in the *Comparing ambient scan results* on page 358 topic.

Tip: See the *Ambient tab* topic for more information about ambient settings.

Comparing ambient scan results

If you performed an ambient scan with the EUT turned on and the results table is populated with Spots (frequencies that have failed the threshold or limit line), then comparison of those results with an ambient scan with the EUT off can be done. The comparison between the Ambient trace (the scan with the EUT off) and Scan trace (the scan with the EUT on) is done at each failing frequency (Spot) in the Emission Results table.

- Comparison of results is done only at all failing frequencies. The Delta difference between the Ambient trace and the Scan trace is shown.
- The comparison of results is done only if the detector type for Scan and Ambient match.
- This Delta difference is compared against the Delta threshold setting made in from the Ambient tab in the EMC Settings control panel.
- If the absolute difference between the Ambient trace and Scan trace is less than the delta threshold, then those cells are shown shaded in blue in the Emission Results table, as shown below. This means that the emission could be the result of the environment and not the EUT.


Emission Results

Spot ...	Spot #	Range	Freq (Hz)	Scan CISPR +Pk		Ambient CISPR +Pk	
				Ampl	Delta(Limit1)	Ampl	Delta(Scan)
☑	1	A	99.725 MHz	23.1 dBuV...	3.07 dBuV...	7.64 dBu...	15.4 dBu...
☑	2	B	560.041 MHz	21.0 dBuV...	1.02 dBuV...	10.6 dBu...	10.4 dBu...
☑	3	B	922.037 MHz	18.8 dBuV...	-1.20 dBu...	19.3 dBu...	-0.486 dB...
☑	4	B	945.907 MHz	16.2 dBuV...	-3.85 dBu...	15.9 dBu...	0.269 dB...

Note: The Measure Ambient item in the Favorites toolbar will not be active if no instrument is connected or if no playback is selected.

Re-measure spot

Click **Setup > EMC > Re-measure Spot** or click **Re-measure Spot** from the from the EMC related items on the *Favorites toolbar*, to perform the spot re-measurement.

Spot re-measurement is performed on the selected spot (frequencies that have failed Threshold/Limit lines) from the Emission Results table with detectors recommended by the standard or detectors defined by you. These detectors could typically be detectors that require larger measurement/dwell time like CISPR Quasi peak.

Spot re-measurement is useful when you want to do a quick pre-scan with peak detectors and then apply detectors with larger dwell time only on those frequencies that have failed the Threshold or Limit line settings. It is also useful when the selected measurement method is Pre-scan + Manual Spot or Pre-scan + Auto Spot.

Emission Results

Spot ...	Spot #	Range	Freq (Hz)	Scan CISPR +Pk		Spot CISPR QPk		Spot CISPR Avg	
				Ampl	Delta(Limit1)	Ampl	Delta(Limit1)	Ampl	Delta(Limit1)
☑	1	A	99.725 MHz	23.1 dBuV...	3.07 dBuV...	15.1 dBuV...	-4.93 dBu...	7.86 dBuV...	-12.1 dBu...
☑	2	B	560.041 MHz	21.0 dBuV...	1.02 dBuV...	14.2 dBuV...	-5.77 dBu...	9.39 dBuV...	-10.6 dBu...
☑	3	B	922.037 MHz	18.8 dBuV...	-1.20 dBu...	5.15 dBuV...	-14.8 dBu...	-2.20 dBu...	-22.2 dBu...
☑	4	B	945.907 MHz	16.2 dBuV...	-3.85 dBu...	12.1 dBuV...	-7.91 dBu...	4.44 dBuV...	-15.6 dBu...

- Once the scan is done for the trace, failing frequencies are listed in the Emission Results table and you can choose the spot(s) which should be re-measured.
- You can choose the Spot(s) for performing spot measurements either from the plot or from the Emission Results table.
- The RBW for Spot measurement will be the same as that used by the pre-scan. This is because it would only be correct to compare scan and spot results when they are done with the same RBW.
- The detector choice, limit line for comparison and dwell time for spot measurement are based on the choices you made while using the Setup Wizard.
- You can also change the choice of detector(s) from the *Measurement Type* tab in the EMC Settings control panel. You can also choose up to 3 detectors to analyze these spots.
- The Limit lines for comparison and the dwell time also can be edited.
- The re-measured spot results are then shown in the Emission Results table and also compared with appropriate limit lines.

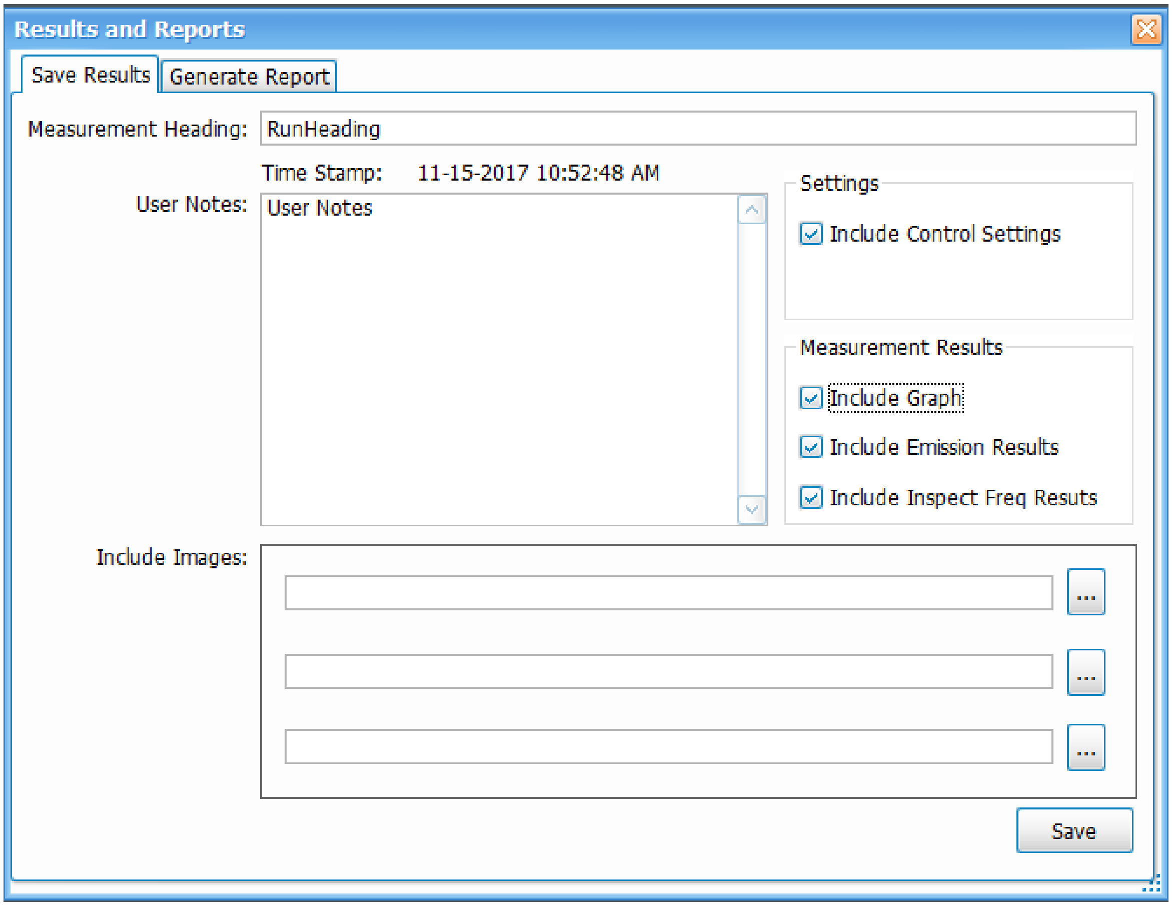
If the Measurement method chosen is Pre-scan + Auto Spot, then the Re-measure Spot step is automatically performed. You can set the maximum number spots to be automatically re-measured in the Measurement Type tab of the EMC Settings control panel. This option is visible only when the measurement method is Pre-scan + Auto Spot.

⚠ **Note:** The Re-measure Spot item on the Favorites toolbar will not be active when no device is connected or when no playback is selected.

Generating and saving reports

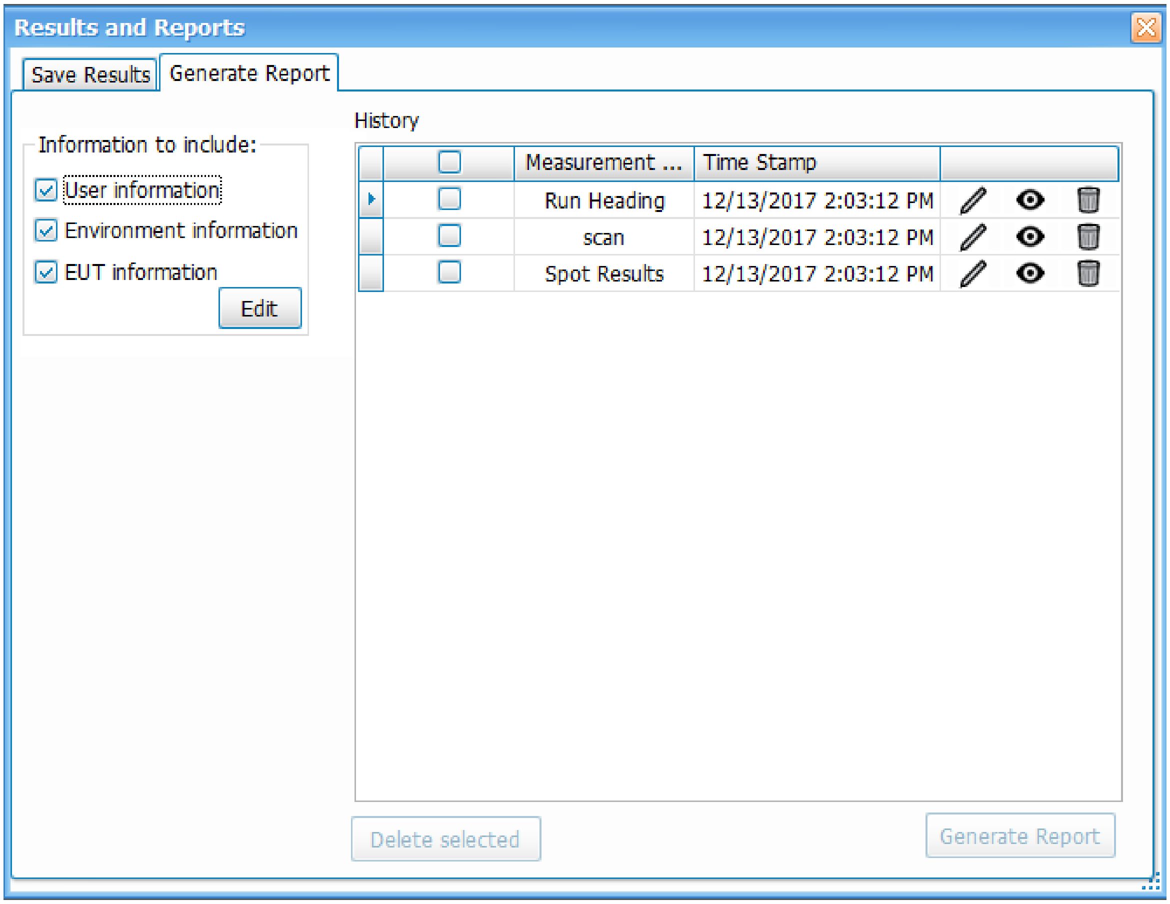
The Results and Reports window can be opened by selecting the Report (Report) icon from the EMC related items on the *Favorites toolbar*. This window has two tabs that allow you to save results, select what to include in a report, generate a report, export a report, and view a report.

Save Results tab

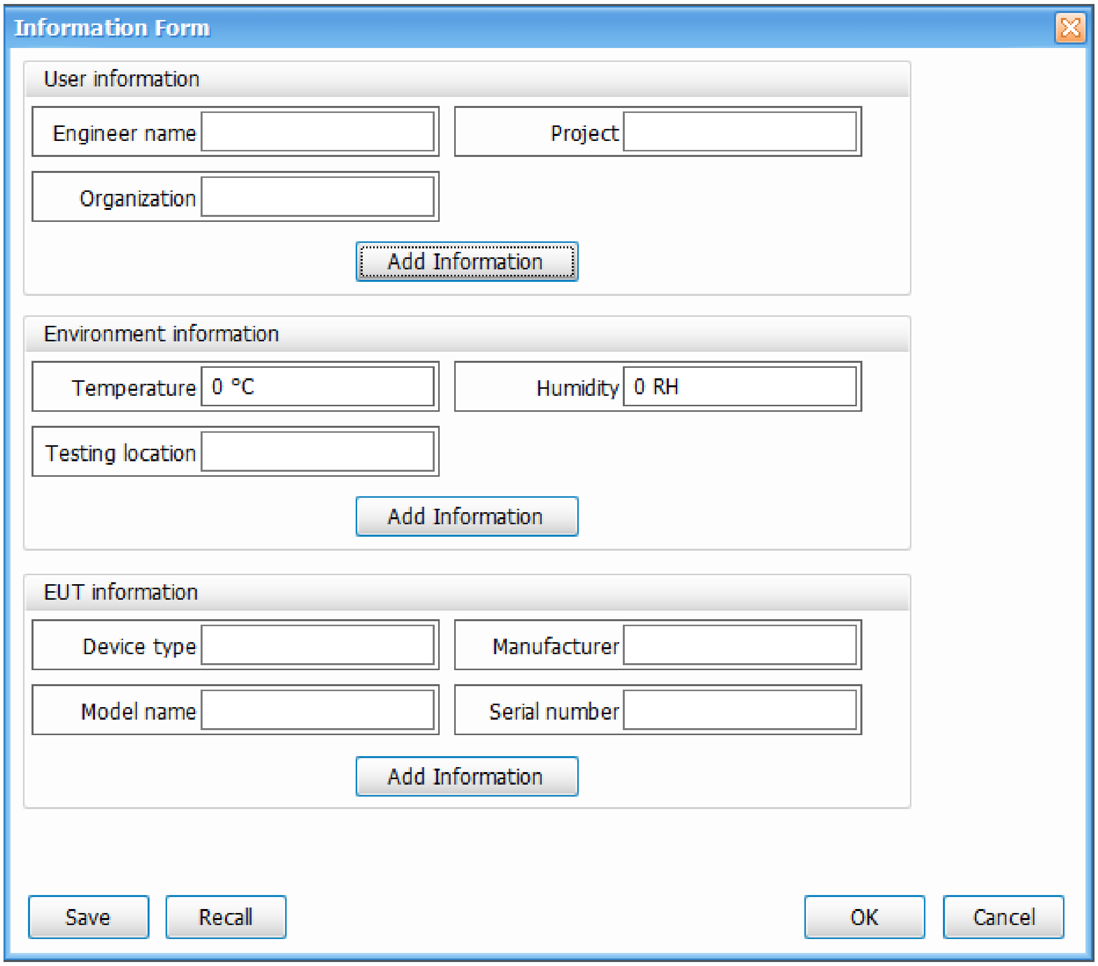


1. Fill in the Measurement Heading field.
2. Add any additional information related to the test in the User Notes field.
3. Check the **Include Control Settings** box to include the EMC Settings control panel settings in the report.
4. Check the **Include Graph** check box and the **Include Emission Results** check box to include plot results and emission results in the test report.
5. If available, check the **Include Inspect Freq Result** box to include Inspect results in the test report. This option is only available if an Inspect measurement is chosen.
6. Select and browse to include any images in the report. Select the image file and click **OK**.
7. Click **Save** in the Save Results tab. The view will then change to the Generate Report tab where you can proceed to generate the report.

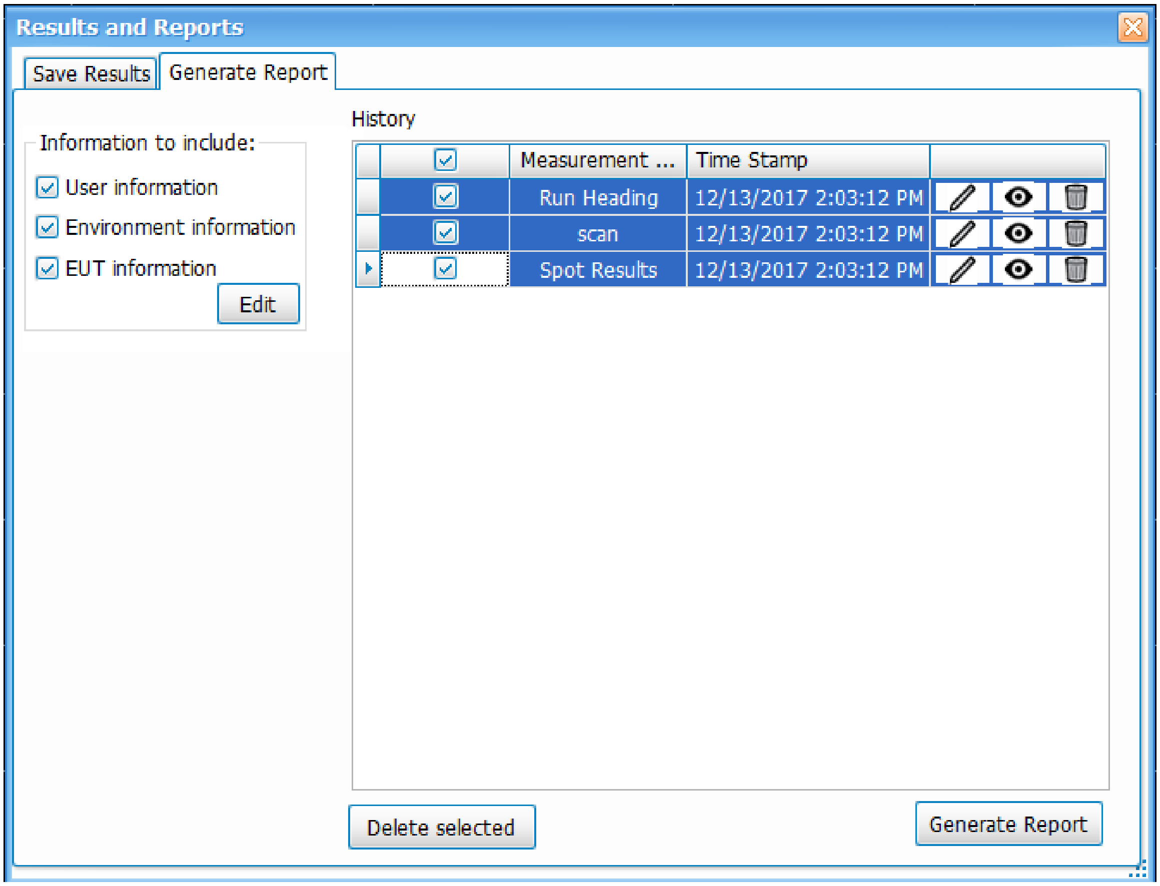
Generate Report tab



1. Select the details to be included in the report by checking or unchecking User Information, Environment information, and EUT information.
2. Click the **Edit** button to edit the information, as needed. The following window will appear.



3. Click the **Add Information** button in the desired information area to add an extra field or a parameter.
4. Click the **Save** button to save the information to a file for later recall. Or you can simply click the **OK** button to save the information for this report. The Information Form will close and you can then select your results.
5. Check the box next to the result(s) for which you want to generate a report. You can select more then one result if you want to include multiple measurement results in a single report.



6. Click the **Generate Report** button to generate a report.
7. A preview window of the generated report will open. This window allows you to navigate, print, bookmark, email, and export the report. A report can be exported in the preferred format (.pdf, .rtf, .xlsx, etc.) and saved locally for future use. Recommended file types are .pdf and .rtf.
8. To delete existing results from the History panel of the Generate Report tab, check the boxes next to the items you want to delete, and then click the **Delete selected** button. You can also use the edit, view, and delete icons next to a result to perform the related task.

EMC Troubleshooting

EMC testing with Tektronix provides you the following suite of troubleshooting tools and displays to help you debug problems faster.

Tools

- *Harmonic Markers* on page 364
- *Inspect* on page 364 (suspect frequencies)
- *Level Target* on page 367
- *Compare Traces* on page 368
- *Persistence Display* on page 370

Displays

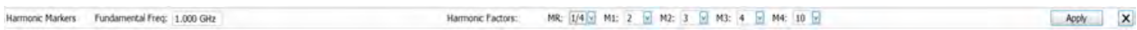
- *EMC-EMI*

- *DPX*
- *Spectrogram*
- *Spectrum*

Harmonic Markers

Harmonic markers tool allows you to place the markers at selected harmonic factors of a chosen fundamental frequency. It will be helpful for you to see if certain emissions that result out of a scan are caused due to the harmonics of a known fundamental frequency. The harmonic marker toolbar is used to define the fundamental frequency and harmonic factors.

1. Click **Setup > EMC > Harmonic Markers** from the Main menu bar, or click Harmonic Markers (Harmonic Markers) on the Favorites bar to open the Harmonic Markers toolbar.



2. Enter the Fundamental frequency in the Harmonic Markers toolbar. This is the base frequency on which harmonics are calculated.
3. Choose the harmonic factors from the drop down for the 5 markers (MR, M1, M2, M3, M4). The harmonic factors in the drop down can be 1/8, 1/4, 1/2, 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10.
4. Click **Apply** to place the markers at the appropriate harmonics.
5. Clicking **Apply** will also open the Marker table which will give information about the frequency at which these markers are placed and the amplitude values can be seen under the respective display column (for example, in the EMC-EMI if that is the active display).

Marker Readout Table

Marker	Frequency	Δ Frequency	Time	Δ Time	Amplitude	Δ Amplitude	Phase	Δ Phase	Distance	Δ Distance	EMC-EMI	Δ EMC-EMI
MR	0.000 Hz		-5.086 ms		106.99 dBm		0.0000 °		0.000 m		---	
M1	0.000 Hz	0.000 Hz	-5.086 ms	0.0000 s	106.99 dBm	0.00 dBm	0.0000 °	0.0000 °	0.000 m	0.000 m	---	---
M2	0.000 Hz	0.000 Hz	-5.086 ms	0.0000 s	106.99 dBm	0.00 dBm	0.0000 °	0.0000 °	0.000 m	0.000 m	---	---
M3	0.000 Hz	0.000 Hz	-5.086 ms	0.0000 s	106.99 dBm	0.00 dBm	0.0000 °	0.0000 °	0.000 m	0.000 m	---	---
M4	0.000 Hz	0.000 Hz	-5.086 ms	0.0000 s	106.99 dBm	0.00 dBm	0.0000 °	0.0000 °	0.000 m	0.000 m	---	---

When the chosen harmonic factors are not in the range of the scan results then the markers could be aligned with the left or right edges to indicate that the chosen factors are outside the range of the scan. For example, if the stop frequency is 6.2 GHz and if we attempt to place a marker at the 10th harmonic of a fundamental frequency that is 1 GHz, then the marker will be placed at 6.2 GHz itself.

Tip: Harmonic markers can be used for other spectral displays; that is, displays having Amplitude vs Freq, such as Spectrum and DPX). Even if EMC-EMI display is not open, this toolbar can be invoked from **View > Harmonic Markers**.

Inspect

Inspect is a troubleshooting tool you can use to analyze a set of suspect frequencies in more detail. As many as 3 detectors can be selected and the detector results will be shown in a table format for each of the suspect frequencies. The result can also be compared with a comparison level and the entire set of results can be reported out.

Click **Setup > EMC > Inspect** from the Main menu bar, or click Inspect (Inspect) on the Favorites bar to open the Results table, which shows the Inspect results.

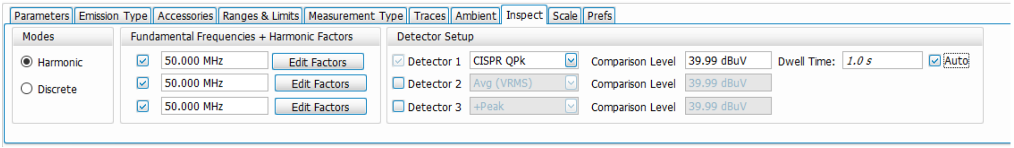
On Selecting Inspect from EMC Toolbar or from Setup > EMC > Inspect, the results table and the Settings Control will open.

The measurement can be triggered by clicking Single or Continuous (located at the top of the Results table). The results can also be brought into the Report using the Report tool from EMC Toolbar.

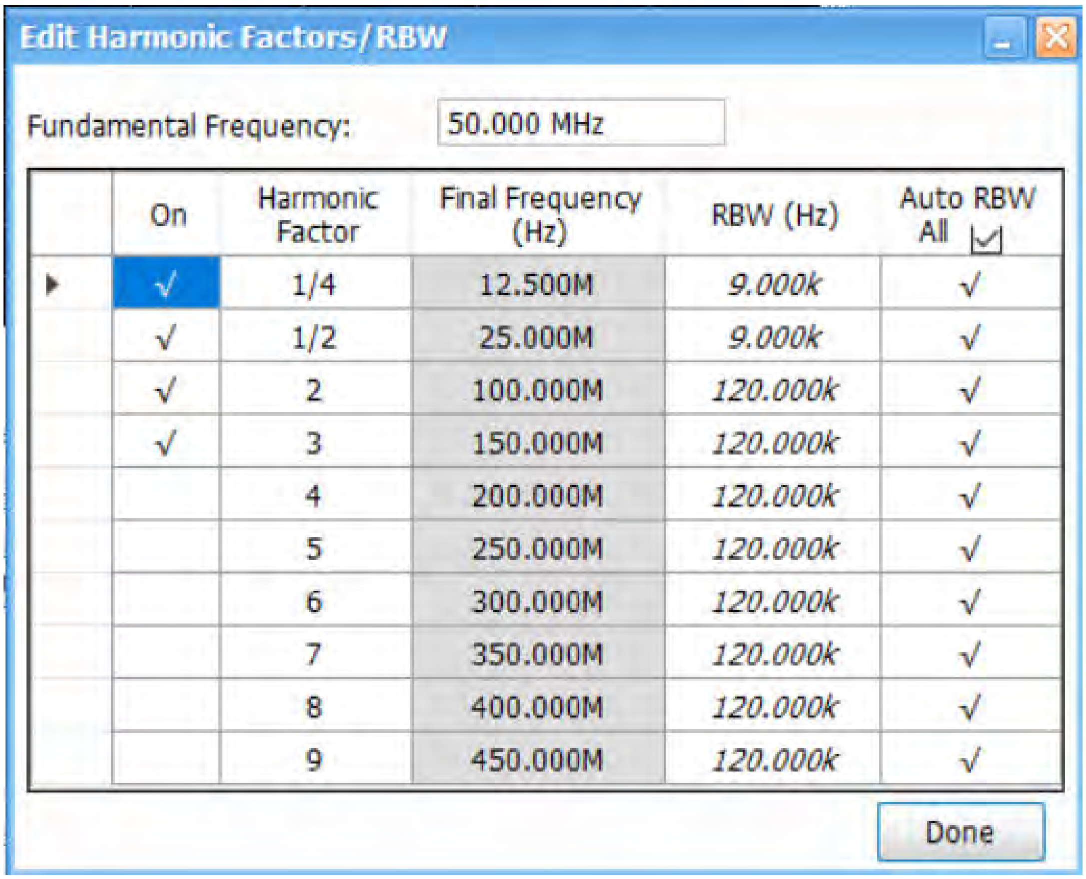
The Inspect display has the following two modes of harmonics measurement:

Harmonic mode

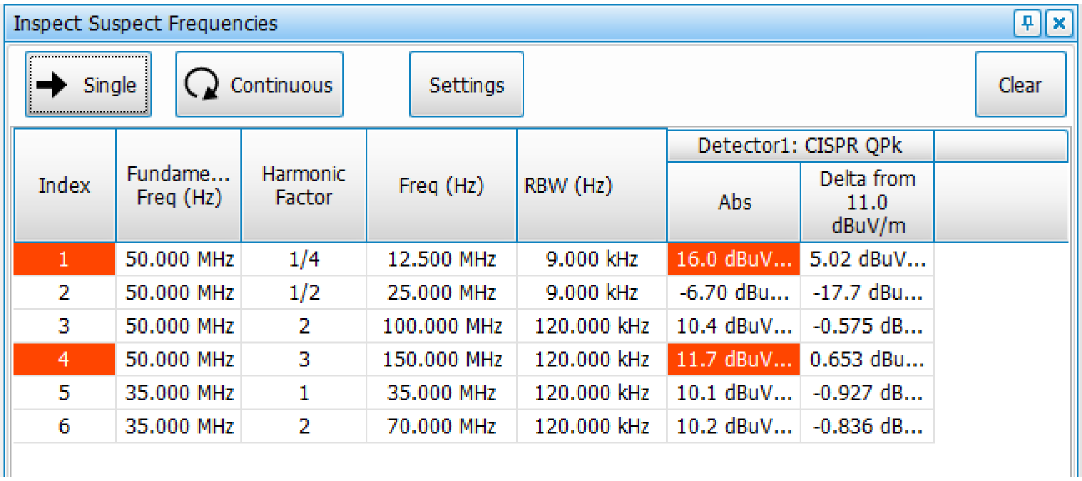
- In Harmonic mode, the suspect frequencies are built as harmonics of fundamental frequencies.



- The detectors can be chosen from the drop down in the Detectors Setup. As many as 3 detectors can be chosen. Comparison level can also be chosen for each detector too. Dwell time can be controlled too.
- Harmonic factors can be entered for each of the fundamental frequency by clicking on Edit factors (see snapshots below). Final frequency is calculated as Fundamental Frequency * Harmonic factor. The Edit Harmonic Factors/RBW table will allow you to edit RBW settings for the frequency that is being analyzed. Auto RBW flag will set RBW based on the chosen detector and frequency band in which the final frequency falls.



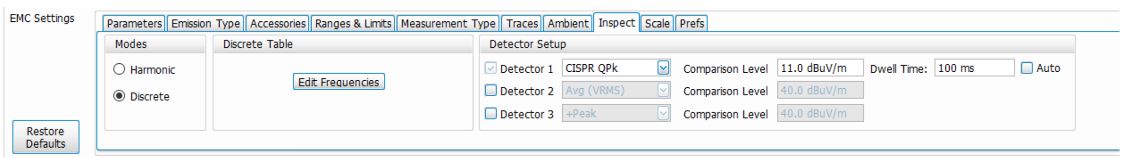
- After selecting Single or Continuous in the Inspect Suspect Frequencies display, the Inspect results will be shown and they will be compared with the respective Comparison Levels. Failures will be shown in red.
- Inspect Suspect frequencies can be done in Single (Stops after all suspect frequencies are analyzed once) or Continuous mode (will continue updating the results table until stopped).



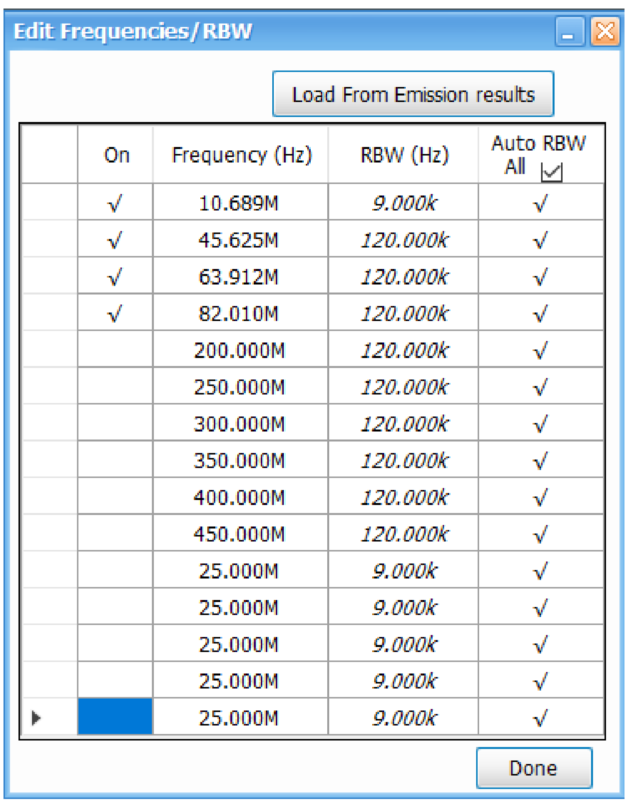
Index	Fundame... Freq (Hz)	Harmonic Factor	Freq (Hz)	RBW (Hz)	Detector1: CISPR QPk Abs	Detector1: CISPR QPk Delta from 11.0 dBuV/m
1	50.000 MHz	1/4	12.500 MHz	9.000 kHz	16.0 dBuV...	5.02 dBuV...
2	50.000 MHz	1/2	25.000 MHz	9.000 kHz	-6.70 dBu...	-17.7 dBu...
3	50.000 MHz	2	100.000 MHz	120.000 kHz	10.4 dBuV...	-0.575 dB...
4	50.000 MHz	3	150.000 MHz	120.000 kHz	11.7 dBuV...	0.653 dBu...
5	35.000 MHz	1	35.000 MHz	120.000 kHz	10.1 dBuV...	-0.927 dB...
6	35.000 MHz	2	70.000 MHz	120.000 kHz	10.2 dBuV...	-0.836 dB...

Discrete mode

- In Discrete mode, you can develop a list of suspect frequencies by clicking on Edit Frequencies.

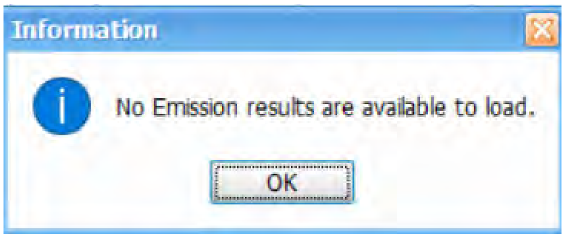


- The detectors can be chosen from the drop down in the Detectors Setup. As many as 3 detectors can be chosen. Comparison level can also be chosen for each detector.
- Suspect frequencies can be entered by clicking on Edit Frequencies button.

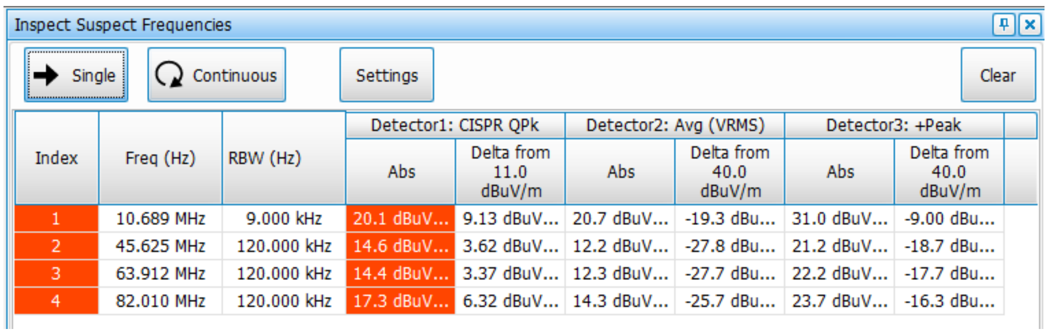


	On	Frequency (Hz)	RBW (Hz)	Auto RBW All
	√	10.689M	9.000k	√
	√	45.625M	120.000k	√
	√	63.912M	120.000k	√
	√	82.010M	120.000k	√
		200.000M	120.000k	√
		250.000M	120.000k	√
		300.000M	120.000k	√
		350.000M	120.000k	√
		400.000M	120.000k	√
		450.000M	120.000k	√
		25.000M	9.000k	√
		25.000M	9.000k	√
		25.000M	9.000k	√
		25.000M	9.000k	√
▶		25.000M	9.000k	√

- The suspect list can also be loaded from "Load from Emission results" which will load the top 15 spots recorded in the Emission Results table at the result of a scan.
- If no spots are listed in the Emission Results table, the following warning message is shown when the **Load from Emission results** button is clicked.



- After selecting Single or Continuous in the Inspect Suspect Frequencies display, the Inspect results in Discrete mode will be shown and the results are then compared with the respective Comparison Levels. Failures are shown in red.



Index	Freq (Hz)	RBW (Hz)	Detector1: CISPR QPk		Detector2: Avg (VRMS)		Detector3: +Peak	
			Abs	Delta from 11.0 dBuV/m	Abs	Delta from 40.0 dBuV/m	Abs	Delta from 40.0 dBuV/m
1	10.689 MHz	9.000 kHz	20.1 dBuV...	9.13 dBuV...	20.7 dBuV...	-19.3 dBu...	31.0 dBuV...	-9.00 dBu...
2	45.625 MHz	120.000 kHz	14.6 dBuV...	3.62 dBuV...	12.2 dBuV...	-27.8 dBu...	21.2 dBuV...	-18.7 dBu...
3	63.912 MHz	120.000 kHz	14.4 dBuV...	3.37 dBuV...	12.3 dBuV...	-27.7 dBu...	22.2 dBuV...	-17.7 dBu...
4	82.010 MHz	120.000 kHz	17.3 dBuV...	6.32 dBuV...	14.3 dBuV...	-25.7 dBu...	23.7 dBuV...	-16.3 dBu...

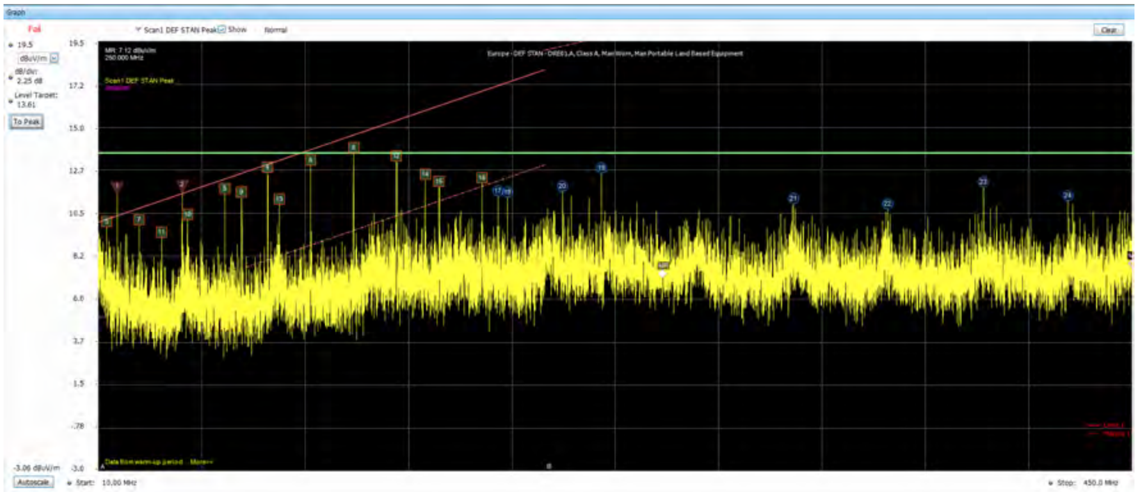
In the Inspect Suspect Frequencies display, all detector results are held between acquisitions, unlike the scan results, which are computed with every scan. When the **Clear** button is clicked, all detectors results will be cleared. This will allow you to set a smaller dwell time, even for detectors such as CISPR Quasi Peak, and build stable results over acquisitions, resulting in faster analysis/updating.

Level Target

Level target is an indicator on the display that can be set by you. You can move it with a mouse. It can also be set at the Peak of the active waveform. This tool is available on four displays (EMC-EMI, Spectrum, DPX, and Spurious). The Level Target will change in other displays when changed in the active display.

You can use Level Target to assign it to the peak of a scan and retain the level for comparison for the next scan and see how it compares with the new scan results.

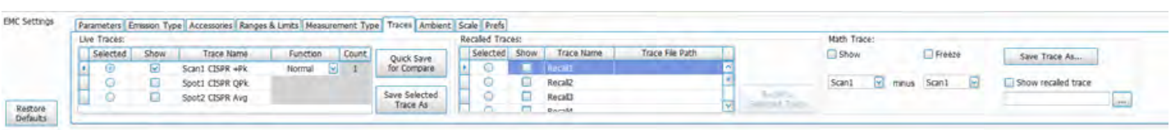
1. Click **Setup > EMC > Level Target** from the Main menu bar, or click Level Target (Level Target) on the Favorites bar. This will open the Spectrum display and place the Level Target in the display. If the Spectrum display is already open, then hitting Level Target toggles visibility of Level Target.
2. Click the **To Peak** button located on the left side of the Spectrum display to move the Level Target to the peak of the trace. You can also click the **To Peak** button that appears in the Prefs tab of the Spectrum Settings control panel when the **Show Level Target** check box is checked. To hide the Level Target indicator, uncheck the box.



Compare Traces

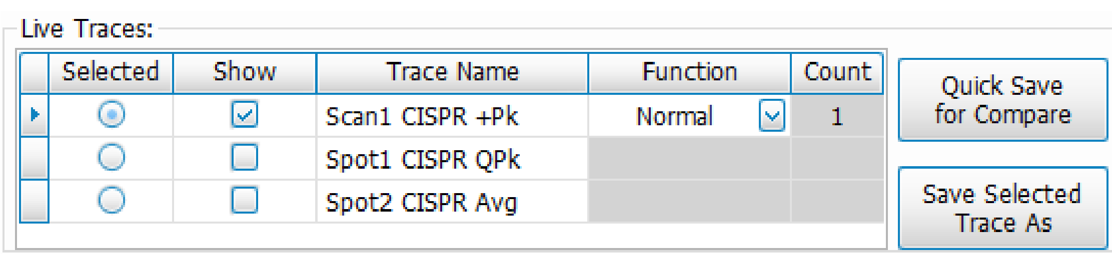
This troubleshooting tool can be used to compare traces of different scan results. It can be used to compare as many as 2 Live Scan traces, 3 Spot traces, 5 Recalled traces and a Math Trace (which is the result of subtracting any two traces). Legends for these traces will also appear in the graph.

Click **Setup > EMC > Compare Traces** from the Main menu bar or click Compare Traces (Compare Traces) on the *Favorites toolbar* to open the *Traces tab* in the EMC Settings control panel.



The control panel is divided into the following three areas:

Live traces area

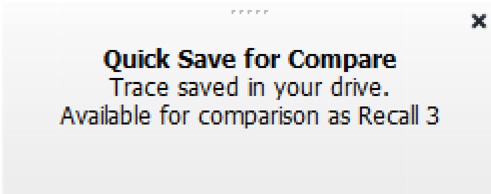


- This area includes the traces that are shown on screen after a Scan or Spot re-measurement.
- Include up to a maximum of 2 scan traces and up to a maximum of 3 spot detector results.
- Function is available for Scan traces. This allows you to select to Max-hold or Average multiple acquisition results.
- The **Save Selected Trace As** button is only available if a live trace is selected. This button is disabled if no Live trace is selected.
- The check boxes in the Show column control the visibility of the trace in the main graph display.

Using Quick Save for Compare button

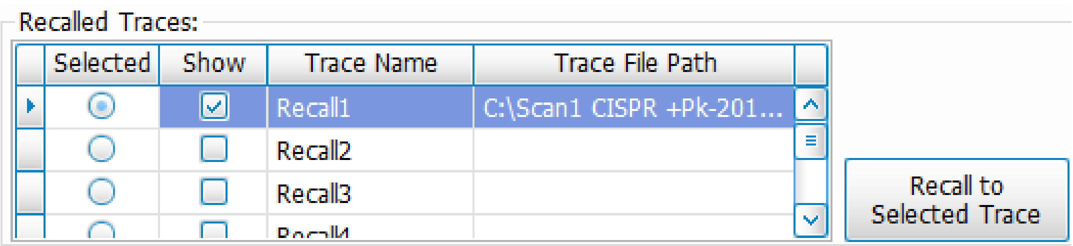
- You can compare scan results of two or more successive scan tests using this button.
- This button is only visible when one of the Live traces is selected.

- When you click this button, the selected Live trace is saved automatically in your drive and recalled into one of the rows in Recalled Traces. It will be automatically recalled into a row (Recall1 through Recall 5, in that order) depending on which one is free. The following timed pop-up message will appear indicating the Recall Trace in which it is available for comparison.

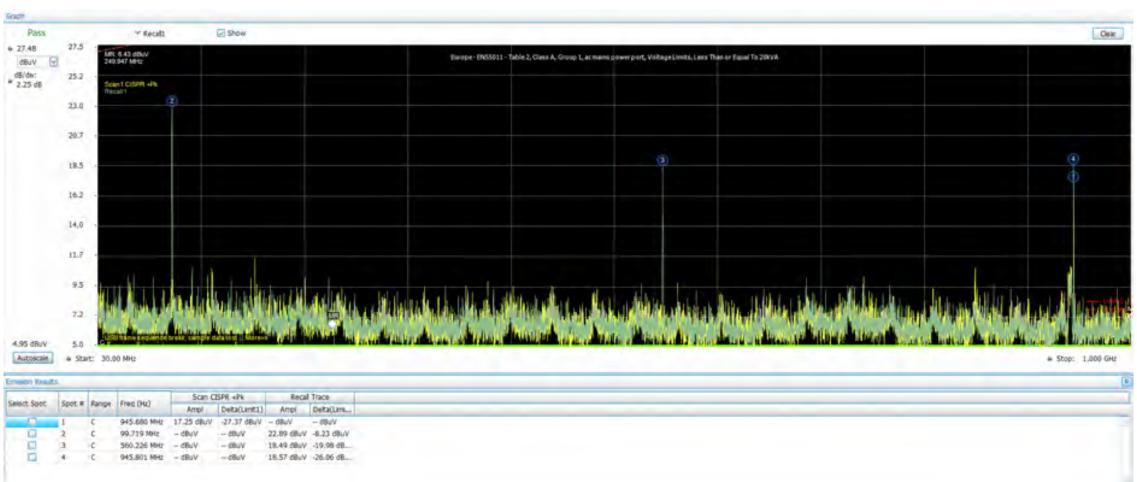


- If none of the Recalled Traces are free, then clicking this button will save the trace in your drive and recall the trace as Recall 1 (replacing the earlier recalled trace in Recall 1). However, the files replaced can be browsed for and recalled using the Recall to Selected Trace control.
- All traces saved with this button are saved in the *C:\RSA5100B Files* directory.

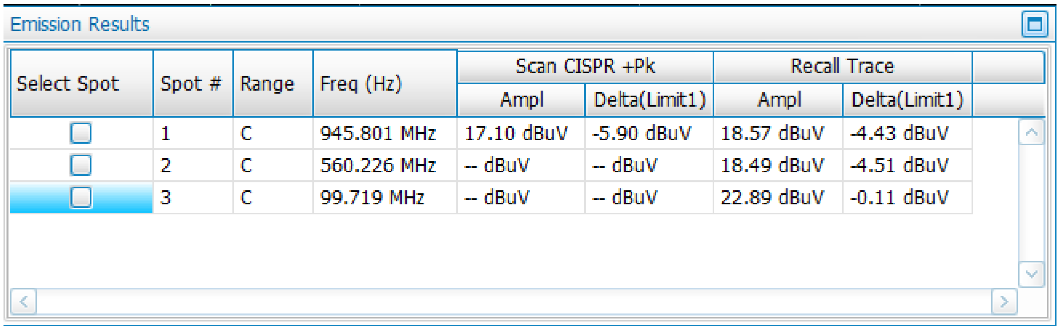
Recalled traces area



- Select any Recall trace (Recall 1 to Recall 5) to recall a saved trace.
- The **Recall to Selected Trace** button is only available if a Recall trace is selected.
- Once a trace is successfully recalled, the trace will be displayed in the graph for the chosen frequency range (set in the Ranges & Limits tab of the EMC Settings control panel). Here is an example. The recalled trace is green:



- The recalled trace will be compared with the Limit lines (in the Ranges & Limits control settings) and the Emission results table will be populated. Here is an example:

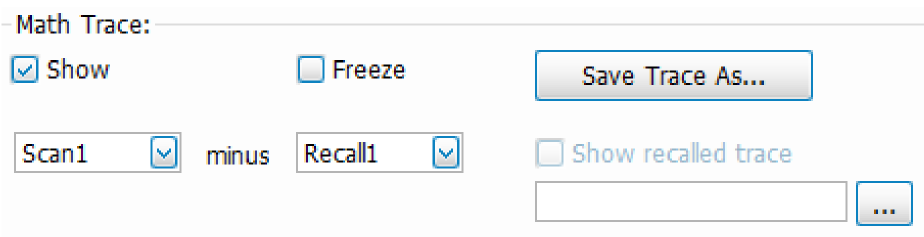


Emission Results

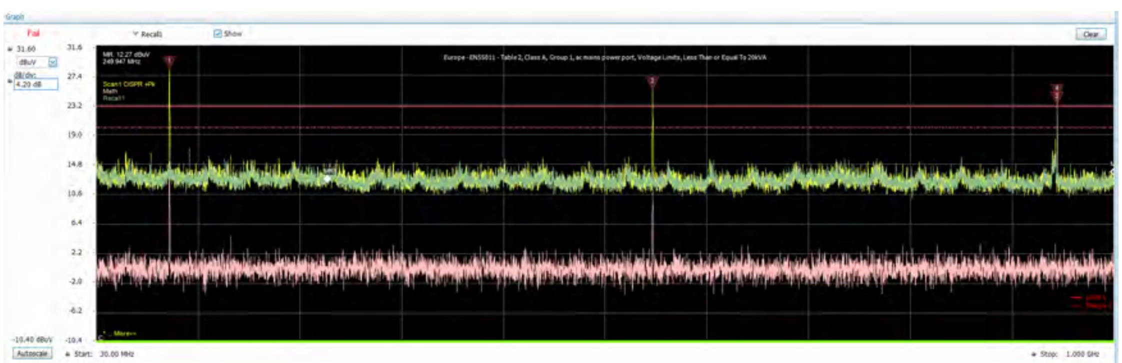
Select Spot	Spot #	Range	Freq (Hz)	Scan CISPR +Pk		Recall Trace	
				Ampl	Delta(Limit1)	Ampl	Delta(Limit1)
☐	1	C	945.801 MHz	17.10 dBuV	-5.90 dBuV	18.57 dBuV	-4.43 dBuV
☐	2	C	560.226 MHz	-- dBuV	-- dBuV	18.49 dBuV	-4.51 dBuV
☐	3	C	99.719 MHz	-- dBuV	-- dBuV	22.89 dBuV	-0.11 dBuV

Math trace area

Math Trace is a feature that allows you to obtain the subtraction result of any two traces. Two traces must be chosen from the Traces tab and the difference trace will be shown in the graph. The Math trace is done only for log units in Y-axis and the difference trace is calculated by subtraction of the dB values. The Math trace can also be saved (**Save Trace As** button) and recalled (check **Show recalled trace** box).

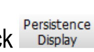


Math Trace allows you to check if emission components still exist from one scan trial to another or even to check if a live scan trace has additional emission components as compared to the emission results obtained from *Ambient* (with EUT turned off). The following image shows two traces and a Math trace. You can see that emission components 1 and 2 are emission components that are present in Scan1, but not present in Recall1 (therefore it shows up in Math trace); however, the emission component at the far end is present both in Scan1 and Recall1 (hence cancelled out in the Math trace).

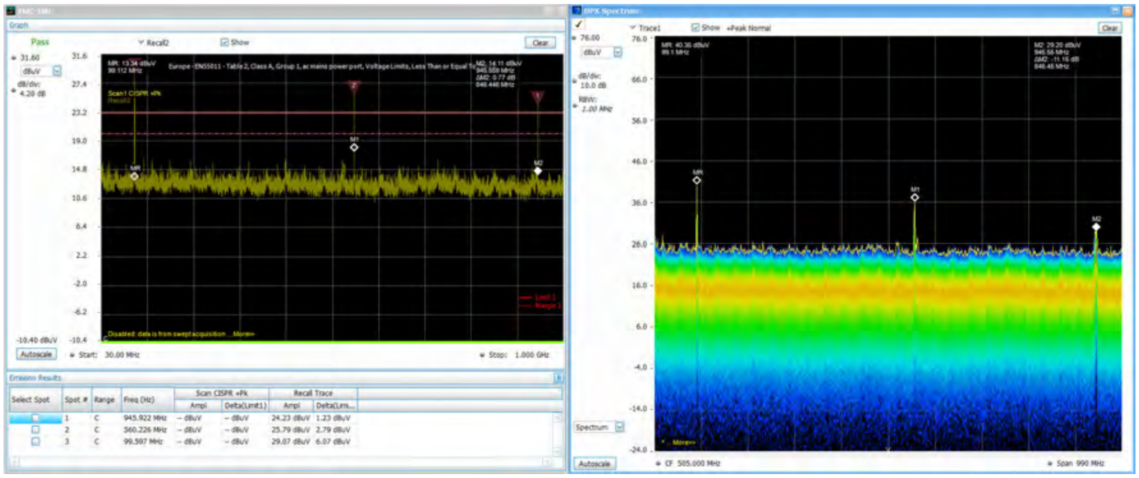


Persistence Display

This troubleshooting tool launches the DPX Spectrum display. This has the capability to show a persistence view over multiple acquisitions. The speed of DPX allows you to select even transient emissions.

Click **Setup > EMC > Persistence Display** from the Main menu bar, or click 

(Persistence Display) on the Favorites bar, to open the DPX Spectrum display.



Tip: You can read more about the *DPX Spectrum display* here.

EMC-EMI display

To show the EMC-EMI display:

1. Double click the 

icon on the Desktop to launch EMCVu. This automatically opens the EMC-EMI display.
2. Alternatively, from the analyzer:
   a. Click the **Displays** button or select **Setup** > **Displays**.
   b. From the Measurements box, select **EMC Analysis**.
   c. Double-click the **EMC-EMI** icon in the **Available displays** box. This adds the EMC-EMI icon to the **Selected displays** box (and removes it from the Available displays box). Alternatively, you can click the EMC-EMI icon and then click the Add button to select EMC-EMI for display.
   d. Click the **OK** button.

Elements of the display

The EMC-EMI display window has three main areas:

1. Graph
2. Emission Results table
3. Inspect suspect frequency display

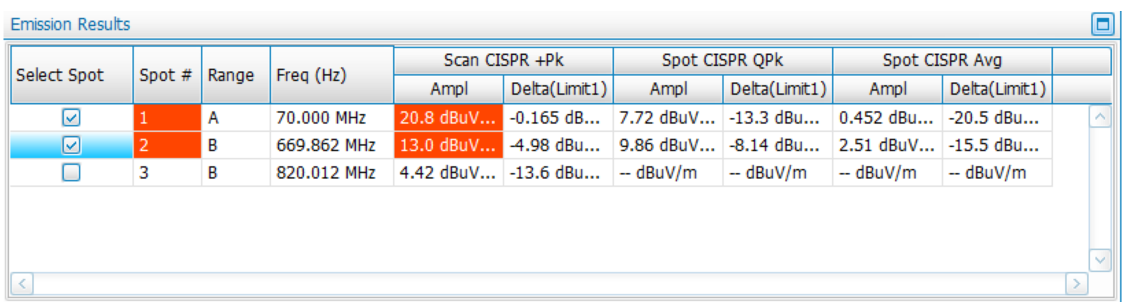
0720-017

Item	Display element	Description
1	dB/ div	Sets the vertical scale value per division. The maximum value is 20.00 dB/division.
2	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the Amplitude selection in the Units tab of the Analysis Settings control panel.
3	Vert 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 Settings control panel. By default, Vert Position = Ref Level.
4	Pass / Fail readout	Indicates whether one or more frequencies have exceeded a limit specified on the **Settings** > **Limits** tab. The readout will show as Fail even if a single Spot (either from Scan or Spot Re-measurement) exceeds the Limit line. The Fail criteria can be modified to include Margin from the Prefs tab.
5	Selected trace	Indicates the selected or active trace.
6	Show	Controls whether the selected trace is visible or not. When trace is Off, the box is not checked.

Table continued…

Item	Display element	Description
7	Trace function	Indicates the trace processing method. If Average or Max Hold is selected, this readout displays the number of traces being processed (averaged or compared for the Max Hold value).
8	Clear	Restarts multi-trace functions (Average, Max Hold).
9	Stop	Adjusts the graph stop frequency. This setting affects only visual scaling, not measurement parameters.
10	Emission results table	Displays Emission results. See the *Emission Results* image and table that follow for details.
11	Start	Adjusts the graph start frequency. This setting affects only visual scaling, not measurement parameters.
12	Autoscale	Adjusts the Vertical and Horizontal scaling to display the entire trace on screen. Selects Multi-range display mode.
13	Bottom of graph readout	Indicates the amplitude at the bottom of the graph. This value changes with the dB/div and Vertical Position settings.
14	Green bar	Indicates the range that is selected on the Settings > Ranges and Settings > Limits tabs.
(Not shown)	Inspect suspect frequencies	This portion of the display appears to the right of the EMC-EMI graph when **Inspect** is selected from the EMC related items on the Favorites toolbar. See the *Inspect Suspect Frequencies* image and table that follow for more information about this display.

Emission Results table elements



Column	Description
Select spot	Selects the spot frequency for Re-measurement. Is shown in the graph too with white indicator.
Spot #	A number that identifies a spot in the graph area. The instrument can display a maximum of 999 spots.
Range	The letter representing the frequency range where the spot is located.
Freq (Hz)	The failed frequency at which the spot occurs.

Table continued…

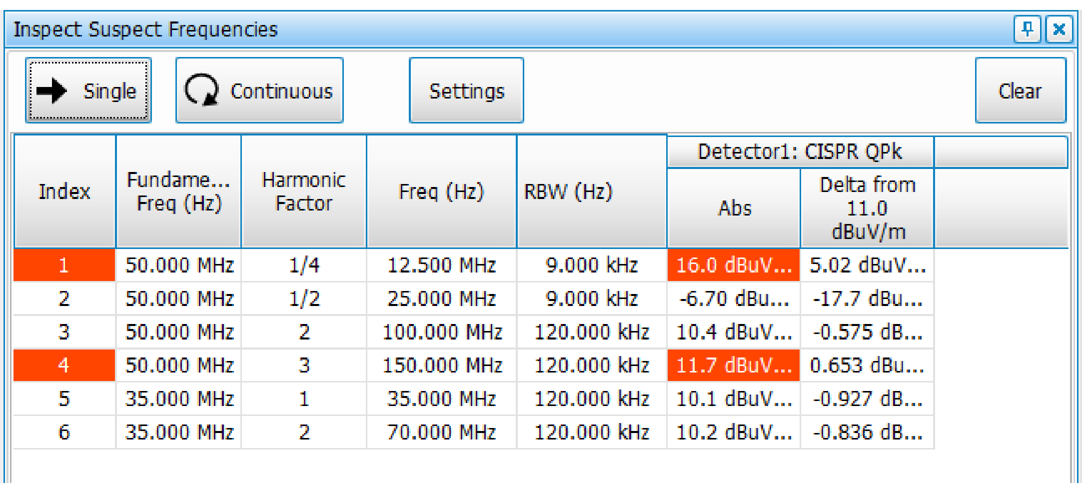
Column	Description
Ampl (Scan)	The amplitude of the spot identified in scan.
Delta (Scan)	Specifies the difference between Amplitude in scan and specified Limit line.
Ampl (Spot)	The amplitude of the spot for chosen detector.
Delta (Spot)	Specifies the difference between Amplitude and specified Limit line for the chosen detector.

- You can rearrange the order of the columns in the Emission Results table. To move a column, click on the column heading and drag it to the desired position.
- You can sort the rows in the Emission Results table by clicking on the column heading. For example, if you click on the Freq, the results in the Emission Results table will be sorted by frequency. If you click on Range, the rows will be sorted by range. Clicking a second time on the same heading reverses the order.
- There can be as many as 2 Scan results (Ampl and Delta for each) and as many as 3 Spot Re-measure results (Ampl and Delta for each) in the Emission results table.
- In addition to that, the Emission results table will also have columns for Recall trace (Amplitude and Delta with Limit 1) and Ambient measurement results (Amplitude and Delta with Scan results).

Elements of Inspect Suspect Frequencies display

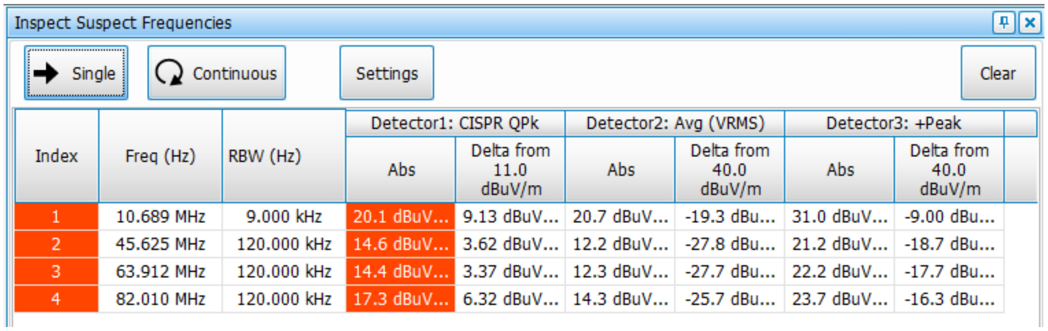
This section of EMC-EMI display shows the results of the Inspect Suspect Frequencies troubleshooting tool. This measurement has the following two modes:

- Harmonic



Index	Fundame... Freq (Hz)	Harmonic Factor	Freq (Hz)	RBW (Hz)	Detector1: CISPR QPk Abs	Delta from 11.0 dBuV/m
1	50.000 MHz	1/4	12.500 MHz	9.000 kHz	16.0 dBuV...	5.02 dBuV...
2	50.000 MHz	1/2	25.000 MHz	9.000 kHz	-6.70 dBu...	-17.7 dBu...
3	50.000 MHz	2	100.000 MHz	120.000 kHz	10.4 dBuV...	-0.575 dB...
4	50.000 MHz	3	150.000 MHz	120.000 kHz	11.7 dBuV...	0.653 dBu...
5	35.000 MHz	1	35.000 MHz	120.000 kHz	10.1 dBuV...	-0.927 dB...
6	35.000 MHz	2	70.000 MHz	120.000 kHz	10.2 dBuV...	-0.836 dB...

- Discrete



Setting	Description
Single	Selects the spot frequency for Re-measurement. Is shown in the graph too with white indicator.
Continuous	A number that identifies a spot in the graph area. The instrument can display a maximum of 999 spots.
Settings	The letter representing the frequency range where the spot is located.
Clear	The failed frequency at which the spot occurs.

Column	Description
Index	Suspect frequencies numbered in the order in which they are defined.
Fundamental Frequency (Hz) *(Harmonic mode only)*	Shows the fundamental frequency (Hz).
Harmonic Factor *(Harmonic mode only)*	Shows the harmonic factor.
Frequency (Hz)	Shows the frequency (Hz).
RBW	The RBW you set in the *Ranges and Limits tab* on page 351 of the EMC Settings control panel is shown in here.
Detector	Detector results are shown in two columns (Abs and Delta) from comparison level for each detector.
Abs	
Delta	

Tip: Read the *Inspect* on page 364 topic in the Troubleshooting section for more information about this tool.

EMC-EMI settings

Main menu bar: Setup > Settings

Favorites toolbar: ⚙

The following tabs are available for the EMC-EMI display from the EMC Settings control panel.

Table 19: Common controls for RF measurement displays

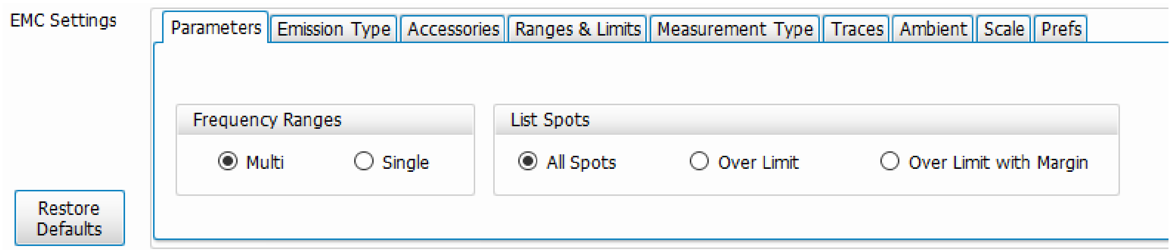
Settings tab	Description
Parameters	Allows you to specify whether the graph displays one range or multiple ranges. You can also specify whether all *Spur/Spot* on page 741 are shown or only spurs/spots over specified limits and margins.
Emission Type	Enables you to specify conducted or radiated emissions for the EMI test.
Accessories	Enables you to select, edit, load, and save accessories for conducted and radiated emissions tests.
Ranges & Limits	Allows you to specify the start and stop frequencies for ranges, the parameters that define a spot (for listing in the Emission Results table), and Pass/Fail parameters for limit testing.
Measurement Type	Allows you to define the detectors for scan and spot measurement.
Traces	Provides controls for live traces, recalled traces, and Math trace.
Ambient	settings related to Ambient measurement and Ambient trace control. Ambient measurement can be triggered by selecting Setup > EMC > Measure Ambient or clicking on Measure Ambient in EMC Toolbar. The settings in the Ambient tab of Settings control panel apply only to measurements done by selection of “Measure Ambient” This measurement is useful for capturing emissions caused by environment or the Spectrum analyzer equipment. Before an Ambient scan is done, the EUT must be switched off/or completely removed from the setup. Note - For workflow of this measurement can be done, refer Measure Ambient section in the Pre-compliance section
Scale	Allows you to change the vertical and horizontal scale settings.
Prefs	Allows you to change the parameters of the EMC-EMI display.

⚠ **Tip:** Access to a subset of the above settings is available in the *EMC Project Setup Wizard*.

Parameters tab - EMC

Favorites toolbar: ⚙

This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to specify settings that control the EMC Spurious measurement.

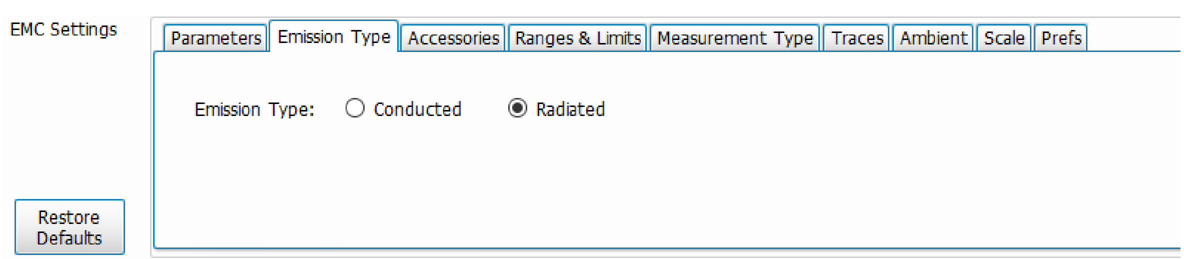


Setting	Description
Frequency Ranges	
Multi	Sets the analyzer to display all enabled ranges in the graph.
Single	Limits the graph to display only the first range. Trace is shown only if this range is selected.
List Spots	
All Spots	Displays all frequency peaks that exceed the threshold values set in the Ranges & Limits tab.
Over Limit	Displays frequency peaks that exceed the threshold values and the chosen Limit lines set in the Ranges & Limits tab.
Over limit with margin	Displays frequency peaks that exceed both the threshold values and the margin (corresponding to the chosen limit line).

Emission Type tab - EMC

Favorites toolbar: 

This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to specify the emission type for the EMI test you want to perform. This selection affects the list of accessories available for selection in the Accessories tabs of the EMC Setup wizard and the EMC Settings control panel.

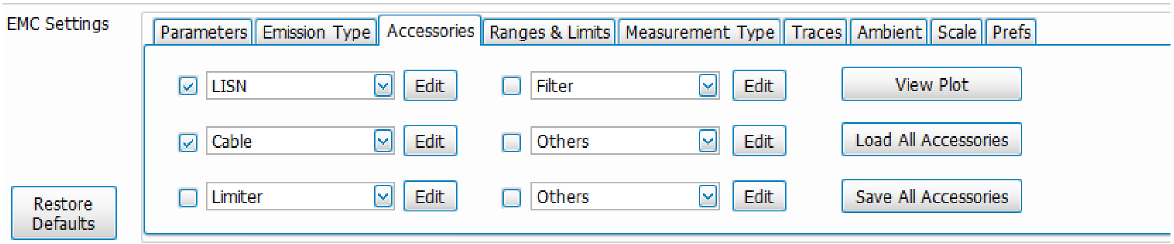


Setting	Description
Conducted	Select when conducted emission tests are to be done. Conducted emission tests measure the radio disturbance voltage at the mains terminal of the equipment under test (EUT) using LISN.
Radiated	Select when radiated emission tests are to be done. Radiated emission tests measure the radio disturbance field strength emitted by the equipment under test (EUT) using an antenna.

Accessories tab - EMC

Favorites toolbar:

This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to select, edit, load, and save accessories. You can also view a gain/loss plot. More accessories settings are available from the *Accessories* tab in the *EMC Project Setup Wizard*.



Setting	Description
Accessory name and drop down list	Shows the names of the six selected accessories. You can select from the associated drop down list. The content of the list is determined by the selected emission type. Check the box next to an accessory to select it for a test. You can see a table of all of the available accessories, by emission type, in the *Accessories tab* topic.
Edit	Click to open a window that allows you to edit the details of the associated accessory. See the *Add and/or edit individual accessories* on page 349 topic for detailed information about how to use this window.
View Plot	Click to view a gain/loss plot. This will also show the combined gain/loss as a net impact of all the accessories. You can read more about this is the *Combined impact of gains/losses* on page 384 topic.
Load All Accessories	Click to load a complete accessories setup from a saved file. This is faster than loading accessories one by one if you have many.
Save All Accessories	Click to save a complete accessories setup to a file for reuse. Details about all of the accessories will be saved.

Tip: Read about setting up accessories in the *Accessories setup* topic.

Tip: Read about available accessories from Tektronix in the *EMC accessories* topic.

Accessories setup

Accessories can be set up for EMI test using the Accessories tab in the EMC Project Setup Wizard and the one in the EMC Settings control panel . These tabs allow you to set up the accessories required for a test and view a graph showing the combined impact of accessories gains and losses. The final measurement reading is corrected based on these accessory contributions before it is shown in the display. The correction is calculated by negating the combined impact of all of the accessory gains/losses you entered.

When any accessory is selected, its contribution will impact the final measurement results shown in the display. “Ext corrections enabled for traces” is the message you will see in the status bar and display. This message can be suppressed from **Tools > Options > Prefs**.

Tip: See the *Accessories tab* topic for information about the tab in the EMC Settings control panel.

See these topics about accessories setup:

- *Available accessories in the drop-down lists*
- *Combined impact of gains/losses* on page 384
- *Edit accessory contributions* on page 380
- *External correction in DPX* on page 389
- *Loading accessories from a file* on page 382
- *Two types of mismatch issues when recalling the csv file*
- *Changing accessory details* on page 381

Available accessories in the drop-down lists

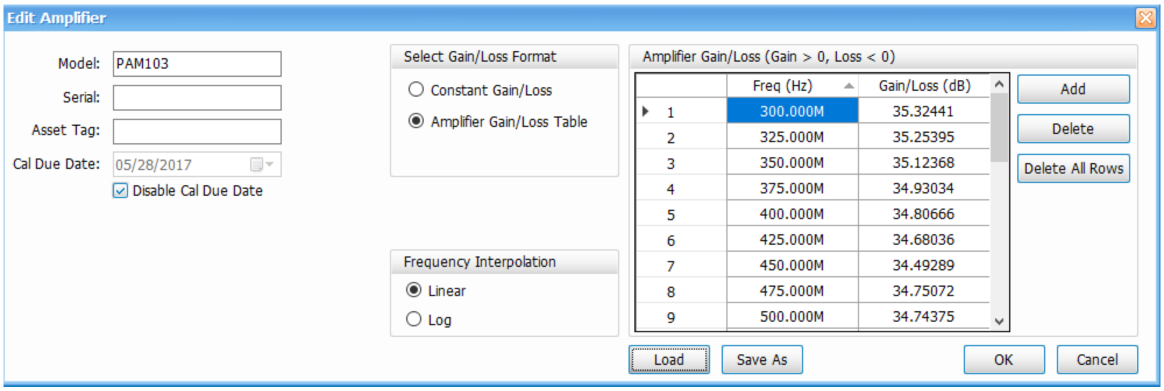
A total of six accessories can be included in the test setup, as shown on the right side of the following image. Accessories can be selected using the drop down lists. The content of these lists depends on the selected emission type, as show in the following table.

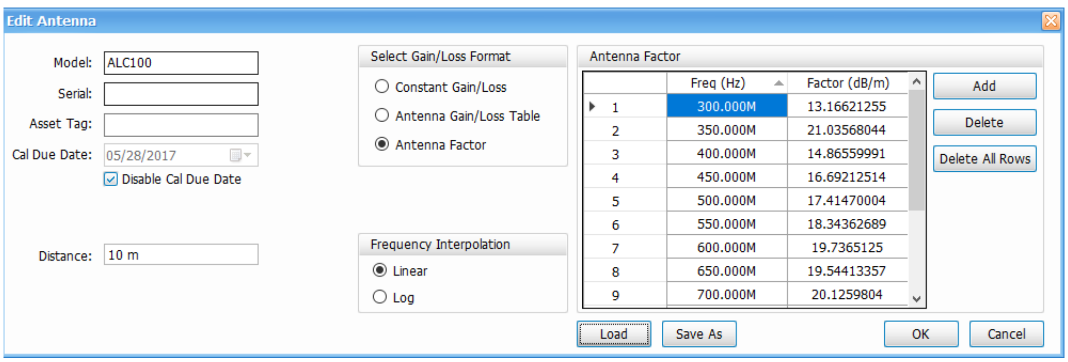
Emission type	Available accessories
Conducted	LISN, Cable, Limiter, Amplifier, Attenuator, Filter, Others
Radiated	Antenna, Near field probe, Cable, Amplifier, Limiter, Attenuator, Filter, Others

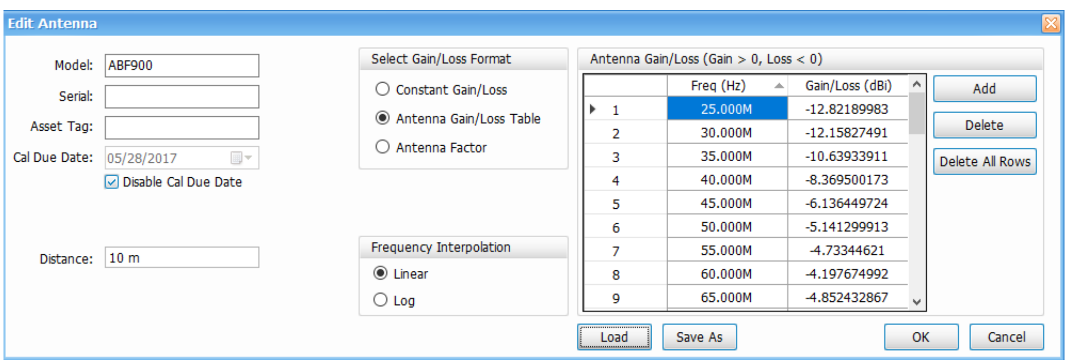
Tip: Loss factors of Tektronix supported accessories can be quickly loaded by clicking the *Load Tektronix provided accessories gains/losses* on page 348 button.

Edit accessory contributions

Accessories specific information and details like Model no, Serial no, Asset tag, calibration due date can be edited using Edit option. A window such as the one shown below will open. The following images show examples for Amplifier and Antennas (Factor and isotropic gain).







Setting	Description
Model	Specify the Model Name/number of the accessory.
Serial	Specify the Serial Number of the accessory.
Asset Tag	Specify any user-specific Asset tag id for the accessory

Table continued…

Setting	Description
Cal Due Date	Specify the Calibration due date of the accessory. It can be disabled by checking the check box if not required.
Distance	Specify the Distance between EUT and Antenna (Applies only when accessory is antenna).
Select Gain/Loss format	Choose between the options available below. A) Constant Gain/Loss, B) Gain/Loss Table. For Antenna, you will have a third selection available C) Antenna Factor
Constant Gain/Loss	Specify the loss value which is constant for the complete frequency range. The Gain/ Loss will be entered in dB. Gain values are entered as positive dB value and Loss as negative.
Gain Loss Table *(Corresponds to the accessory selected)*	Specify the loss values at specific frequency points. The Gain/ Loss values in these tables will be entered in dB. Gain values are entered as positive dB value and Loss as negative. The values in between the frequency points are interpolated with frequency axis treated as Linear/Log based on the Frequency interpolation selection. Note- For Antenna, this table will be entered in dBi (isotropic Gain values) as shown in the snapshot above
Antenna Factor	Applicable only for Antenna. Antenna factors are given in dB/m. These values are typically available in vendor data sheets. You can also load the typical values from Example Files if you have purchases them from Tektronix.
Frequency Interpolation	Specifies the frequency interpolation method used for interpolating Gain/Loss values or Antenna factors. The frequency axis points are either taken as Linear or Log values based on this choice. Linear interpolation is followed but x axis values can be either in Log or Linear as per this selection.
Load	Click to load a saved Accessory details from a file. This will recall all parameters seen in this window.
Save As	Click to save the Accessory details to a file. (All details shown above)
OK	Click OK to give confirmation of the entered details.
Cancel	Click Cancel to ignore the edit window and exit. This will discard any changes that you might have made before OK is pressed.

Changing accessory details

To change the accessories details, click on the Edit button present against the antenna which needs to be edited.

1. A dialogue box pop up is displayed which contains the parameters of the accessory to be edited and updated.
2. Parameters to be updated are like Model No, Serial No, Asset Tag, Calibration due date, polarization, Distance, Loss Factor and Frequency Interpolation.
3. Details which are updated can be saved for future analysis by clicking Save all Accessories button which saves the details to a file.
4. Click OK button to load all the updated details of the accessory.

Loading accessories from a file

Tek supported accessories

Tektronix supports some of accessories namely Antenna, Amplifier, Near field probe and LISN with their detailed information embedded in a .csv file which is readily available for the user as a part of the software in *C:\RSA5100B Files\EMC Accessories.*

Non-Tek supported accessories

Details of Non - Tek supported accessories can be loaded by preparing a .csv file manually by the user. (You can also build it using the UI by adding a row for each frequency)

The Gain/Loss table values are usually found from the datasheet or graphs and accessory supported documents provided by the vendor when purchased.

You can build a csv file with only two columns (Freq column and Gain/Loss column) without headers and you can load the file into this User interface through Load button. You can also add more frequency rows by editing the csv fie. Once you load such a csv file, you can enter the other details like Model, Serial number etc and save the file again and another csv file with all additional details and with appropriate headers would get saved.

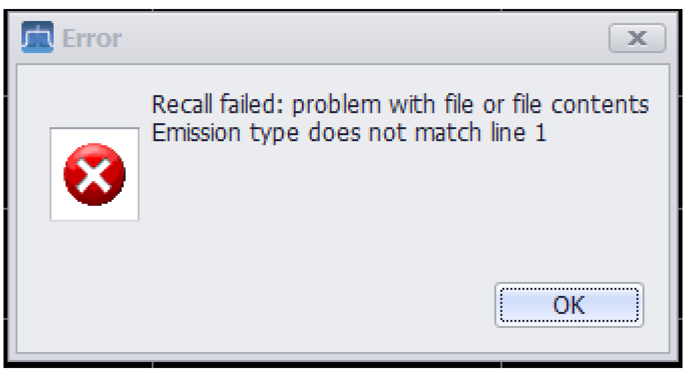
Tip: See the *Two types of mismatch issues when recalling the .csv file* on page 382 topic.

Two types of mismatch issues when recalling the .csv file

Emission type mismatch (for Load All)

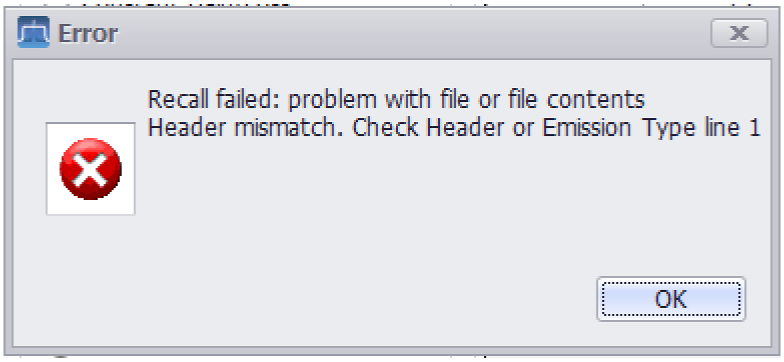
When Load All Accessories is used, the complete setup which is saved for a specific emission type can be recalled only when emission type matches. If the Emission type has been changed and if a recall is attempted, "Emission type mismatch" error is shown.

For example, if the setup saved in conducted emission type mode, it cannot be recalled into radiated emission type mode.



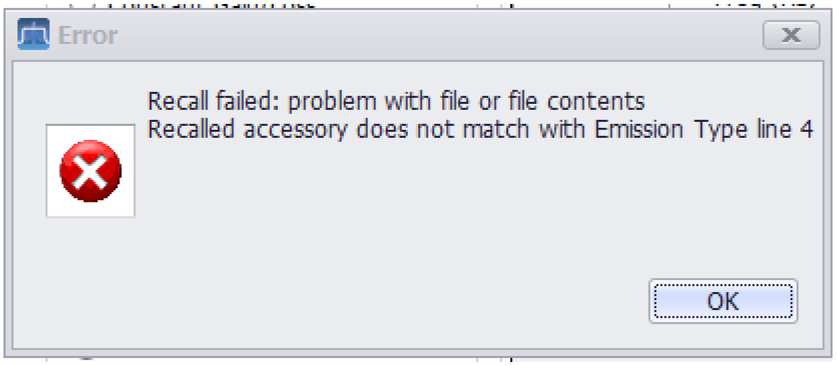
Header type mismatch

If the right type of csv file is not loaded in the Edit Accessory section, then the below error message is shown. For example, if the csv file header line is modified externally, the error message will be shown when an attempt is made to load the csv in the Edit Accessory section.



Emission Type mismatch (for individual accessories)

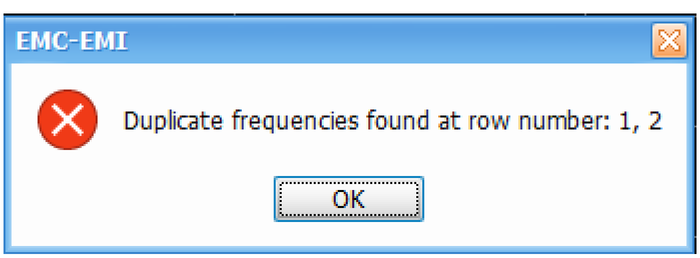
When the accessory is specific to Radiated (Near Field Probe or Antenna) or Conducted (LISN) emission type and an attempt is made to Load the accessory information under a different emission type, the following error message is shown. For example, if the Emission Type is Radiated, the error message will be shown if you attempt to load LISN Accessory information in the Edit Accessory section.



Sorting the Freq column in the Loss Table

- You can sort the Freq column in the Loss table by clicking on the column heading. For example, if you click on the Freq (Hz) header, the results in the loss table will be sorted by frequency. Clicking a second time on the same heading reverses the order.
- When a new row is added, the column is sorted automatically based on the frequency value entered in the new row.
- When an existing frequency value is edited, then the column is sorted automatically based on the frequency value edited.
- When OK is clicked in the edit window of an antenna automatic sorting of loss column is happened.

Note: Duplicate entries of frequency is not allowed either manually or through csv file. Duplicate entry results in an error message stating the row numbers of the duplicate frequencies.



Combined impact of gains/losses

Details of the contribution of each accessory and the combined impact of gains/losses can be viewed in the Impact of Accessories Gains/Losses plot in the Accessories tab. You can select to **Show Points** on the plot and to view the plot in the log or linear frequency scale (shown on the bottom left of the display shown below).

Figure 71: Individual contributions from Antenna, Amplifier, and Cable, and the combined impact, are shown in the above plot.

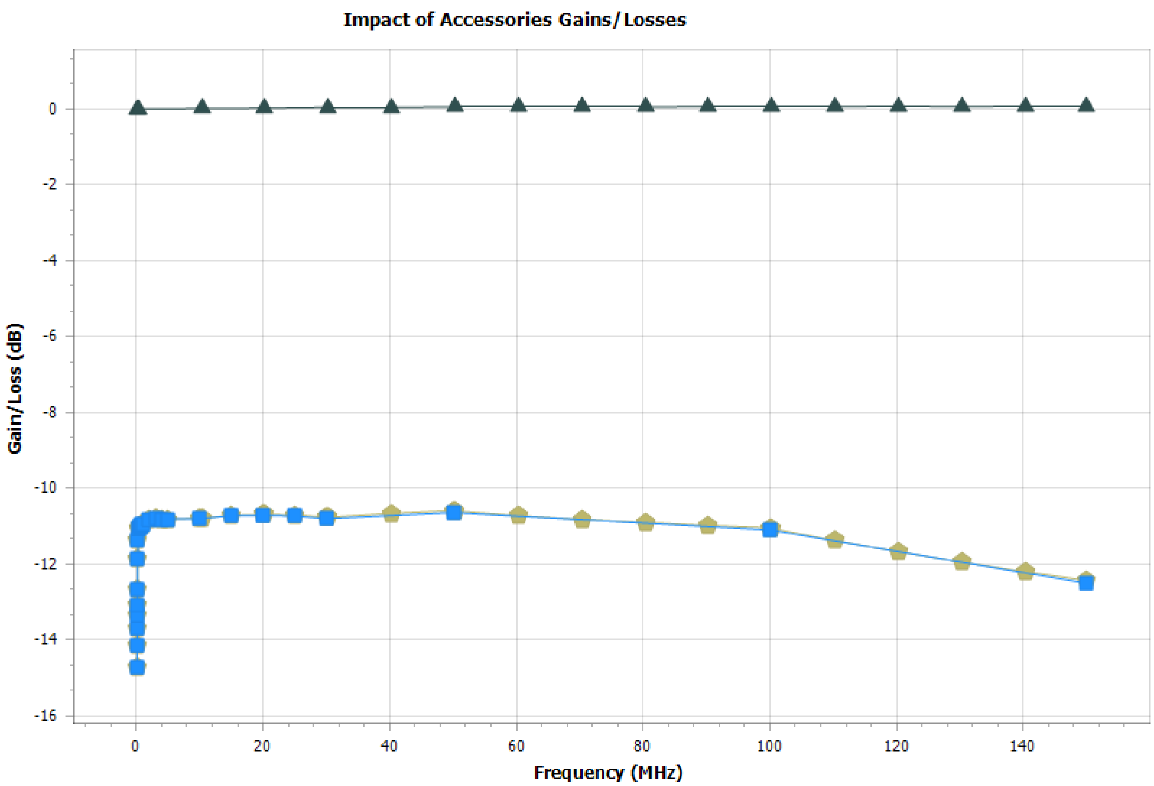
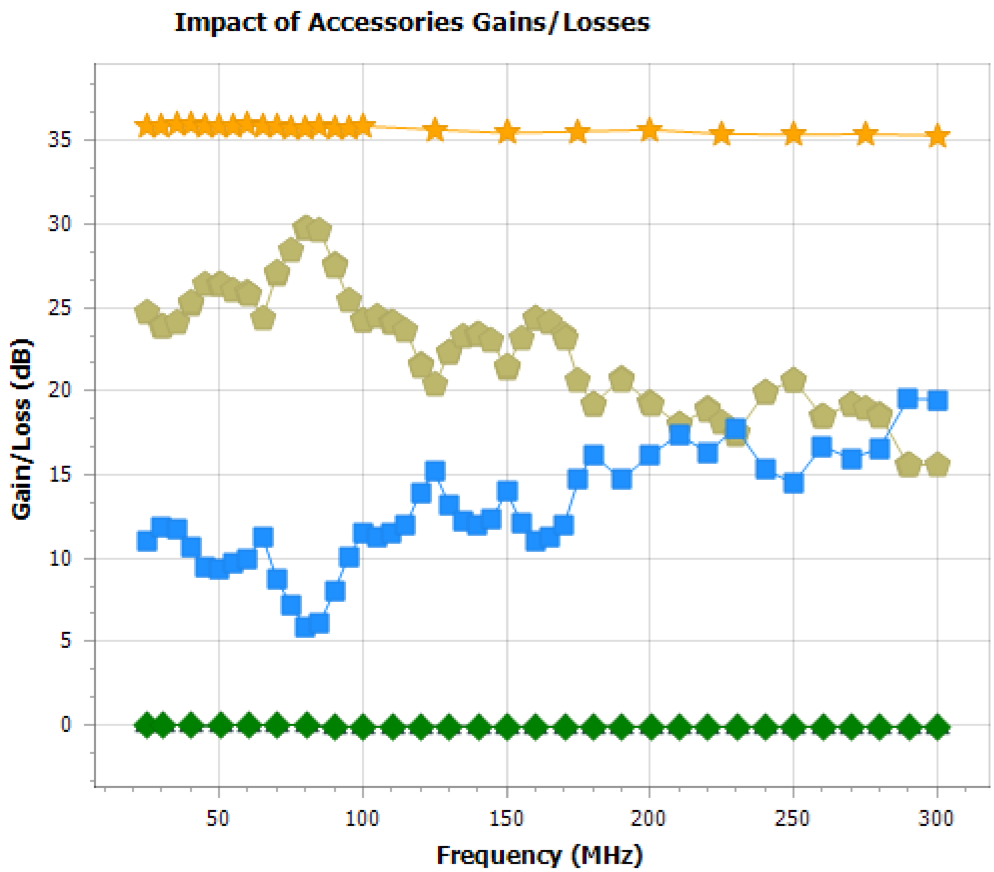


Figure 72: Individual contribution and combined Gain/Loss factors of LISN and a cable (for conducted emission) are shown in the above plot.



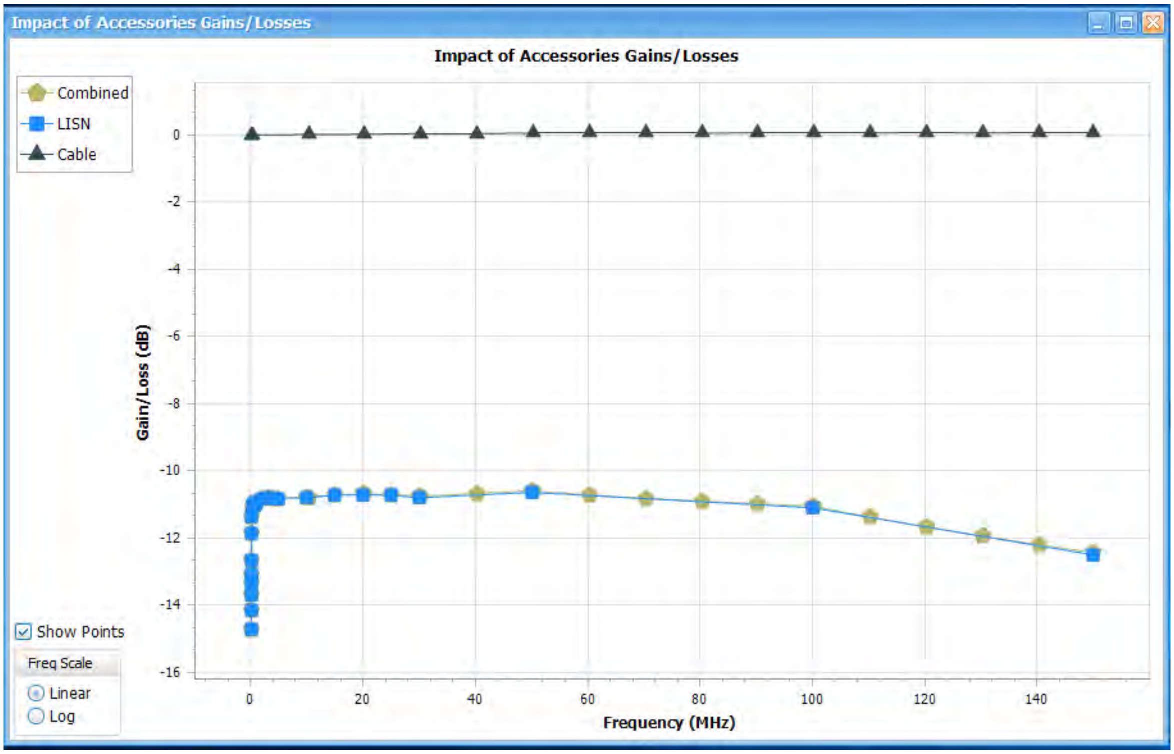
Tip: Read more about combined impact in the *Calculation of combined impact of accessories gains/losses* on page 386 topic.

Calculation of combined impact of accessories gains/losses

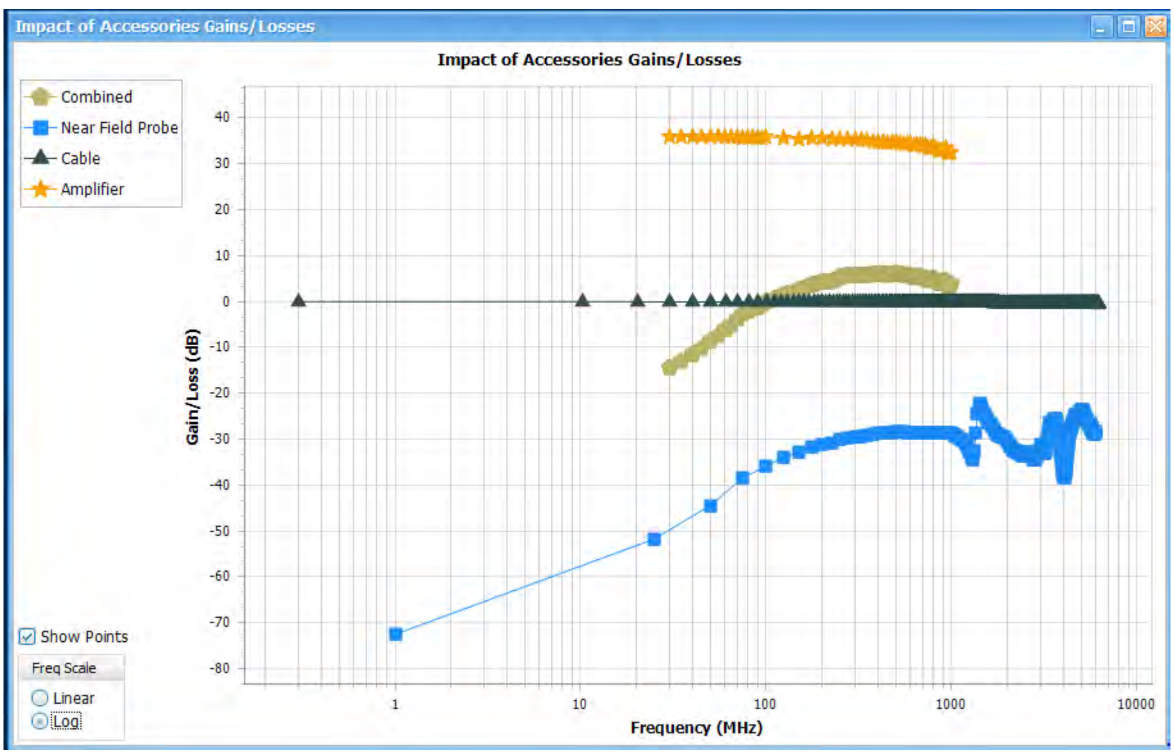
Case 1: non-antenna accessories

Combined gain/loss is calculated by combining the individual gains/losses of individual accessories. Except for Antenna, all accessory gains/losses are in dB (Gain >0, Loss <0). So, the combined gain/loss is calculated by adding all the individual contributions. The plot shows the combined effect in dB.

This combined impact of accessories gains/losses is negated to arrive at the correction factors. Correction factors are applied to the actual spectrum analyzer reading before it is shown in the respective displays.



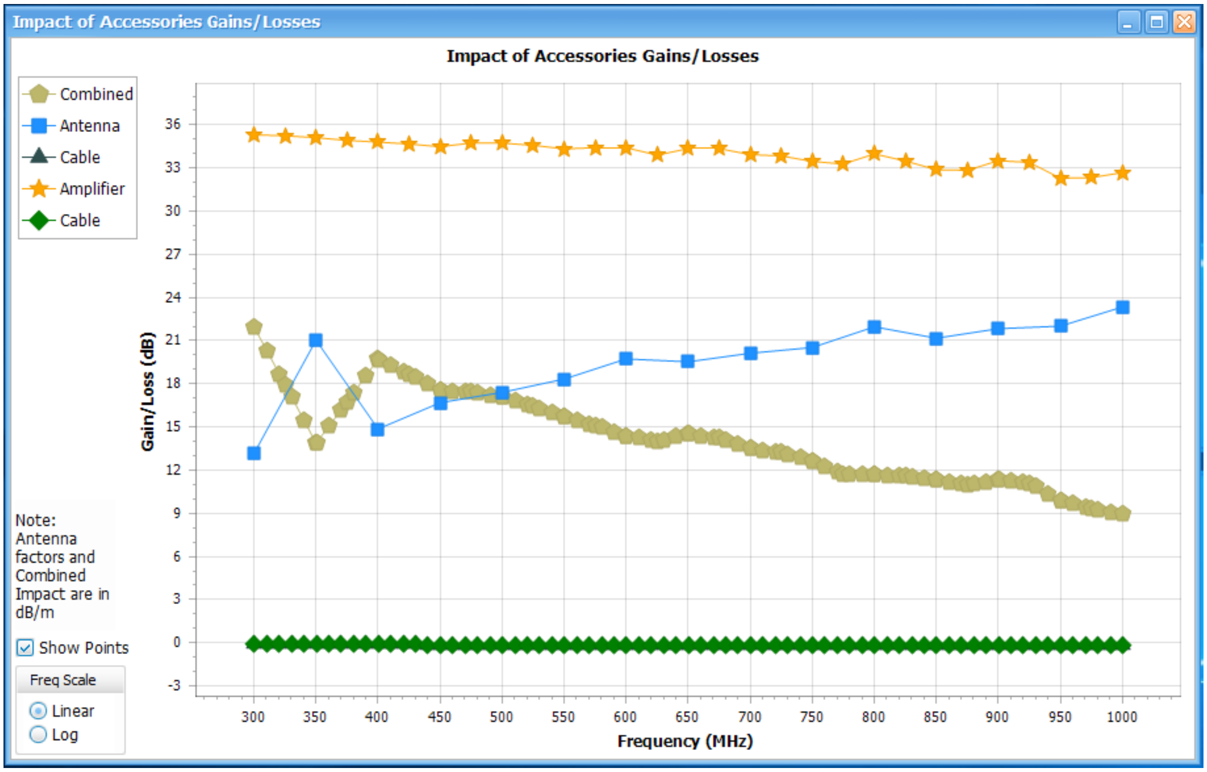
The Combined impact is calculated only for common frequency range. If there are individual accessories that have different frequency ranges, only the common range is chosen for calculation of combined gain/loss. An example is shown below. The combined loss range matches only that of near field probe, although Cable and Amplifier gain/loss information entered for a wider frequency range.



It is this combined impact that is negated to arrive at correction factors which is eventually applied to the measured trace before it is shown in the displays.

Case 2: antenna accessories

In case of Antenna, you can enter the accessory contribution either as isotropic gain values or as Antenna factors (both of which is commonly available in vendor data sheets). Isotropic gain should be entered as any other accessory contribution (Gain >0, Loss<0) and Antenna factors is expected to be entered as you would see the factors in any data sheet in dB/m.



Antenna factors are used to adjust the final reading as follows. *Corrected Reading (dBuV/m) = Spectrum analyzer Reading (dBuV) + Antenna Factor (dB/m)*

- When you have an Antenna as one of the accessories, the results are also shown in field strength units dBuV/m. Note that the above image has a note that says Antenna factor and Combined Impact are in dB/m.

  As mentioned earlier, the combined impact of all accessories are negated to arrive at correction factors. However, as Antenna factors are used as it is given in data sheet for correction of results, Antenna factors are negated before calculating Combined Impact of all Accessories Gains/Losses in the above plot. That is the reason you would observe the combined impact follows the inverse of Antenna factors in the above figure.

The combined impact in the above case would be as follows. *Combined Impact (dB/m) = Amplifier Gain (dB) + Cable effect (dB) – Antenna Factor (dB/m)* (Note that the cable effect is entered as Gain >0 and Loss <0.)

And the combined impact is eventually subtracted from:

Corrected Reading (dBuV/m) = Spectrum Analyzer reading (dBuV) – Combined Impact (dB/m)

Even when the user enters the antenna contribution as isotropic gain, they are converted to antenna factors before presenting in the Combined Impact plot.

*Antenna Factor (dB/m) = (20*log10(f (in MHz) – 29.7707) – Isotropic Gain*

Therefore, in the plot, you will always see the antenna factor contribution and the combined impact is calculated as explained above before it is finally negated to be employed as correction factors to the measured readings.

Warning when frequency range of scan does not match

A warning message is shown in the plot when the frequency range of the Correction factors (-1*Combined Impact) is smaller than the frequency range of the scan. When a scan is attempted beyond the frequency range of the Correction factors, the following warning message is shown “Scan range exceeds range of Combined accessories. Reduce scan range”

External correction in DPX

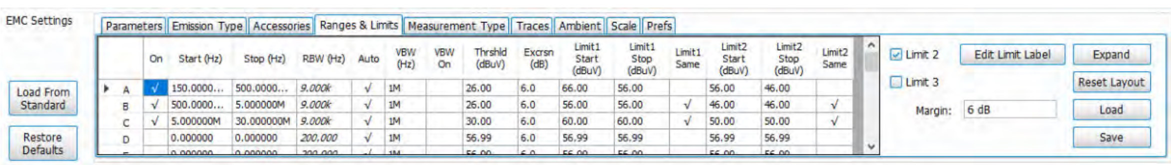
If external correction due to these accessories are to be applied on the DPX display then this can be done only by selecting All acquired data (filter method).

Tip: Read more about external gain correction for *DPX* here.

Ranges & Limits tab - EMC

Favorites toolbar: 

This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to specify the start and stop frequencies for ranges, the parameters that define a spot (for listing in the Emission Results table), and Pass/Fail parameters for limit testing.

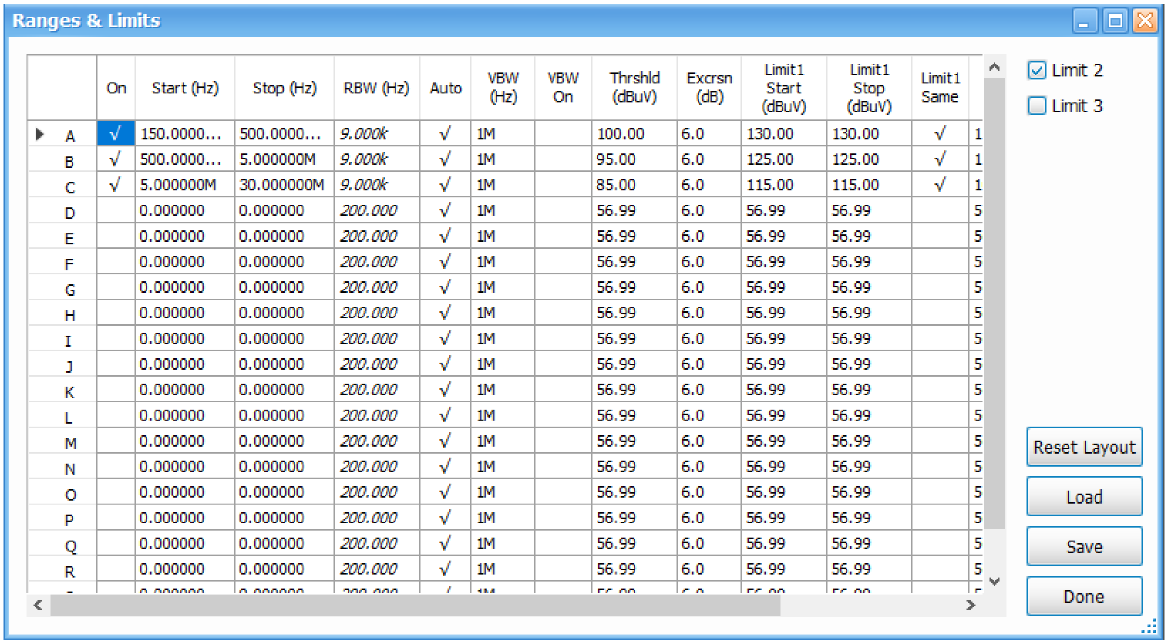


Setting	Description
Expand	Displays the Ranges & Limits table in a new, resizable window.
Table	Shows the ranges and limits for the test. You can edit values in the table directly. You may have to scroll the table to access all settings when multiple ranges are selected. You can reorder columns in the table by dragging the columns to a new position. See the *Ranges & Limits table* topic below this table for more information.
Reset layout	Returns the column order in the Ranges & Limits table to the factory default order.
Load	Click to load a saved Ranges & Limits table from a file. The default directory is the last folder to which you saved a .cvs file.
Save	Click to save the current Ranges & Limits table to a file. The default directory is the last folder to which you saved a .cvs file.
Limit 2	Check to set and Limit 2.
Limit 3	Check to set and Limit 3.
Margin	Set the margin value.

Table continued…

Setting	Description
Load From Standard	Loads a Ranges & Limits table as defined by a Standard.
Edit Limit Label	Allows you to edit the Limit Label.

Ranges & Limits table elements



Setting	Description
On	Specifies whether the measurements are taken in the specified range or not.
Start (Hz)	Readout of the start frequency for the selected range.
Stop (Hz)	Readout of the stop frequency for the selected range.
RBW (Hz)	Specifies the Resolution Bandwidth (RBW) used for the selected range.
Auto	Sets the RBW automatically. For CISPR standards, the frequency range determines the RBW.
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 or not.
Threshold (dBuV or dBuV/m)	Specifies the level that must be exceeded for a signal peak to be recognized as a Spot. A signal peak must also exceed the excursion setting to be considered a Spot.

Table continued…

Setting	Description
Excursion (dB)	Specifies the peak to peak magnitude that must be exceeded for a signal peak to be recognized as a Spot. A signal transition must also exceed the threshold setting to be considered a Spot. A Spot requires the amplitude to drop by the excursion amount between Spots.
Limit 1/2/3 Start (dBuV or dBuV/m)	Specifies the limit at the start frequency. The limit values for the frequency range are calculated by linear interpolating between Limit Start and Limit Stop. The frequency start and stop values are taken in Linear or Log, based on the scale choice.
Limit 1/2/3 Stop (dBuV or dBuV/m)	Specifies the limit at the stop frequency. The limit values for the frequency range are calculated by linear interpolating between Limit Start and Limit Stop. The frequency start and stop values are taken in Linear or Log, based on the scale choice.
Limit 1/2/3 Same	Sets the starting and stopping frequencies for Limit 1, Limit 2, and Limit 3 to the same value.
Limit 2	Set and display Limit 2.
Limit 3	Set and display Limit 3.
Margin	Set the margin value.
Rest layout	Returns the column order in the Ranges & Limits table to the factory default order.
Done	Saves changes and closes the Ranges & Limits table expanded window.
Save	Saves the current Ranges & Limits table to a file.
Load	Loads a saved Ranges & Limits table from a file.

See these related Ranges & Limits topics:

- *Change range Start and Stop frequencies* on page 391
- *Specify Spot requirements* on page 392
- *Set limits* on page 392
- *Perform Pass/Fail testing* on page 392
- *Load from Standard* on page 352

Change range Start and Stop frequencies

To change the range start and stop frequencies from the Ranges & Limits tab edit the Start and Stop frequencies in the table as follows.

1. Click the **Expand** button on the Ranges & Limits tab. This displays the Ranges and Limits table.
2. Check the On box for the ranges that you want to measure.
3. Click on the Start or Stop frequency setting to change it. Type in a number for the frequency and a letter as a multiplier. You can use k, m, or g to set the frequency multiplier.
4. Click **Done** to save your changes.

⚠ **Tip:** You can read about settings in the *Ranges & Limits tab - EMC* on page 389 topic.

Specify Spot requirements

A Spot is a signal peak that exceeds both the Threshold and Excursion settings in the Ranges and Limits table. The Threshold and Excursion settings are specific to the selected range. If you want to use different settings for Spots in different ranges, you must set the values separately for each range. The Excursion control is used to avoid interpreting a single spot as multiple narrower spots by requiring the amplitude to drop by the Excursion amount between spots. Raising the Threshold value means that fewer, larger signals will be identified as spots.

Specify the Spot requirements for a range as follows:

1. Click the **Expand** button on the Ranges & Limits tab. This displays the Ranges and Limits Table.
2. Select the **Range** (A–T) for which you want to specify the Spot requirements.
3. Set the **Thrshld** value
4. Set the **Excrsn** value.

Spot specification is also dependent on the **List Spots** selection in the *Parameters* tab. By default, this selection is All Spots, in which case all frequency peaks above the Threshold (subject to Excursion violation) are classified as Spots for listing in the Emission Results table. If this selection is Over Limit, then only those frequency peaks above the limit line classify as a Spot for listing in the Emission Results table. The third selection is **Over Limit with Margin**, which will only classify frequency peak that violate limit lines with margin included in them.

Tip: You can read about settings in the *Ranges & Limits tab* topic.

Set limits

Use the Limits settings in the Ranges & Limits table to specify the *pass/fail* parameters for the EMC-EMI measurement.

- When the Mask setting is set to any value except off, the analyzer identifies any signal peak that exceeds the specified limits as a violation and displays **Fail** on the screen. If no signal peak exceeds the limits, the analyzer displays **Pass** on the screen.
- The Margin control lets you set the buffer that you want around the limit line.
- The frequency peaks that violate the limit lines are shown in red both in the graph and Emission Results section. If they violate only the limit line, then they are shown in orange.

Tip: You can read about settings in the *Ranges & Limits tab* topic.

Perform Pass/Fail testing

Set up Pass/Fail EMI testing using the Ranges & Limits tab and table. All the following parameters can be set manually or loaded from a file or from a specified Standard.

1. Click the **Expand** button on the Ranges & Limits tab. This displays the Ranges and Limits Table.
2. Adjust the Start and Stop frequencies as required for each range you want to test.
3. Verify that the On box is checked for ranges that you want to test.
4. Set the limits in the Start, Stop.
5. Set the required RBW and VBW.
6. Verify that the **Thrshld** and **Excrsn** values are set as required. These are the values that define a Spot.
7. Click **Done** to save your changes and close the Range and Limits table window.
8. Click **Run** to begin testing.

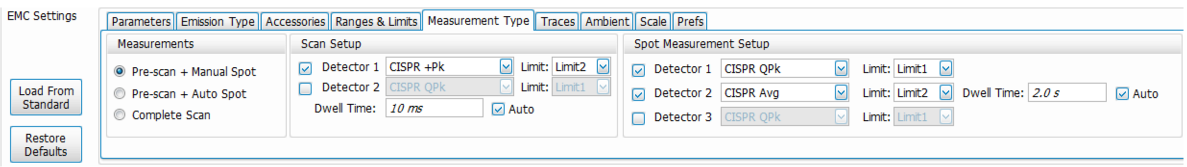
Tip: You can read about setting limits using the Ranges & Limits tab in the *Set limits* on page 392 topic.

Tip: You can read about settings in the *Ranges & Limits tab* topic.

Measurement Type tab - EMC

Favorites toolbar:

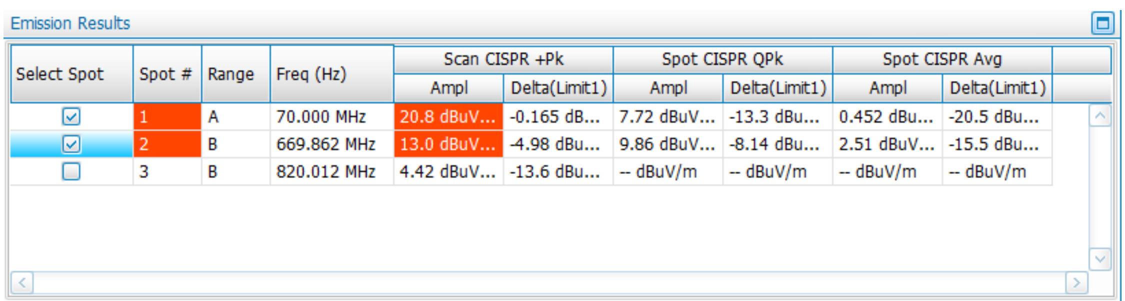
This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to define the detectors for scan and spot measurement.



This tab is divided into the following three areas:

- *Measurements* on page 393
- *Scan Settings* on page 394
- *Spot Measurement Setup* on page 395

The results of Scan and Spot re-measurements are tabulated in the Emission Results table (shown below). This table is accessed from the *EMC-EMI display*.


Emission Results

Select Spot	Spot #	Range	Freq (Hz)	Scan CISPR +Pk		Spot CISPR QPk		Spot CISPR Avg	
				Ampl	Delta(Limit1)	Ampl	Delta(Limit1)	Ampl	Delta(Limit1)
☑	1	A	70.000 MHz	20.8 dBuV...	-0.165 dB...	7.72 dBuV...	-13.3 dBu...	0.452 dBu...	-20.5 dBu...
☑	2	B	669.862 MHz	13.0 dBuV...	-4.98 dBu...	9.86 dBuV...	-8.14 dBu...	2.51 dBuV...	-15.5 dBu...
☐	3	B	820.012 MHz	4.42 dBuV...	-13.6 dBu...	-- dBuV/m	-- dBuV/m	-- dBuV/m	-- dBuV/m

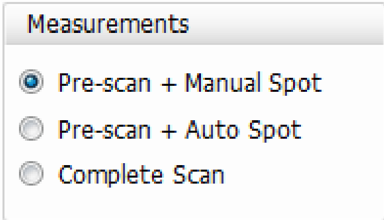
Measurements

There are three Measurement settings:

Pre-scan + Manual Spot

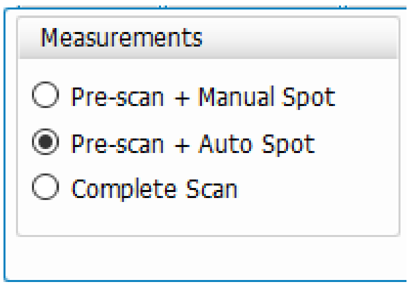
Select to perform a scan with the chosen detector(s) for the selected ranges. The scan will populate the Emission Results table with Spots (frequency peaks that are above Threshold or Limit lines). The application then waits for you to select Spots from the Emission Results table for Re-measurement.

This measurement type is useful for Standard recommended detectors that require longer measurement/dwell time. A quick Pre-scan with Peak detector can be done in such cases. As a second step, Spots (frequencies that fail Threshold or Limit lines) can be chosen for re-measurement with detectors recommended by the Standard. For example, if the Standard recommends usage of CISPR QP and CISPR Avg detectors, then a pre-scan is performed CISPR +Peak. After the scan, you can choose the Spot(s) for performing Spot Re-measurement using CISPR QP and CISPR Avg detectors (max 3 detectors). The RBW for Spot measurement is chosen based on the ranges and limits set for the scan.



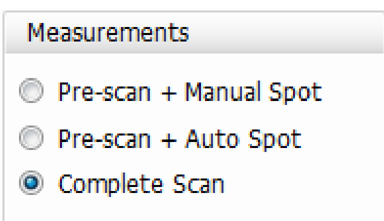
Pre-scan + Auto Spot

Select to perform a scan with the chosen detector(s) for the selected ranges. The scan will populate the Emission Results table with Spots (frequency peaks that are above Threshold or Limit lines). The application then automatically triggers a Spot re-measurement for the number of Spots chosen by you. You can control the number of spots to be automatically re-measured under Max Spots, which is visible only when Pre-scan + Auto Spot is selected.



Complete Scan

Performs a scan using detector(s) specified by you. You can also choose to load the detector choice from a Standard by clicking the **Load from Standard** button located on the far left side of the Ranges & Limits tab (above the Restore Defaults button) in the EMC Settings control panel. You can also access this button on the Ranges & Limits tab in the EMC Project Setup Wizard.



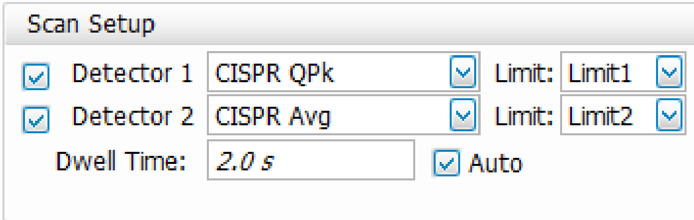
When the detector choices are loaded from the standard, Complete Scan will show the actual detectors recommended by the standard and the results will be compared against appropriate limit lines. When the Pre-scan measurement type is chosen, a first scan is done with Peak detector and the actual detectors recommended by the standard and the corresponding limit lines are set in the Spot Measurement setup.

Although you are free to change the detector choice after choosing a measurement type (Pre-scan +Manual Spot, Pre-scan + Auto Spot, and Complete Scan), changing the measurement type will re-load the detectors recommended by the standard, and a detector you added will not be remembered. For example, assume the standard recommends only CISPR QPk for Complete Scan and you choose to add an additional detector in CISPR Avg. If you then change to Pre-scan mode, and then change back to Complete Scan mode, the detector choice will be CISPR QPk, because that is the detector recommended by the standard. Your addition of CISPR Avg is not remembered when the measurement mode is changed.

However, when a setup file is saved, or a project file is saved in EMC Project Setup Wizard, only the detector choices of the chosen measurement type are saved.

Scan Settings

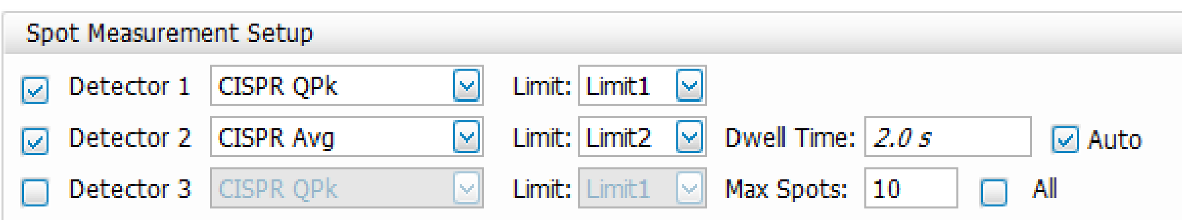
The following settings are available in the Scan Settings area of the Measurement Type tab.



Setting	Description
Detector	Set the detection method using the drop down list. This will be loaded automatically when Load from Standard is chosen from the Ranges & Limits tab of the EMC Settings control panel or EMC Project Setup Wizard. Available detection methods are: Avg(VRMS), + Peak, MIL +Peak, DEFSTAN Avg, CISPR QPk, CISPR Pk, CISPR Avg, Avg (of logs), and CISPR Avg (of logs).
Limit	Set the limit lines (drop down list shows enabled limit lines) that will be used for comparison for the chosen detector result. As many as 3 limit lines can be defined in the Ranges & Limits tab of the EMC Settings control panel or EMC Project Setup Wizard. When ranges and limits are loaded from a Standard, the Standard typically recommends separate limit lines for each detector type. The limit lines that are loaded as Limit 1/2/3 are mapped to the appropriate detector here. You can also customize your own limit line into one of the three limit lines available and map it to a detector from the drop down for limit lines here.
Dwell Time	Shows the duration of the measurement. When the **Auto** check box is checked, it sets the Dwell Time automatically based on detector choice.

Spot Measurement Setup

The following settings are available in the Spot Measurement Setup area of the Measurement Type tab.

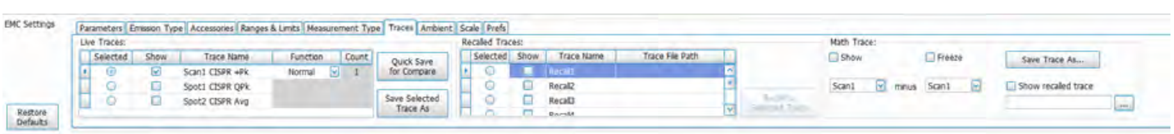


Setting	Description
Detector	Set the detection method using the drop down list. This will be loaded automatically when Load from Standard is chosen from the Ranges & Limits tab of the EMC Settings control panel or EMC Project Setup Wizard. Available detection methods are: Avg(VRMS), + Peak, MIL +Peak, DEFSTAN Avg, CISPR QPk, CISPR Pk, CISPR Avg, Avg (of logs), and CISPR Avg (of logs).
Limit	This is the same limit as for Scan Setup, but it is used for Spot re-measurement comparison. You can set the limit lines (drop down list shows enabled limit lines) that will be used for comparison for the chosen detector result. As many as 3 limit lines can be defined in the Ranges & Limits tab of the EMC Settings control panel or EMC Project Setup Wizard. When ranges and limits are loaded from a Standard, the Standard typically recommends separate limit lines for each detector type. The limit lines that are loaded as Limit 1/2/3 are mapped to the appropriate detector here. You can also customize your own limit line into one of the three limit lines available and map it to a detector from the drop down for limit lines here.
Dwell Time	Shows the duration of the measurement. When the **Auto** check box is checked, it sets the Dwell Time automatically based on detector choice.
Max Spots *(Only available when Pre-scan + Auto Spot is selected)*	Specifies the maximum number of top Spots in the Emission Results table (resulting from a scan) that will be selected for re-measurement. Check the **All** check box to include all Spots in the Emission Results table for re-measurement.

Traces tab — EMC

Favorites toolbar: 

This tab is available for the EMC-EMI display from the EMC Settings control panel. It provides information and controls for the trace results from Scan and Re-measure Spot measurement results. It provides controls for live traces, recalled traces, and Math trace.



Setting	Description
Live Traces	Traces shown here are the trace results for the last Scan or re-measure Spot measurements.
Selected	Selecting a trace makes it the active trace. The active trace shows on the top of the graph and is useful when there are multiple traces viewed together. You can also select a trace from the top of the EMC-EMI display.
Show	Shows / hides the selected live trace.

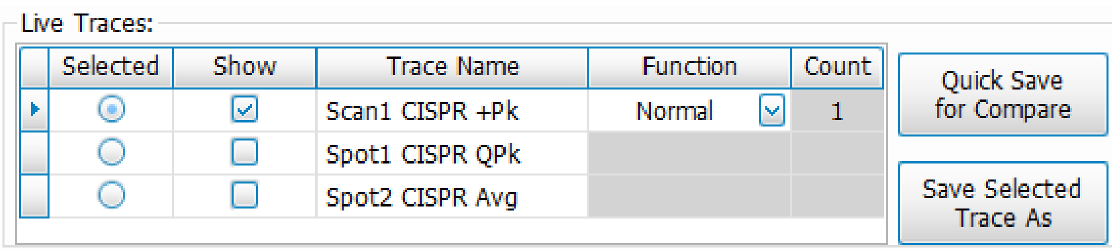
Table continued…

Setting	Description
Trace Name	Specifies the name of the trace. For live traces, these names are set by appending the detector choice with the measurement (Scan vs Spot based on whether scan is done or Re-measure Spot is done). The number after Scan or Spot is based on the number of detectors chosen for Scan and Re-measure spot measurements in the Measurement Type tab of the EMC Settings control panel.
Function	Specifies the function performed on the trace. Applicable only for scan trace in Live Traces.
Count	Specifies the count value for Function when Function is not Normal (Max Hold, Average etc.). When Function is Normal, this control is not editable because the Count is 1.
Quick Save for Compare	Click this button to automatically save the selected Live Trace in your drive and recall it into one of the rows in Recalled Traces, depending on which one is free. The search is done from Recall1 through Recall 5, in that order. There will be a timed pop-up message indicating the Recall trace in which it is available for comparison. If none of the Recalled traces are free, then clicking this button will save the trace in your drive and recall the trace as Recall 1 (replacing the earlier recalled trace in Recall 1). However, the files replaced can be browsed for and recalled using the Recall to Selected Trace function. All traces saved with this button are saved in the *C:\SignalVu-PC Files* directory. See the *Compare Traces* on page 368 topic for additional information.
Save Selected Trace As	Saves the selected live trace to a file for later recall and analysis. This button is active only when a live trace is selected and saved.
Recalled Traces	
Selected	Selecting a trace makes it the active trace. The active trace shows on the top of the graph and is useful when there are multiple traces viewed together. The Emission Results table will be populated with Spots based on the comparison of the selected recalled trace with Limit 1.
Show	Shows / hides the selected recalled trace.
Trace Name	Shows the name of the saved trace.
Trace File Path	Shows the path of the saved trace file to be recalled.
Recall to Selected Trace	Recalls the trace for analysis into the Recalled Traces table.
Math Trace on page 399	
Show	Shows / hides the selected Math trace.
Freeze	Halts updates to the Math trace.
Save Trace As	Saves the selected trace to a file for later recall and analysis.

Table continued…

Setting	Description
Show recalled trace	Displays a saved Math trace instead of a live trace. When a Math trace is recalled, controls such as Show, Freeze and selections of traces for Math will be disabled.
Trace selections for Math	The Math trace is the result of subtracting one trace from another. Choose the traces for the difference operation from the two drop down menus. Trace 1 – Trace 2 is performed at every trace point.

Save a live trace



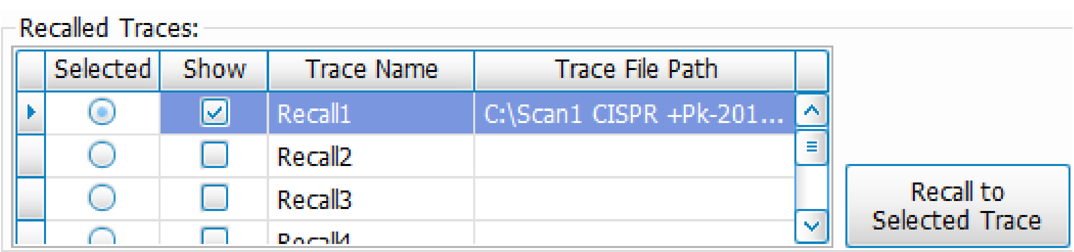
To save a live trace for later analysis:

1. Select the **Save Selected 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**.

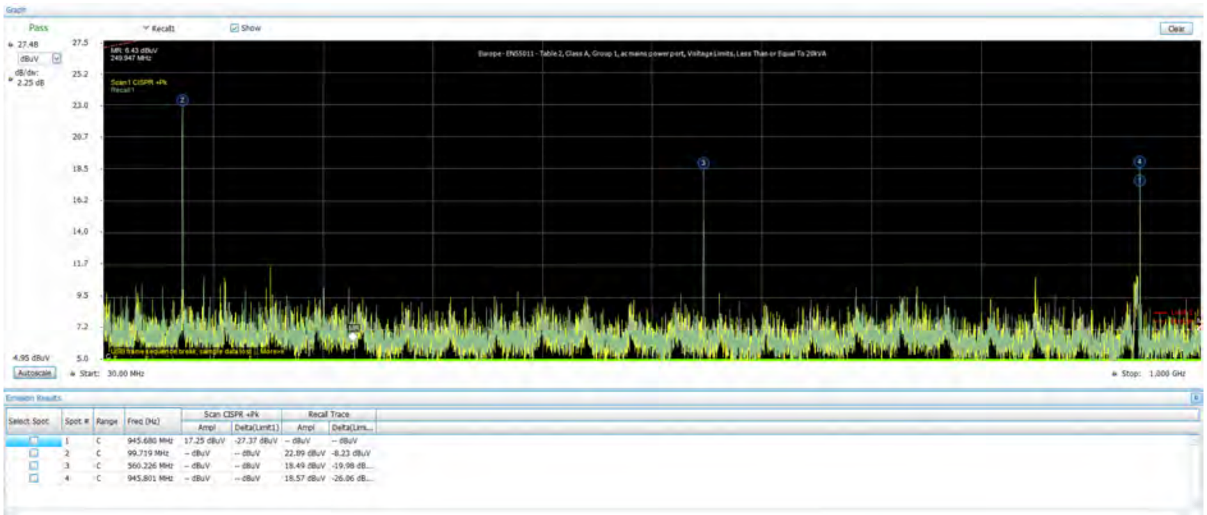
Recalling Traces

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

1. Select a trace from the Recalled Traces table in the Traces tab and check the **Show** check box next to it. This will be the trace to which you will recall a previously saved trace.



2. Click the **Recall to Selected Trace** button to display the Open dialog box.
3. Navigate to the desired file or use the default.
4. Select the appropriate trace to be opened and click **Open**.
5. The recalled trace will be plotted on the graph and comparison with Limit 1 will be done. Results will be shown in the Emission Results table.

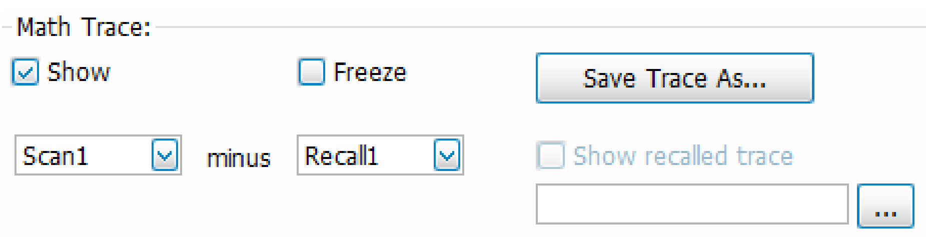


Math Trace

The Math trace is a mathematically-derived trace defined as the difference between two traces. You can select the two traces for the difference calculation from the Live Traces, Recalled Traces, and the Ambient Traces.

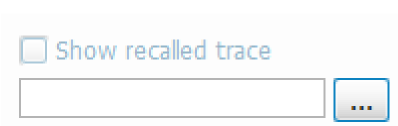
1. Select any trace from the two drop-down lists provided. Traces can either be live Scan traces, any of the 5 recalled traces, or an Ambient trace.

   The difference between the two traces will be derived from the operation Trace1 minus Trace 2.

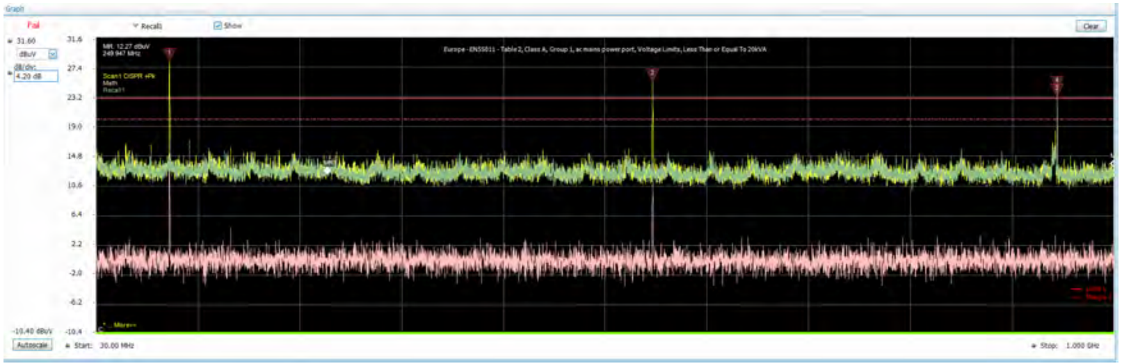
2. Check the **Show** check box to set the Math trace as the active trace on the graph. You can also check the Freeze check box to halt updates of the trace on the graph.
3. Save the Math trace to a file using the **Save Trace As** button.
4. A saved trace can be recalled for analysis as follows:

   a. Click the **...** button.

   b. Navigate to the desired file and click Open. The path will appear in the field next to the **...**.

   c. Check the **Show recalled trace** check box to show the recalled trace. When a trace is recalled under Math, controls such as Show, Freeze, and selections of traces for Math will be disabled.



- The Math function is done for each range set in the Ranges & Limits tab of the EMC Settings control panel.
- If the span or trace points for any range does not match, then an error message will appear for Math traces. For example:

  “No Math trace: Unmatched trace X range”

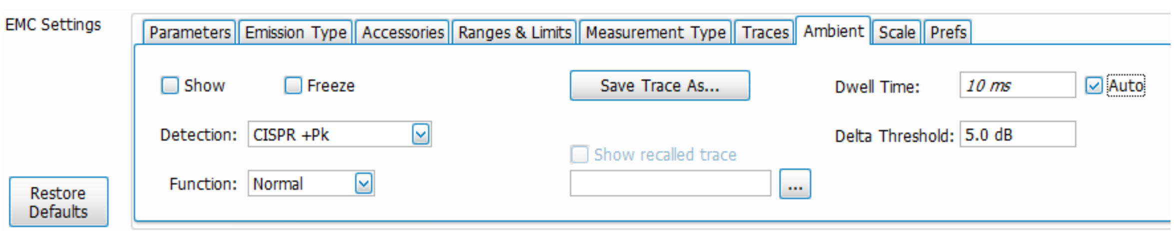
  “No Math trace: Unmatched trace lengths”
- The Math trace is done only for log units in Y axis and the difference trace is calculated by mere subtraction of the dB values.

Tip: See the *Compare Traces* on page 368 topic for more information about using traces for *EMC Troubleshooting* on page 363.

Ambient tab - EMC

Favorites toolbar:

This tab is available for the EMC-EMI display from the EMC Settings control panel. It provides settings related to the Ambient measurement and Ambient trace control. These settings only apply to measurements performed when **Measure Ambient** is clicked from the EMC related items on the Favorites toolbar (or **Setup > EMC > Measure Ambient**). This measurement is useful for capturing emissions caused by the environment or the spectrum analyzer equipment.



Setting	Description
Show	Shows / hides the ambient trace in the graph. Also controls the visibility of the ambient results in the Emission Results table (Amplitude and Delta values). *See the Measure ambient* on page 357 *topic for more information about ambient results and how to perform a scan.*
Freeze	Halts updates to the ambient trace.

Table continued…

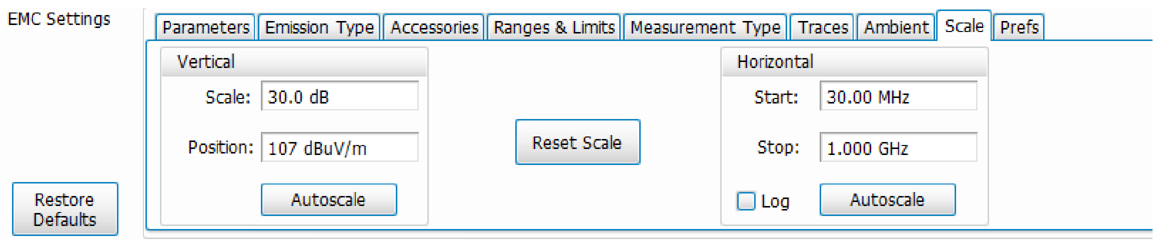
Setting	Description
Detection	Sets the detection method. Ambient trace comparison results with Scan will not be shown in the Emission Results table if the detector type of Ambient and Scan do not match. Available detection methods are: Avg(VRMS), + Peak, MIL +Peak, CISPR QPk, CISPR Pk, CISPR Avg, Avg (of logs), CISPR Avg (of logs).
Function	Selects the ambient trace processing method. Available settings are: Normal, Max Hold, Avg (VRMS), and Avg (of logs).
Count	Sets the number of traces averaged to generate the displayed trace. Only available when Function is set to anything other then Normal. When Function is Normal, this control is not editable because the count is 1.
Save Trace As	Saves the selected ambient trace and selected detector to a file for later recall and analysis. Traces are saved along with the selected detector for help in comparing Scan trace with Ambient trace A save performed from the Traces tab saves only the trace. The detector type is not saved.
Show recalled trace	Shows the recalled ambient trace information and the saved selected detector. When this check box is checked, the detection control is loaded with the saved detector result and is not available for selection. Function, Freeze, and Dwell Time controls are also disabled when Show recalled trace is selected. Traces that were saved from the Traces tab can also be recalled into the Ambient tab. However, those recalled traces will not contain saved detector selections. In these cases, you must manually select the detector type before recalling such a trace.
Dwell Time	Shows the duration of the measurement. When the **Auto** check box is checked, it sets the Dwell Time automatically based on the frequency range set in the Ranges & Limits tab of the EMC Settings control panel.
Delta Threshold	Shows the threshold difference. If the absolute difference between a Scan trace and an Ambient trace is less than the Delta Threshold, then those Spot Ambient results are shown in blue. This threshold setting allows you to *quickly check* if the peaks/spots obtained are due to ambient interference or the equipment.

Tip: See the *Measure ambient* on page 357 topic for more information about ambient measurements.

Scale tab — EMC

Favorites toolbar:

This tab is available for the EMC-EMI display from the EMC Settings control panel. It 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. In effect, these controls operate like pan and zoom controls.

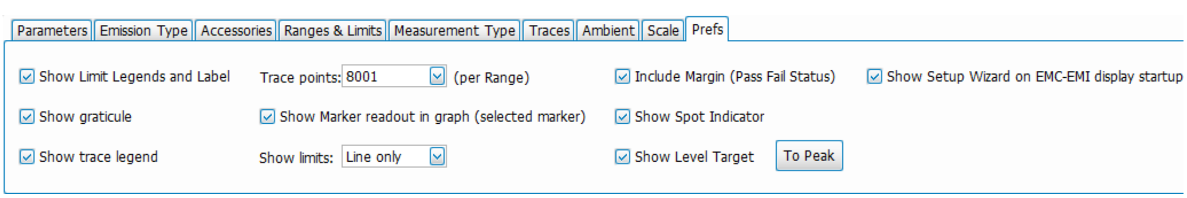


Setting	Description
Vertical	Controls the vertical scale and position of the trace display.
Scale	Changes the vertical scale units. It is 10* dB/div setting on the display.
Position	Sets the value for the top of the display.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	
Start	Sets the Zoom Start frequency. This only affects the start frequency shown on the graph.
Stop	Sets the Zoom Stop frequency. This only affects the stop frequency shown on the graph.
Log	Sets the display to show the frequency axis in a logarithmic scale. The Limit lines are also interpolated with x-axis in Log scale when this is selected.
Autoscale	Resets the scale of the horizontal axis to contain the complete trace.
Reset Scale	Resets all settings to their default values.

Prefs tab — EMC

Favorites toolbar: 

This tab is available for the EMC-EMI display from the EMC Settings control panel. It allows you to change the parameters of the EMC-EMI display.



Setting	Description
Show Limit Legends and Label	Shows or hides limit legends and label. Label can be edited in the Ranges & Limits tab.
Show graticule	Shows or hides the graticule in the display.
Show trace legend	Shows or hides the trace legend.

Table continued…

Setting	Description
Trace points (per Range)	Sets the number of trace points used for showing scan results. Default value is 8001.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Show Limits	Set how limits are shown: **Shaded**: Shows limits using a shaded area. **Line Only**: Shows limits using only a line. **Off**: No lines or shading are used to indicate limits in the graph.
Include Margin (Pass/Fail Status)	Sets Pass/Fail status to be based on Limit line with margin and not just Limit line.
Show Spot Indicator	Three types of Spot indicators are there (based on whether a Spot violates limit lines, limit lines with margin, or just threshold).
Show Level Target	Shows or hides Level Target in the EMC-EMI display.
To Peak *(Only available when Show Level Target is enabled)*	Sets the Level target at peak of the trace.
Show Setup Wizard on EMC-EMI display startup	Shows or hides the EMC Project Setup Wizard when launching the EMC-EMI display.

APCO P25 Analysis

P25 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*
- *P25 Standards Presets* on page 405
- *P25 Displays* on page 406
- *P25 Settings*
- *P25 Measurements* on page 406
- *P25 Test Patterns* on page 412

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 P25 Power vs Time	Yes	Yes
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
Frequency deviation	P25 Summary (Freq Dev)	Yes	HCPM
Modulation fidelity	P25 Summary P25 Constellation	Yes	Yes
Symbol rate accuracy	P25 Summary	Yes	Yes

Table continued…

TIA-102 transmitter measurement	Tektronix measurement display(s) (value name if different from TIA-102 measurement name)	Phase 1	Phase 2
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	HCPM
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*.

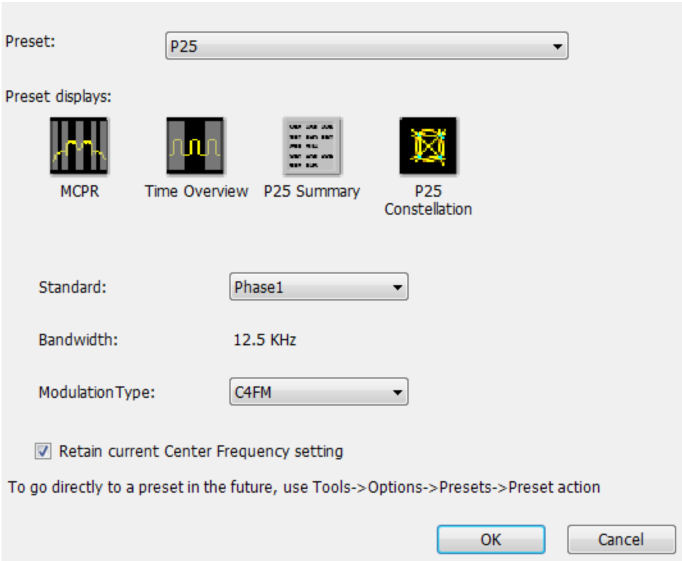
The following table shows the bandwidth, modulation type, and displays that are automatically loaded for each of the listed standards. MCPR masks are also loaded and are explained *here*.

Table 20: 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 Summary
	HDQPSK (outbound)	12.5	

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.



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:

- *MCPR*
- *P25 Constellation*
- *P25 Power vs Time*
- *P25 Eye Diagram Display*
- *P25 Frequency Dev Vs Time*
- *P25 Symbol Table*
- *P25 Summary*
- *Time Overview*

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.
- The result shown in the P25 Summary display does not account for any attenuation introduced by a user. Ensure that this attenuation is accounted for when you enter limits for comparison.
- 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*.

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.

  In Operating Frequency Error, double sided operating frequency error is converted to one sided error and compared against the Absolute Limit.
- 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.
- The Low pass filter cut off frequency can be set from the Analysis Params tab of the Settings Control panel. The default value of the cut off frequency is 5 kHz.
- 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.
- HDQPSK-P25 filter attempts to remove the Inter Symbol Interference before symbol detection.

Note: Read about important information related to HCPM bursty data measurements *here*.

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.
- 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:

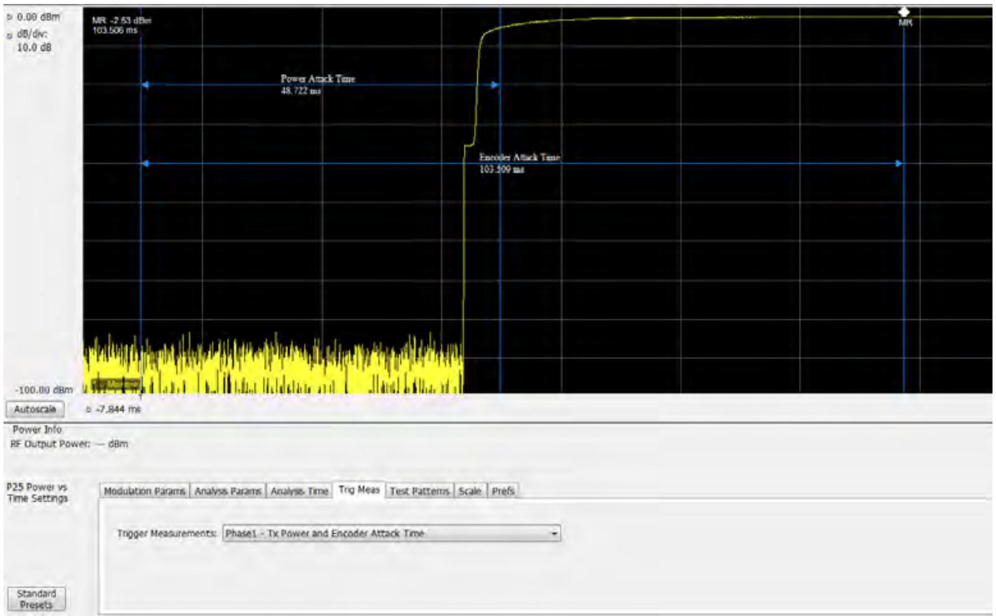
- **Transmitter Power and Encoder Attack Time (Phase 1)**: This measurement is the time required for a transmitter to prepare and transmit information on the radio channel after changing state from standby to transmit (applies to conventional mode). This measurement result can be seen in the P25 Summary 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.
- 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.



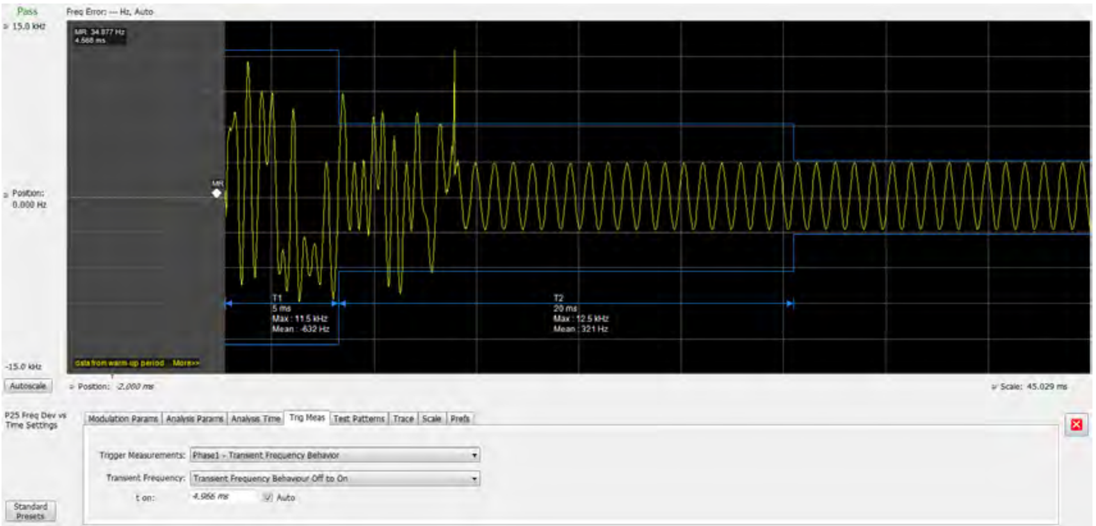
Transmitter Throughput Delay (Phase 1). The following information is specific to this measurement.

- 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/MDO4000B/C (after it has gone through the DUT and calibrated receiver) has hit the power levels desired.
- 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*.

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_{ONREL} is the maximum level observed in the interval 1 ms to 29 ms and P_{OFFREL} is the maximum level observed in 30.2 ms to 59.8 ms.
- P_{TX} is the rated carrier power and can be set by the user 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*.

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*.

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.

Table 21: P25 test patterns, Phase 1 C4FM

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
	Transmitter Power and Encoder Attack Time (With Busy/Idle Operations)

Table continued…

TIA-102 Phase 1 C4FM test pattern	Phase 1 (C4FM) measurement
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 (Same as High Deviation test pattern	Symbol Rate Accuracy
	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 22: 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

Table continued…

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 (User created test pattern)	Can be used for measurements such as RF Output Power, Operating Frequency Accuracy, Modulation Fidelity, and ACPR

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 ≥ 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.

  HCPM Pilot symbols are not displayed in the P25 Symbol Table.

  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.

  The analysis module does not analyze two active adjacent slots (28 ms each) if they do not have the off slot (power off) region between them.

  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.*

Note: The test patterns, except for High Deviation and Low Deviation, do not impact the HCPM pattern analysis for other selected test patterns, such as Standard Transmitter Test Pattern, Inbound Standard Tone Test Pattern Ch0, Inbound Standard Tone Test Pattern Ch1, Inbound Symmetrical Time Bound Test Pattern, and Others.

P25 Constellation Display

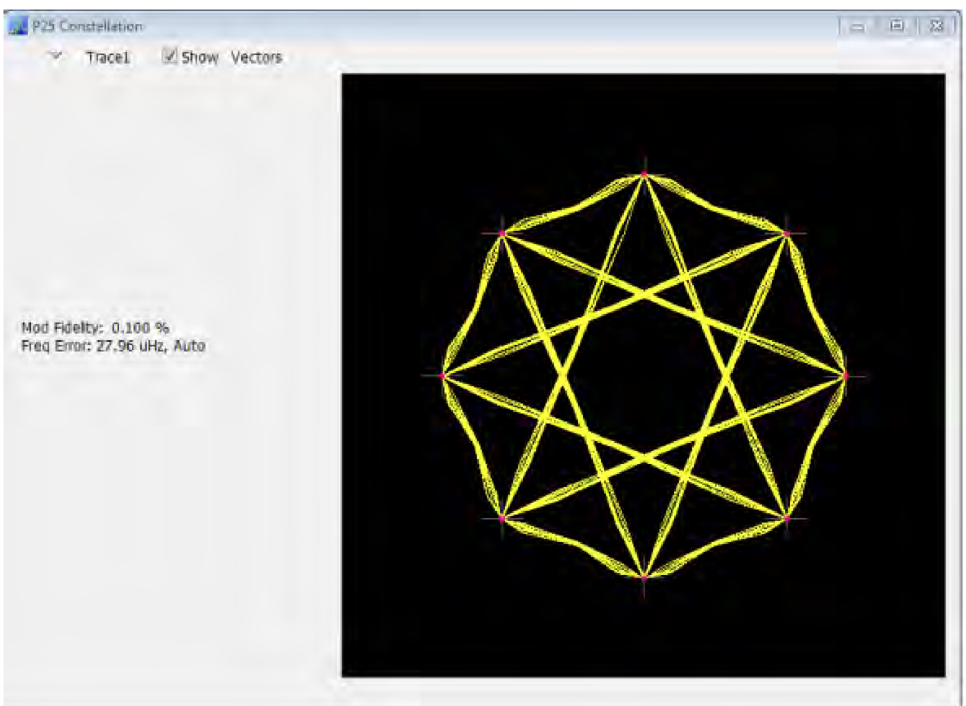
The P25 Constellation Display shows the P25 signal modulation amplitude. For the HCPM and HDQPSK standards, you can view this display as frequency deviation or as I and Q. For the C4FM standard, only the frequency deviation applies.

To show the P25 Constellation display you can select **Presets** > **Standards** > **P25** or do the following:

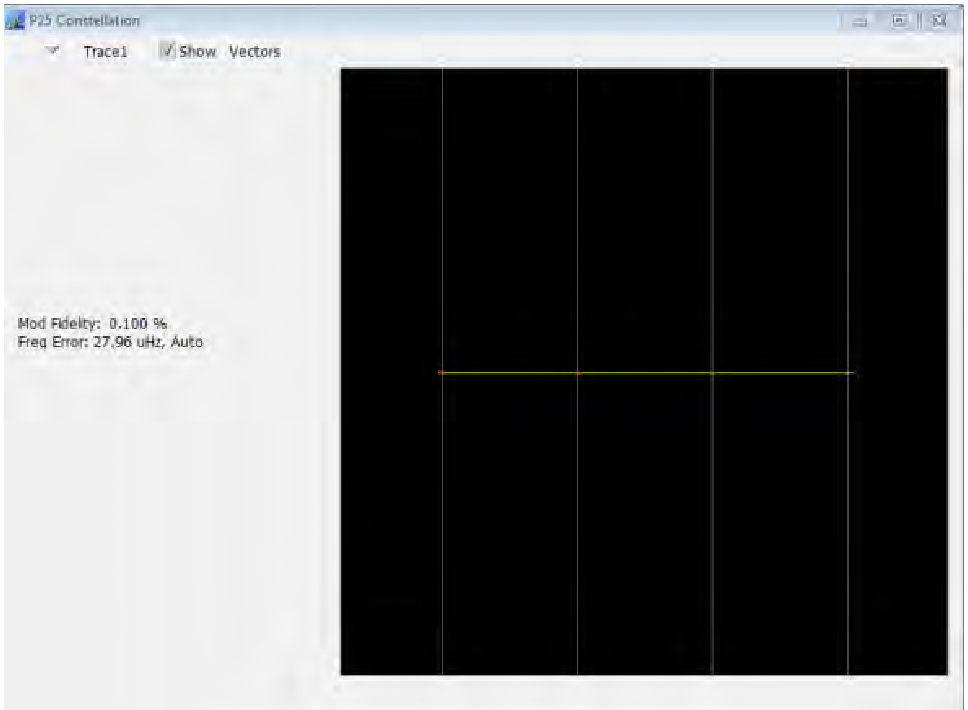
1. Press the **Displays** button or select **Setup** > **Displays**.
2. In the **Select Displays** dialog, select **P25 Analysis** in the **Measurements** box.
3. In the Available displays box, double-click the **P25 Constellation** icon or select the icon and click **Add**. The P25 Constellation icon 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.



Item	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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar: 

The P25 Constellation Settings control panel provides access to settings that control parameters of the Constellation Display.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.

Table continued…

Settings tab	Description
Analysis Params	Specifies parameters 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 P25 Analysis displays.
Test Patterns	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	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	Specifies the radix of the marker readout and whether elements of the graphs are displayed.
Trig Meas	Enables you to select from several different trigger measurements.

P25 Eye Diagram Display

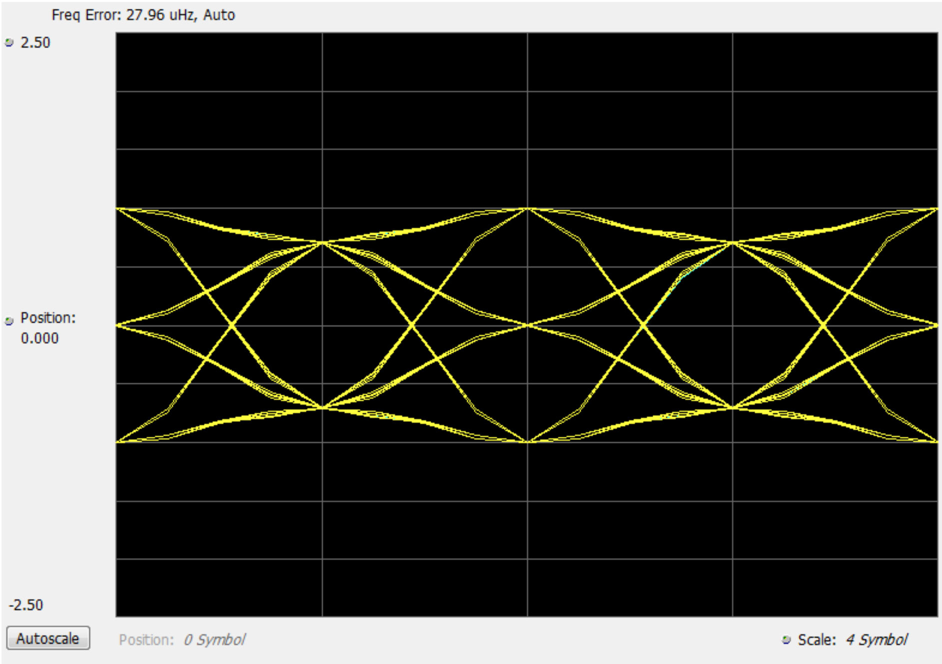
The P25 Eye Diagram display shows a digitally modulated signal overlapped on itself to reveal variations in the signal.

To show the P25 Eye Diagram display:

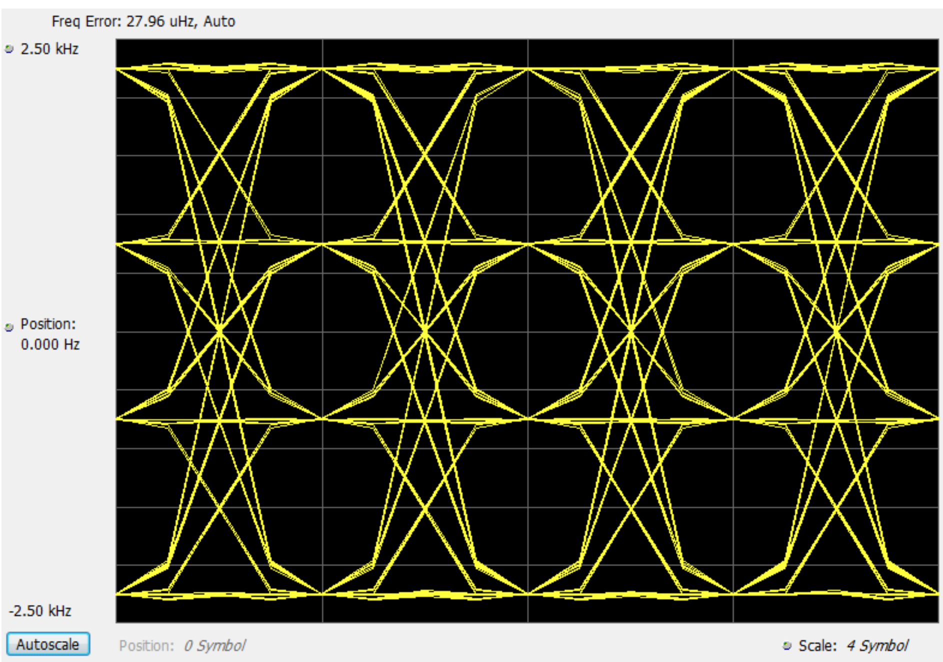
1. Press the **Displays** button or select **Setup** > **Displays**.
2. From the **Measurements** box, select **P25 Analysis**.
3. Double-click the **P25 Eye Diagram** icon in the **Available Displays** box. This adds the P25 Eye Diagram icon to the **Selected displays** box.
4. Click **OK** button. 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.



Item	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.

Table continued…

Item	Display element	Description
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

Main menu bar: Setup > Settings

Front panel: Settings

Favorites toolbar:

The settings for the P25 Eye Diagram display are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters 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) for P25 Analysis displays.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns	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	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	Defines the vertical and horizontal axes.
Prefs	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

P25 Power vs Time Display

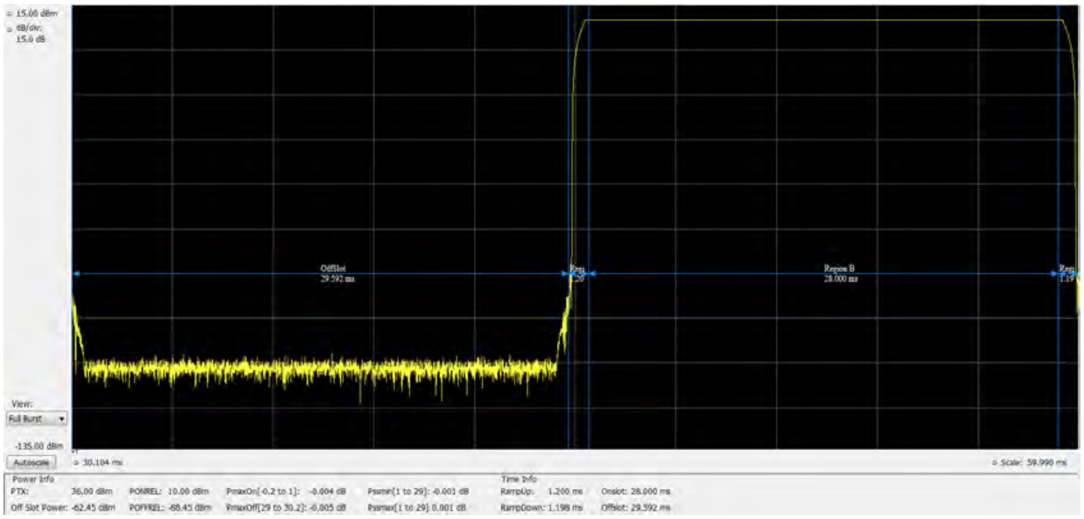
The P25 Power vs Time display shows the signal power amplitude versus time. In HCPM bursty data, the Regions A, B and C are shown based on the middle of the burst and not based on the pilots.

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



Item	Display element	Description
1	Top of graph, first setting	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	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
3	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.
4	View (Only available for bursty HCPM data.)	Selects the specific view of the packet burst within the display: 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.
5	Bottom of graph readout	Shows the Power level at the bottom of the graph in dBm.
6	Autoscale	Adjusts the vertical and horizontal settings to provide the best display.
7	Bottom of graph, left side	Sets the starting time of the graph in seconds
8	Bottom of graph, right side	Sets the scale (width) of the graph in seconds

Table continued…

Item	Display element	Description
9	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

Main menu bar: Setup > Settings

The settings for the P25 Power vs Time display are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters 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) for P25 Analysis displays.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns	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	Defines the vertical and horizontal axes.
Prefs	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:

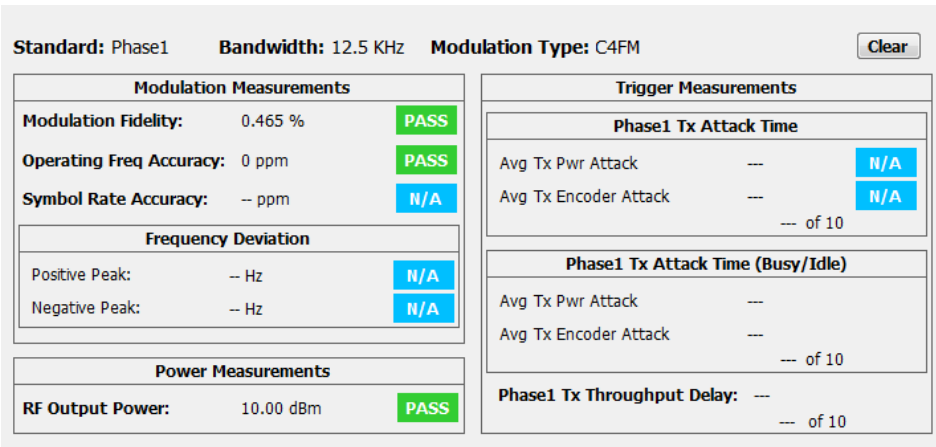
1. Press the **Displays** button or select **Setup** > **Displays**.
2. In the **Select Displays** dialog, select **P25 Analysis** in the **Measurements** box.
3. In the Available displays box, double-click the **P25 Summary** icon or select the icon and click **Add**. The P25 Summary icon will appear 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.

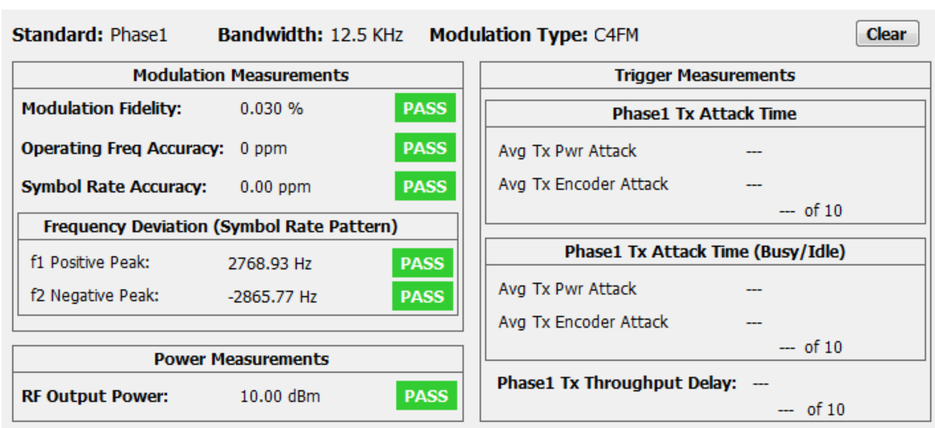
P25 Summary Display

The Modulation Measurements, Power Measurements, and Trigger Measurements components of this display vary depending on which modulation type is selected.

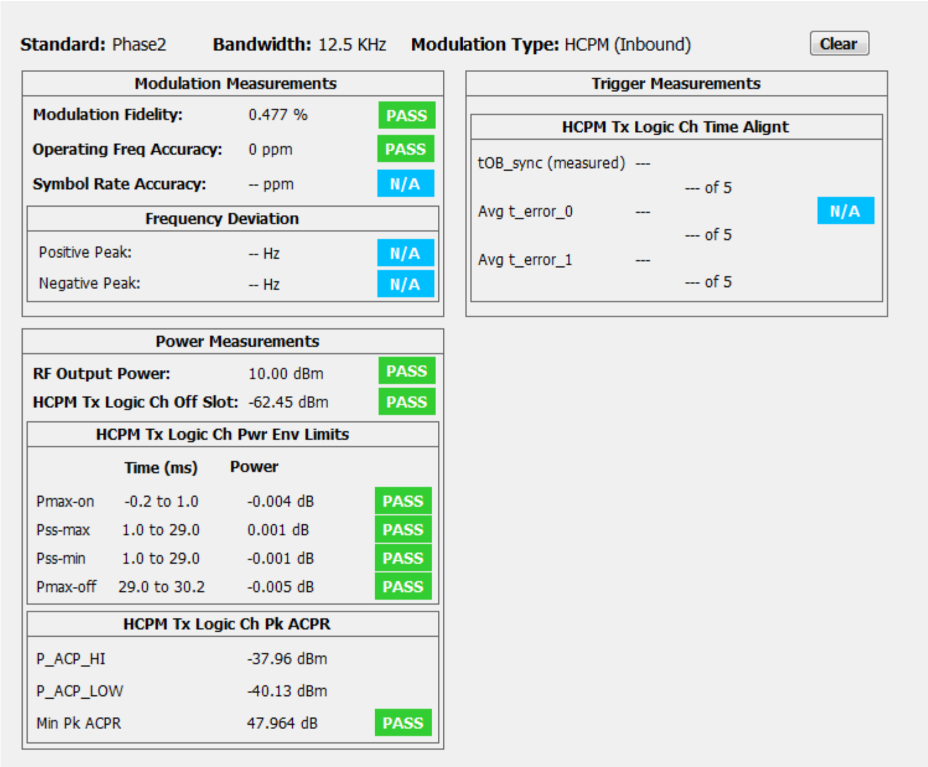
The following image shows an example of the display for a Phase 1 C4FM signal.



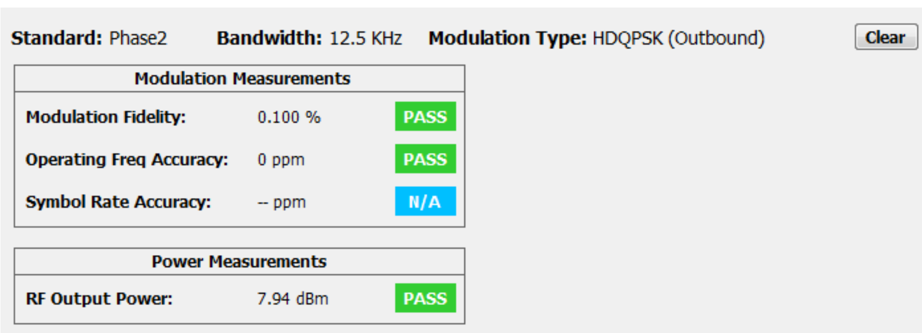
The following image shows an example of the display for a Phase 1 C4FM High Deviation signal.



The following image shows an example of the display for a Phase 2 HCPM (Inbound) signal.



The following image shows an example of the display for a Phase 2 HDQPSK (Outbound) signal.



For more information about specific measurement results, see the P25 Measurements section *here*.

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.

Table continued…

Element	Description
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

Main menu bar: Setup > Settings

The settings for the P25 Summary display are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters 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) for P25 Analysis displays.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns	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	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:

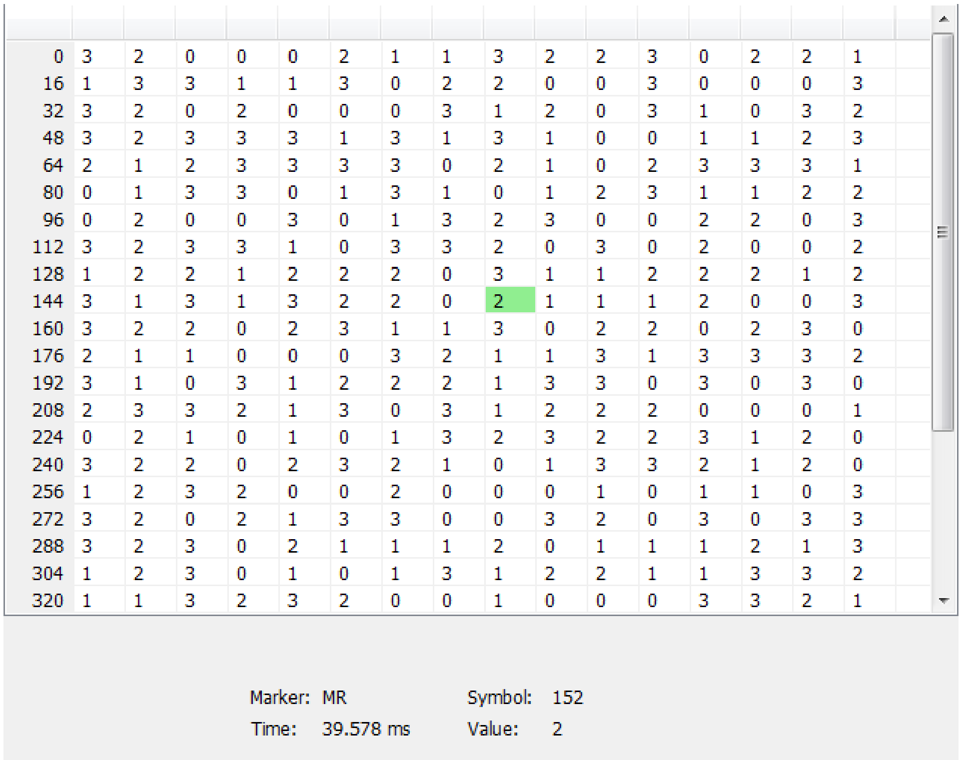
1. Press the **Displays** button or select **Setup** > **Displays**.
2. In the **Select Displays** dialog, select **P25 Analysis** in the **Measurements** box.
3. In the Available displays box, double-click the **P25 Symbol Table** icon or select the icon and click **Add**. The P25 Symbol icon will appear 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*.

	B1	B2
0	1	3
1	3	1
2	2	1
3	1	0
4	2	3
5	3	3
6	0	0
7	3	1
8	2	3
9	1	2
10	0	3
11	2	2
12	3	0
13	1	3
14	2	2
15	2	2
16	0	1
17	0	3
18	0	2
19	3	3
20	2	3
21	1	0
22	3	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

Marker: MR Symbol: 152
Time: 39.578 ms Value: 2

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

Main menu bar: Setup > Settings

The settings for the P25 Symbol Table display are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters used by the instrument to analyze the input signal.

Table continued…

Settings tab	Description
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) for P25 Analysis displays.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns	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	Specifies the radix of the marker readout.

P25 Frequency Dev vs Time Display

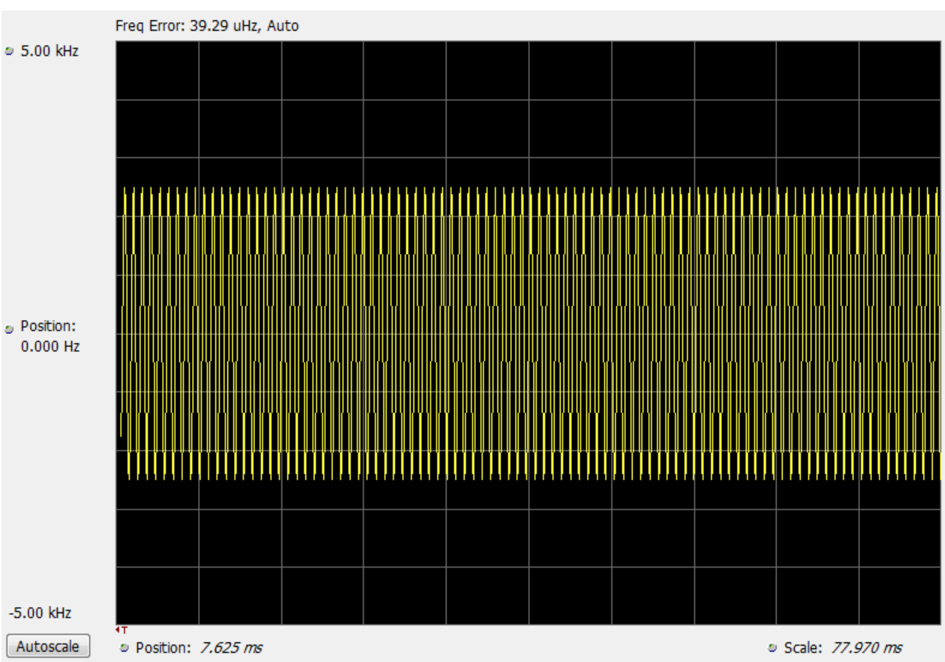
The P25 Frequency Deviation vs. Time Display shows how the signal frequency varies with time.

To display the P25 Frequency Dev vs. Time Display:

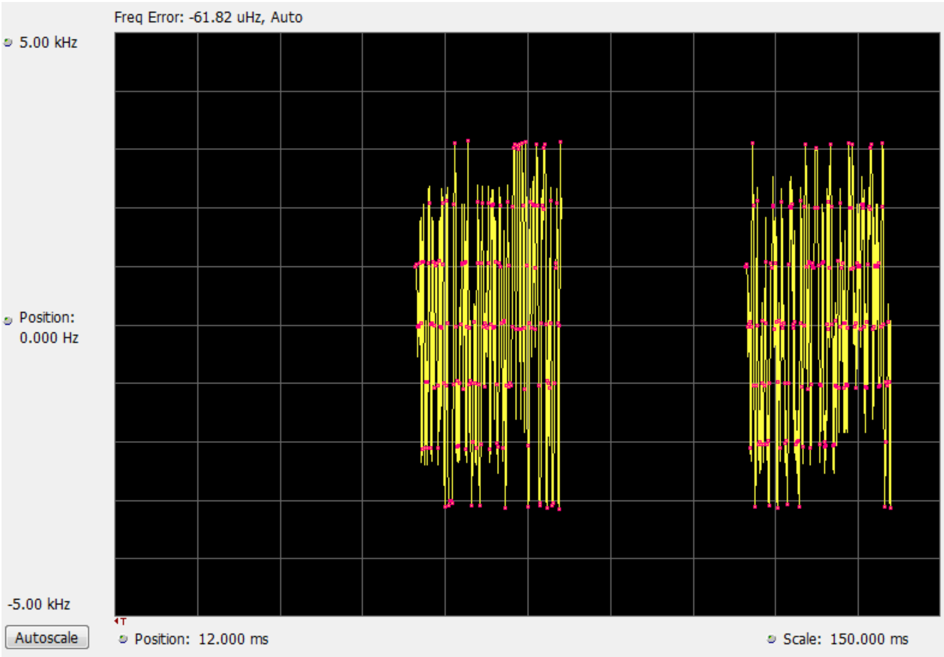
1. Select the **Displays** button or **Setup** > **Displays**.
2. In the **Select Displays** dialog, select **P25 Analysis** in the **Measurements** box.
3. In the **Available displays** box, double-click the **P25 Frequency Dev vs. Time** icon or select the icon and click **Add**. The P25 Frequency 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*.

Elements of the Display

Item	Display element	Description
1	Top of graph adjustment	Adjust the frequency range displayed on the vertical axis.
2	Position (center)	Adjust 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	Position	Displays the horizontal position of the trace on the graph display.
5	Scale	Adjust the horizontal scale (time).

Changing Frequency vs Time Display Settings

P25 Frequency Dev Vs Time Settings

Main menu bar: Setup > Settings

The Setup settings for P25 Frequency Dev vs. Time are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters 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) for P25 Analysis displays.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.
Test Patterns	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	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	Defines the vertical and horizontal axes.
Prefs	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

P25 Analysis Shared Measurement Settings

Main menu bar: Setup > Settings

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.

Table 23: Common controls for P25 analysis displays

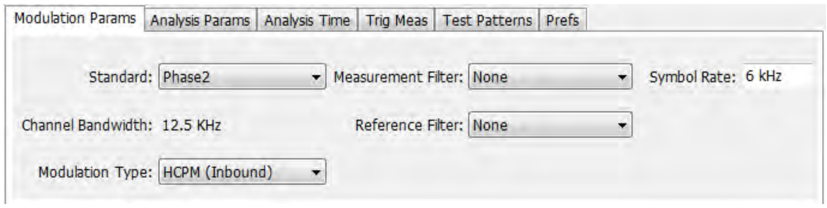
Settings tab	Description
Modulation Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters used by the application to analyze the input signal.
Analysis Time	Specifies parameters that define the portion of the acquisition record that is used for analysis. Also allows you to specify the Units (Symbols or Seconds) for P25 Analysis displays.
Trace	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	Defines the vertical and horizontal axes.
Test Patterns	Enables you to select from eight different test patterns.
Trig Meas	Enables you to select from various trigger measurements. The trigger selections vary by signal type.

Table continued…

Settings tab	Description
Prefs	Specifies the radix of the marker readout and whether elements of the graphs are displayed.

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.



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).

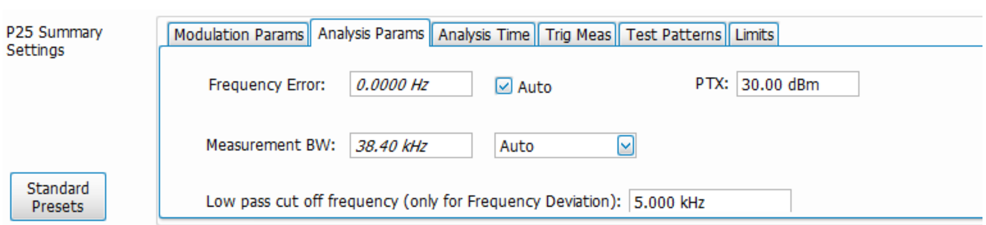
The Reference Filter setting in the analyzer corresponds to the baseband filter in the transmitter-receiver combination (Fr * Ft). The baseband filter for the transmitter-receiver combination is often referred to as the *System Filter*. This filter is called the reference filter because it is used to 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.



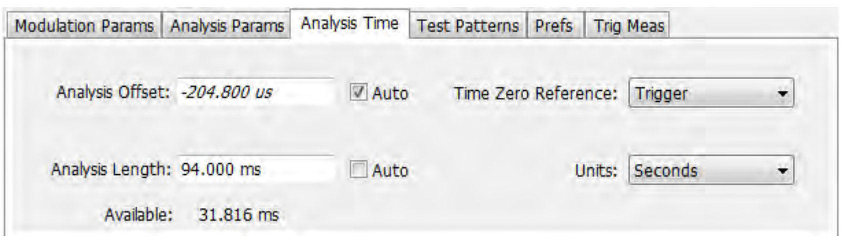
Settings	Description
Frequency Error	When the Auto box is checked, the analysis determines the Frequency Error and the measured Frequency Error is displayed. When the Auto box is unchecked, the entered value is used by the analysis as a fixed frequency offset. This is useful when the exact frequency offset of the signal is known.

Table continued…

Settings	Description
Measurement BW	Specifies the bandwidth about the center frequency at which measurements are made. Select Manual, Auto, or Link to Span.
PTX	Specifies the RF Output Power as recommended for transmitters. This is only used in the computation of off slot power in HCPM modulated signals.
Low Pass cut off frequency (only for frequency deviation)	Specifies the filter cut off frequency for Frequency deviation measurement. This setting will only affect the scalar results Frequency Deviation (Positive and Negative Peak f1,f2,f3, and f4) in the Summary display. This selection is only visible when High or Low Deviation or Standard Transmitter Symbol Rate Pattern is chosen from the Test Patterns tab of the Settings Control panel.

Analysis Time Tab - P25

The Analysis Time tab contains parameters that define how the signal is analyzed in the P25 Analysis displays.



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.

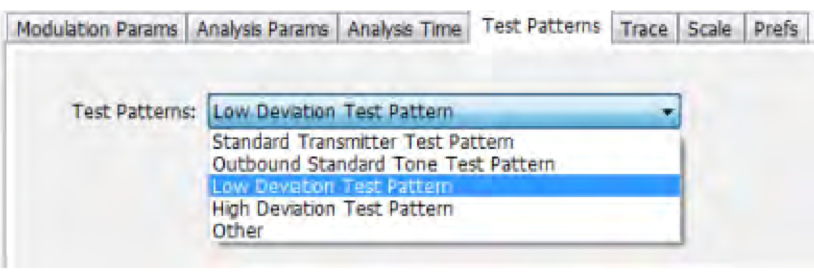
Time Zero Reference

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.



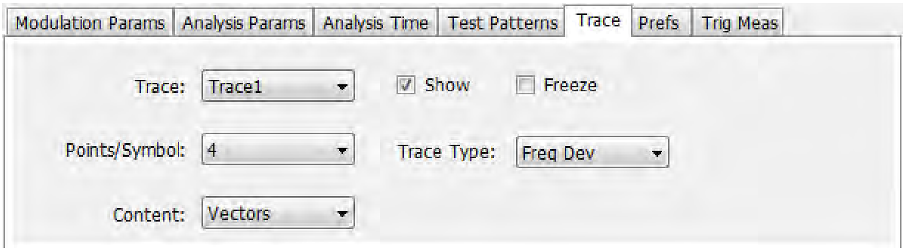
Settings	Description
Test Patterns	Use this drop-down list to select an appropriate test pattern. The list varies depending on which standard and modulation type is selected.

You can read more about test patterns *here*.

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.



Setting	Description
Trace (P25 Constellation and P25 Eye Diagram displays only)	Select the trace to display. P25 Constellation display only: Select the trace that is hidden or displayed based on whether or not Show is selected.
Show (P25 Constellation and P25 Eye Diagram displays only)	Specifies whether the trace selected by Trace is displayed or hidden.
Freeze (P25 Constellation display only)	Halts updates to the trace selected by the Trace setting. Present for the Constellation display only.
Points/Symbol	Select how many points to use between symbols when connecting the dots. Values: 1, 2, 4, 8.
Content (P25 Constellation and P25 Freq Dev & Time displays only)	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 (P25 Constellation and P25 Eye Digram displays only)	Select to specify whether the plots in the Constellation and Eye Diagram displays are 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.

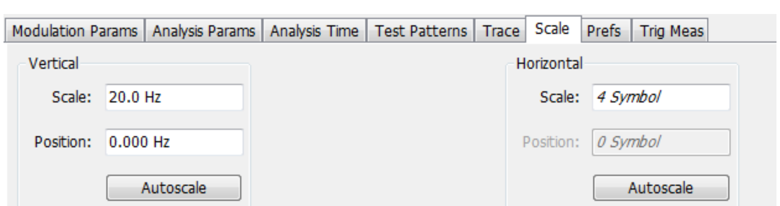


Figure 73: Scale tab for the P25 Eye Diagram display

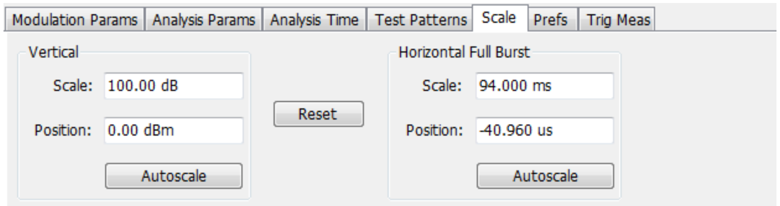


Figure 74: Scale tab for the P25 Power vs Time display

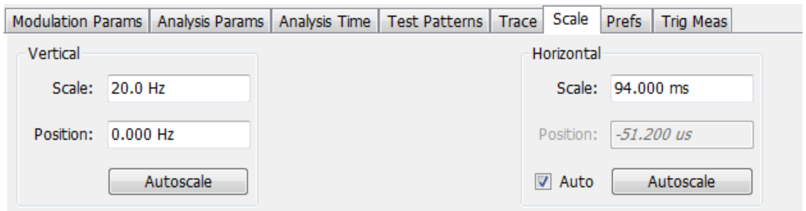


Figure 75: Scale tab for the P25 Freq Dev vs Time display

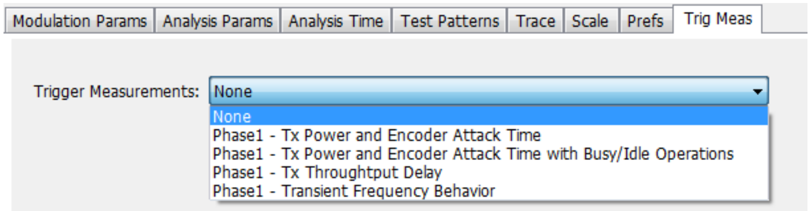
Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale of the graph.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal Horizontal Full Burst	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	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.

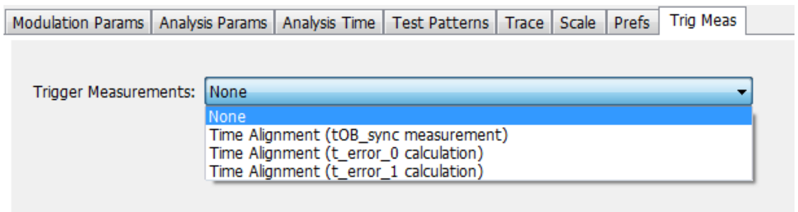
Trig MeasTab - P25

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*.

The following image shows the tab for Phase 1 (C4FM) signals.



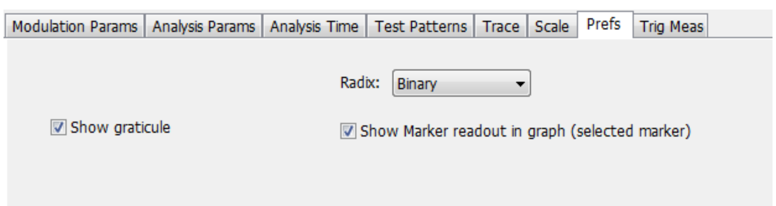
The following image shows the tab for Phase 1 (HCPM Inbound) signals.



Settings	Description
Trigger Measurements	Select the trigger measurement test.

Prefs Tab - P25

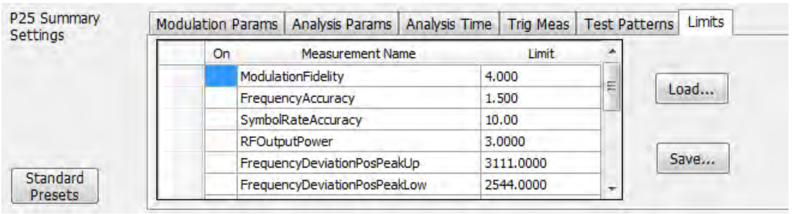
The Prefs tab enables you to change appearance characteristics of the P25 Analysis displays. Not all settings on the Prefs tab shown below appear for every P25 display. The Summary display does not have a Prefs tab.



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.



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.

Table 24: 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

LTE 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
- Reference Signal 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 *LTE measurements* on page 446 section and the supported measurements *table*.

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* on page 439
- *LTE displays* on page 445
- *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. *LTE measurements* on page 446

LTE measurement	LTE standard(s)	Description
Cell ID detection	TDD FDD	The Cell ID is detected from the input LTE 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).
Toff	TDD	The power in off-slot region is computed and compared against selected limits.
Reference Signal Power	TDD FDD	Measures the power of cell specific reference signals.

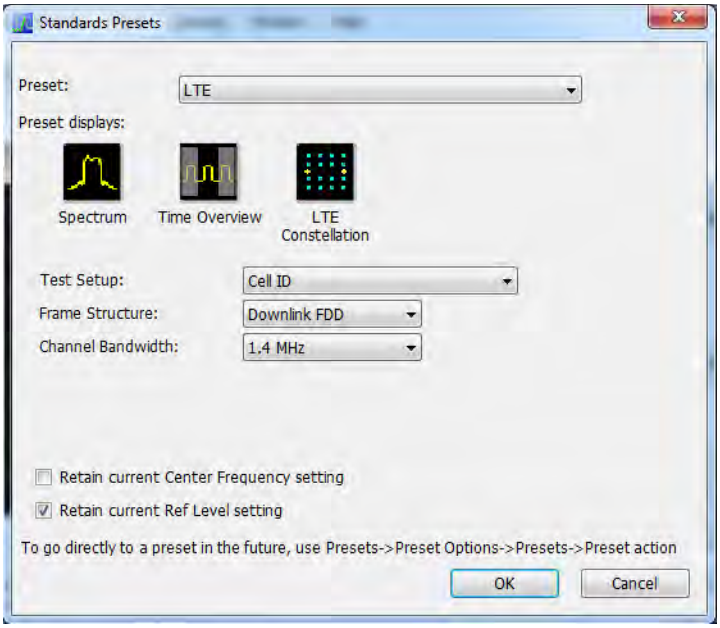
LTE Standards preset test setups

Presets > **Standards**

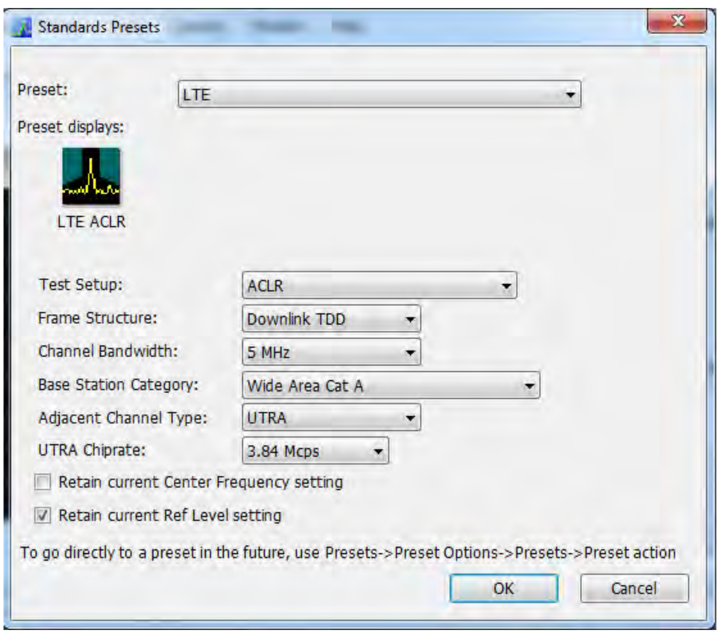
The LTE Standards preset allows you to access displays preconfigured for the test setup you select. The test setups load the displays and control setting options suggested by the LTE standard to perform the measurements. You can read more about how Presets work *here*.

There are four test setups for LTE:

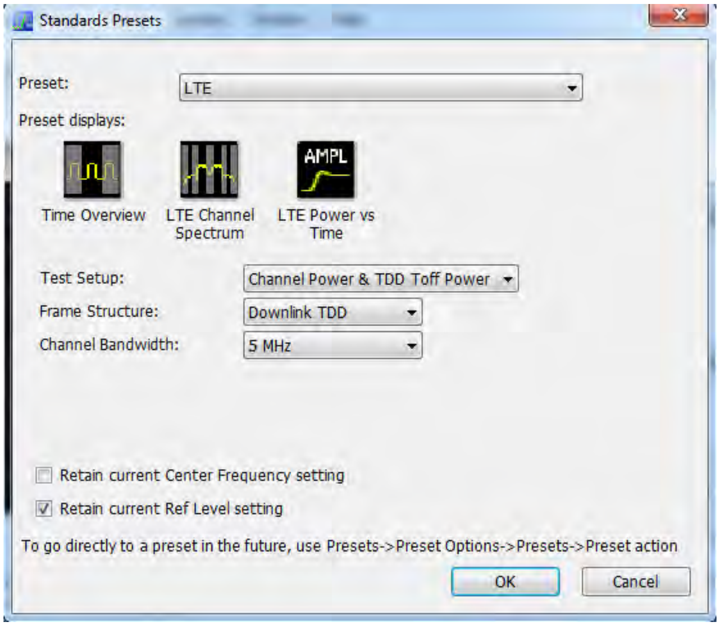
- Cell ID



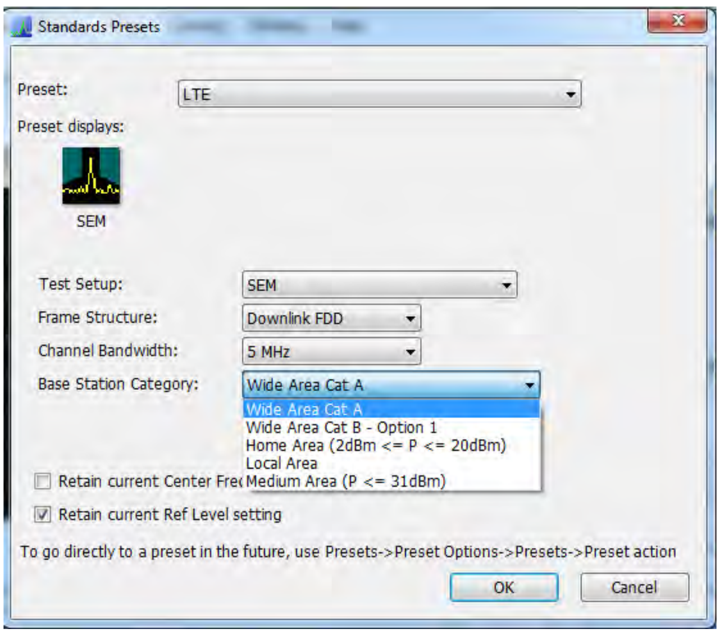
- ACLR



- Channel Power and TDD Toff Power



- SEM



The following table shows what automatically loads with each test setup.

Table 25: LTE preset test setups

Test setup		Displays loaded with preset
Cell ID	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.)	Spectrum, Time Overview, LTE Constellation
	Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz (Default is 1.4 MHz.)	

Table continued…

Test setup		Displays loaded with preset
ACLR	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.)	LTE ACLR
	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 (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.)	

Table continued…

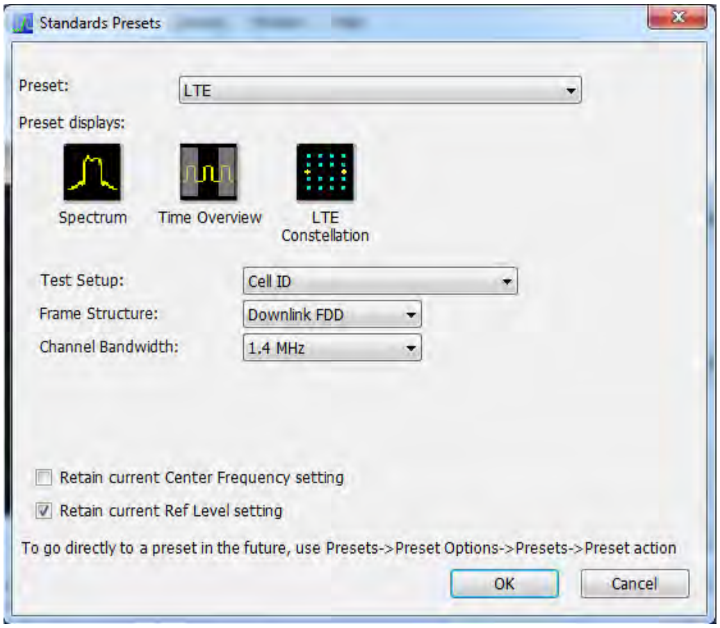
Test setup		Displays loaded with preset
Channel Power and TDD Toff Power	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.)	Time Overview (TDD only), LTE Channel Spectrum, LTE Power vs Time (TDD only)
	Channel bandwidth: 1.4, 3, 5, 10, 15, 20 MHz (Default is 1.4 MHz.)	
SEM	Frame structure: - Downlink FDD - Downlink TDD (Default is Downlink FDD.)	SEM
	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.)	

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.

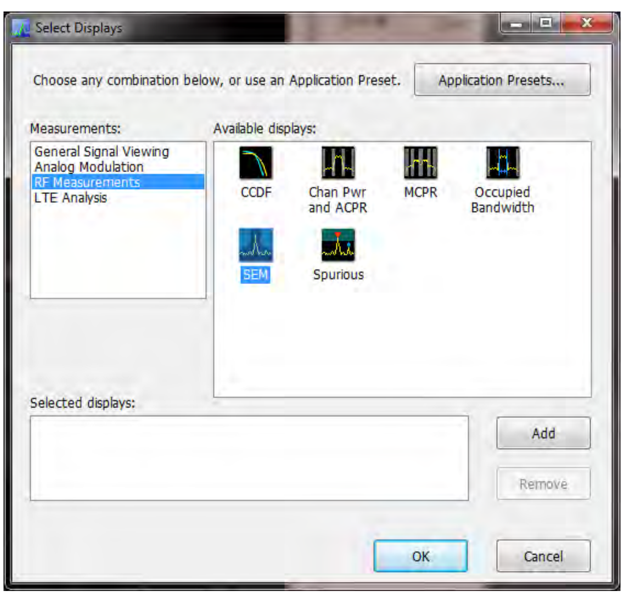
To activate these settings, check the box next to the desired setting. The following image shows the **Retain current Ref Level setting** box checked.



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).)



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 *Parameters tab* 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 dBm ≤ P ≤ 20 dBm), Local Area, Medium Area (P ≤ 31 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 *Parameters tab* 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 *LTE preset test setups table*.
- 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.

Reference Signal Power (TDD and FDD)

Reference Signal Power measures the power of cell specific reference signals. Reference signals are spread across time and frequency. Reference signal position is dependent on the Cell ID, bandwidth, and antenna ports. For Downlink TDD (frame structure type 2), the position of reference signals is also dependent on uplink-downlink and special subframe configurations.

Toff (TDD)

The Toff 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 *LTE preset test setups table*.
- 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 Toff 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**.

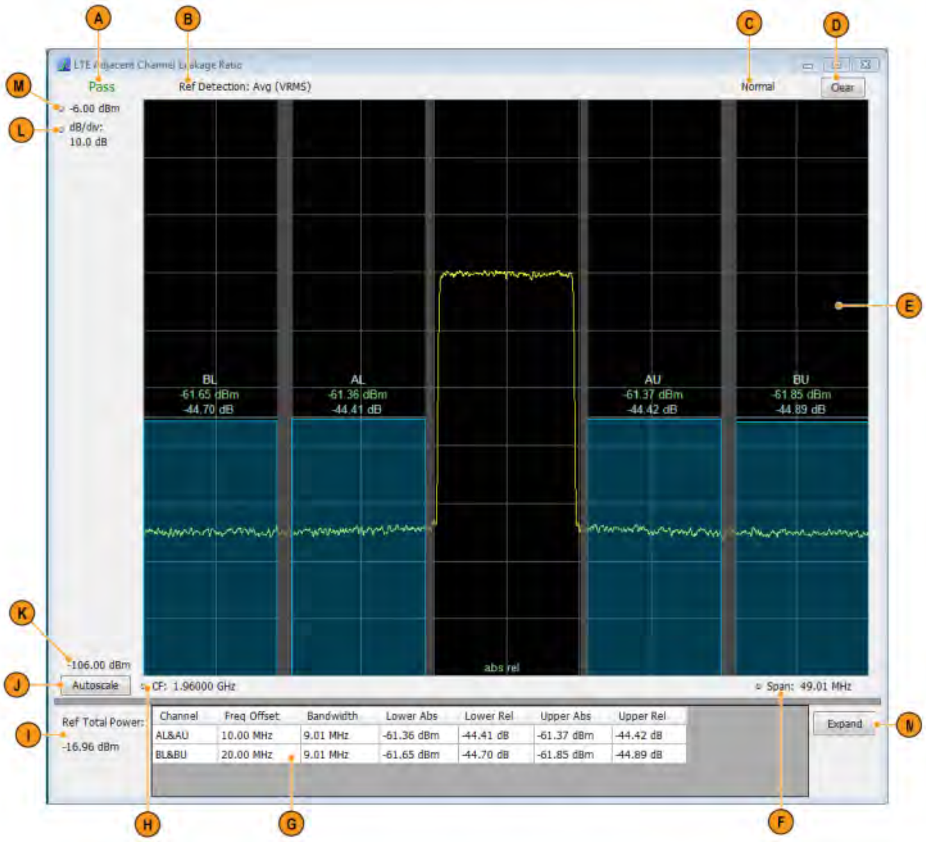
Note: Loading the LTE ACLR display from the **Presets** > **Standards** > **LTE** menu is recommended. This loads the control settings based on the selected options.

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.

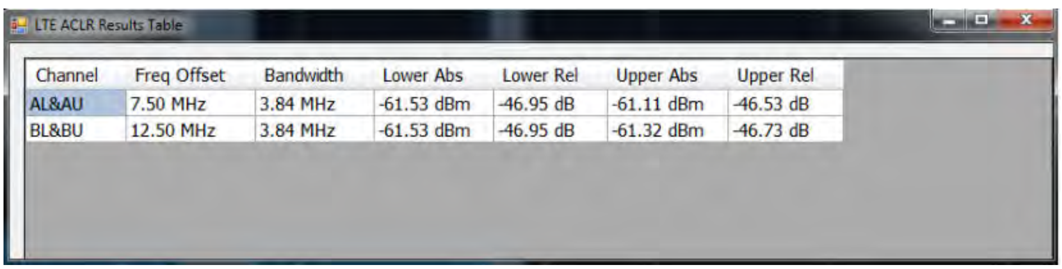


Item	Display element	Description
A	Pass/Fail	Indicates Pass or Fail based on Absolute and Relative limits set by the user. The failure condition is set by Mask in the Offset and Limits Table tab of the Settings control panel. By default, the mask is set to Abs & Rel, meaning failure is reported only when both absolute and relative results fail against the respective limits.
B	Ref Detection	Set to Avg (VRMS) or +Peak based on the choice made in Processing tab of the Settings control panel.
C	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.

Table continued…

Item	Display element	Description
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.
H	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.
(not shown)	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
M	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.


LTE ACLR Results Table

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

Main menu bar: Setup > Settings

The LTE ACLR Settings control panel provides access to settings that control parameters of the LTE ACLR display.

Settings tab	Description
Channels	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	Specifies several characteristics that control how the measurement is made. These parameters are used by the instrument to analyze the input signal.

Table continued…

Settings tab	Description
Processing	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	Allows you to select the characteristics of offsets and mask limits.
Scale	Specifies the vertical and horizontal scale settings.
Prefs	Allows you to select to show or hide the graticule, power level, limits, and marker readouts.

LTE Channel Spectrum display

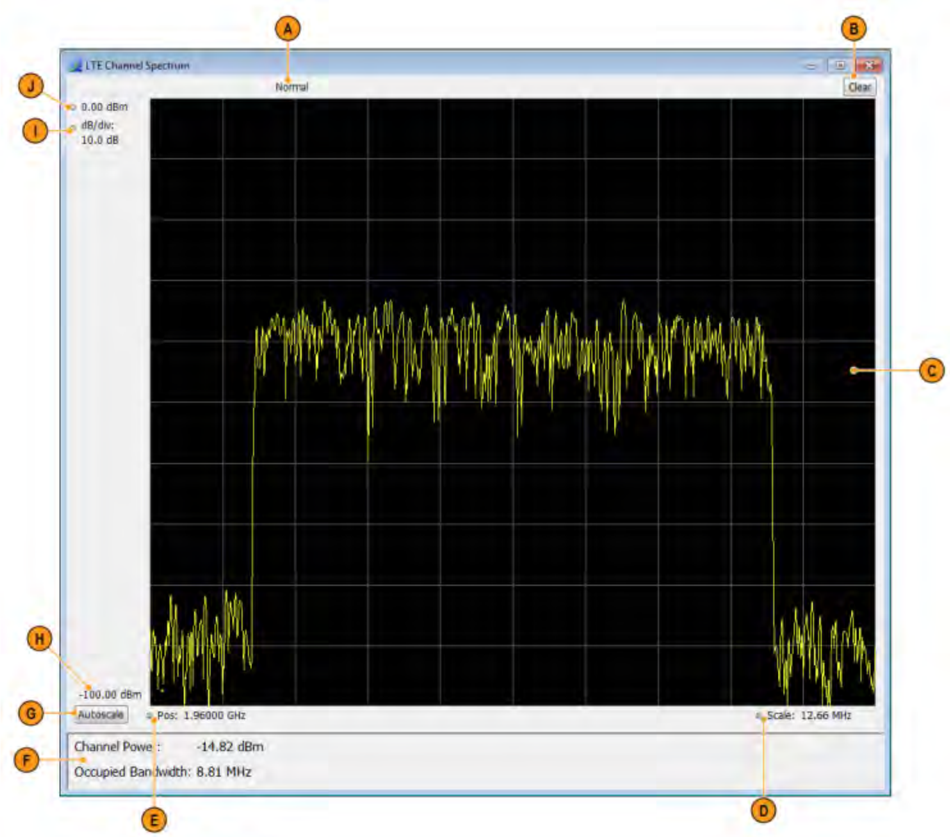
The LTE Channel Spectrum display shows the spectrum of the input signal across one channel. Channel power measures the average power within the selected bandwidth and is expressed in dBm. Other units can be selected from the Units tab of the Analysis control panel. The measured occupied bandwidth is 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.



Item	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.
B	Clear	Resets measurement. Clears all values.
C	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.
H	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.
(not shown)	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
J	Top of graph	The vertical scale is normalized with appropriate power units.

LTE Channel Spectrum Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Freq & RBW	Allows you to specify the frequency and resolution bandwidth used for the measurement.
Measurement Params	Allows you to set averaging (Time Domain, Off, or Frequency Domain) and to set the number value associated with the Average setting.
Channels	Allows you to set the Channel BW for the Channel Power measurement.
Scale	Allows you to specify the horizontal and vertical scale settings.
Prefs	Allows you to select to show or hide certain display elements.

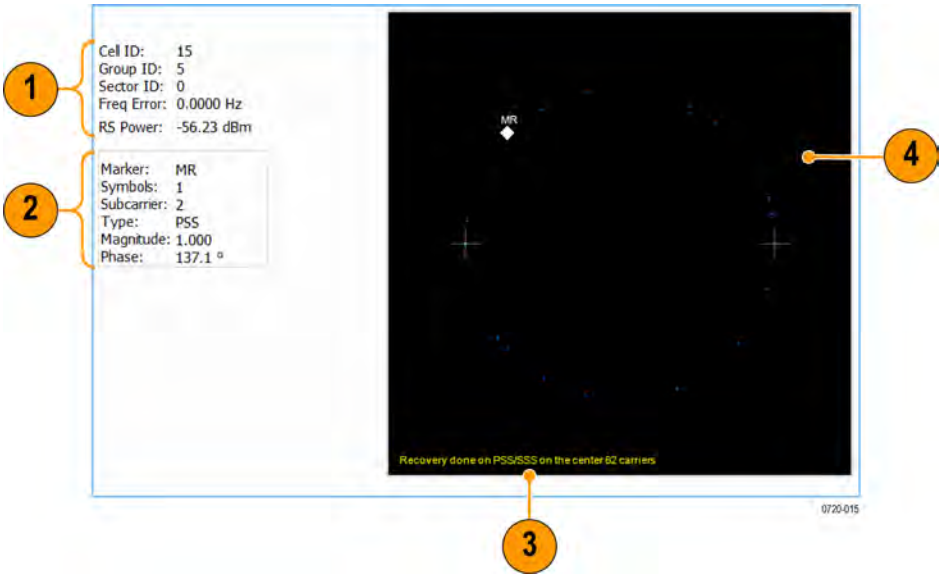
LTE Constellation display

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.



Item	Display element	Description
1	Scalar results	Gives results of Cell ID, Group and Sector ID information along with Frequency error.
2	Marker readout	Shows marker type, magnitude, phase and subcarrier number.
3	Status message	Shows relevant status messages. (You can read about status messages *here*.)
4	Plot	Displays PSS and SSS (Primary and Second Synchronization Signal) constellation.

LTE Constellation Settings

Main menu bar: Setup > Settings

The settings for the LTE Constellation display are shown in the following table.

Settings tab	Description
Modulation Params	Specifies the frame structure and channel bandwidth.
Analysis Params	Allows you to enable Equalization based on PSS (Primary Synchronization 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 LTE Analysis displays.
Trace	Allows you to set the display characteristics of the traces.
Scale	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.

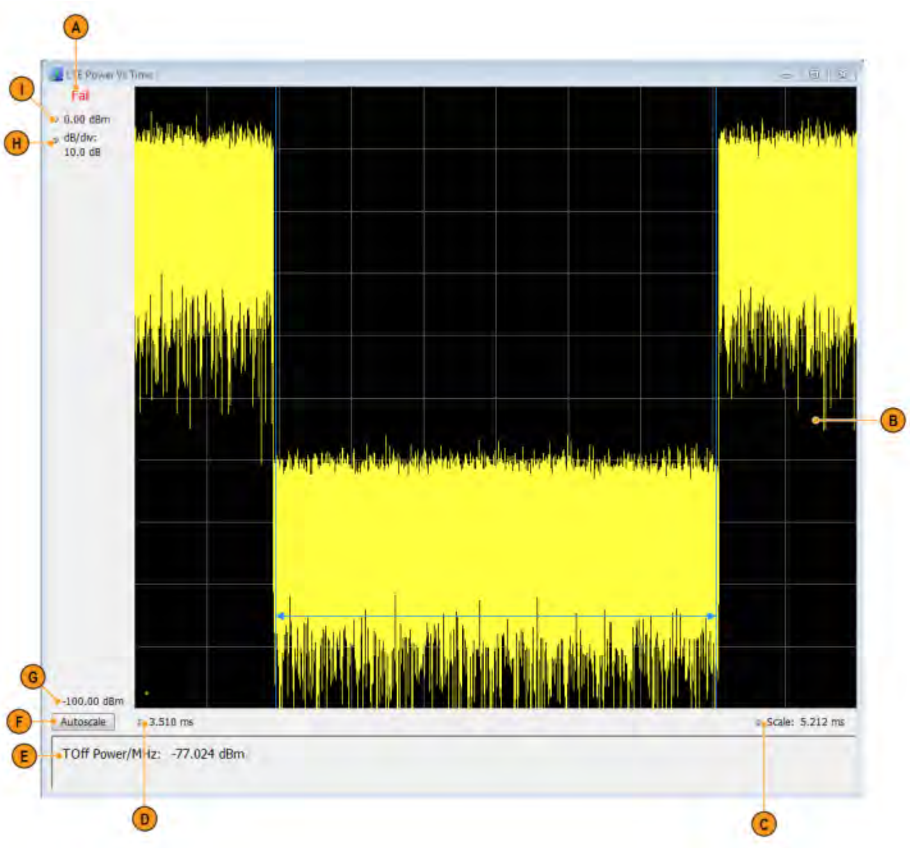
Note: Loading the LTE Power vs Time display from the **Presets** > **Standards** > **LTE** menu is recommended. This loads the control settings based on the selected options.

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.
B	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.
C	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.
H	dB / div	Shows the dB per each division in the Y axis of the plot.
(not shown)	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
I	Top of graph	The vertical scale is normalized with appropriate power units.

LTE Power vs Time Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Modulation Params	Specifies the frame structure and channel bandwidth.
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 LTE Analysis displays.
Prefs	Allows you to select to show or hide the graticule and marker readouts.
Scale	Specifies the vertical and horizontal scale settings.
Limit	Specifies the mask limits.

LTE Analysis Measurement Settings

Main menu bar: Setup > Settings

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.

Table 26: Controls for LTE Analysis displays

Settings tab	Description
Modulation Params	Allows you to set the frame structure and channel bandwidth. *Available for these displays: LTE Power vs Time, LTE Constellation.*
Analysis Params	Allows you to enable Equalization based on PSS (Primary Synchronization 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) for LTE Analysis displays. *Available for these displays: LTE Power vs Time, LTE Constellation.*
Trace	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	Allows preferences with Radix display and marker readouts. *Available for these displays: LTE Power vs Time, LTE ACLR, LTE Channel Spectrum, SEM.*
Scale	Defines the vertical and horizontal axes. *Available for all LTE displays.*
Offsets & Limits Table	**Note:** Available for the LTE ACLR display only.
Freq & RBW	Specifies the frequency and resolution bandwidth used for the measurement. **Note:** Available for the LTE Channel Spectrum display only.
Parameters	Specifies several characteristics that control how the measurement is made.
Processing	Specifies settings for detection on the reference channel and the offsets. Specifies the function setting on how calculations are done across multiple sweeps.
Limit	Allows you to define limits for pass/fail comparison with calculated values. The default values are as recommended in the test specification.

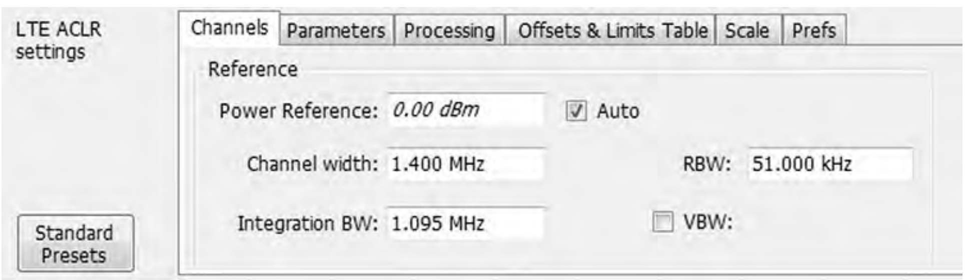
Table continued…

Settings tab	Description
Channels	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	Allows you to set averaging (Time Domain, Off, or Frequency Domain) and to set the number value associated with the Average setting.

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.

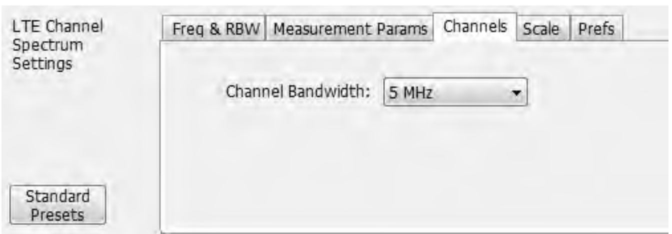


Settings	Description
Reference	
Power Reference	The value used to calculate relative measurements. When Auto is selected, the calculated reference channel power is displayed. When Auto is unchecked, you can enter a value for the reference power, and the measured reference power is not used or displayed.
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 Real-Time mode) Reference Channel (displayed for Non-Real Time mode)	
RBW	Sets the RBW

Table continued…

Settings	Description
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 10 times 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.



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.

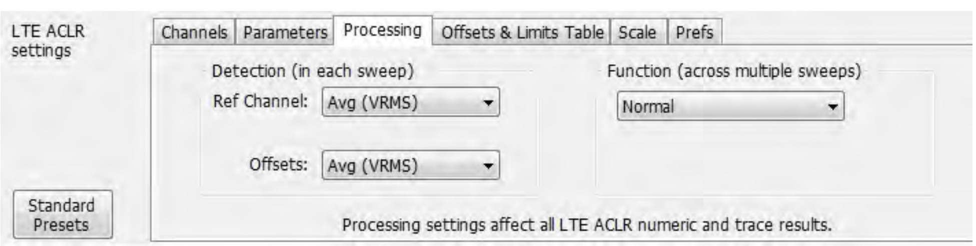
Setting	Description
Meas Freq	Specify the frequency of the signal to be measured.
Step	Sets the increment size when changing the Frequency using the knob or mouse wheel. Auto: When Auto is enabled, the step size is adjusted automatically based on the span setting.
Real-Time	When Real-Time mode is enabled, 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.

Table continued…

Setting	Description
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.



Setting	Description
Detection (in each sweep)	

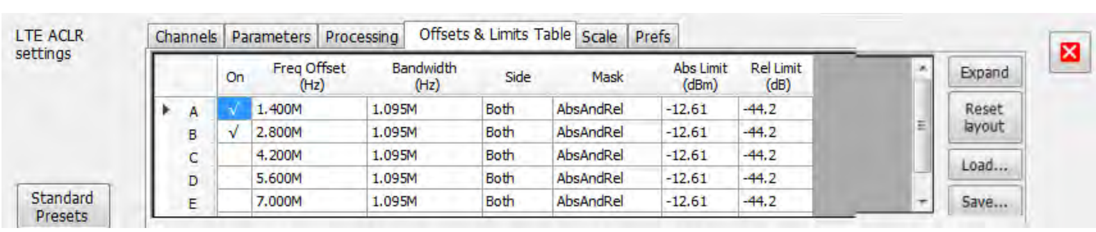
Table continued…

Setting	Description
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 sweeps)	
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

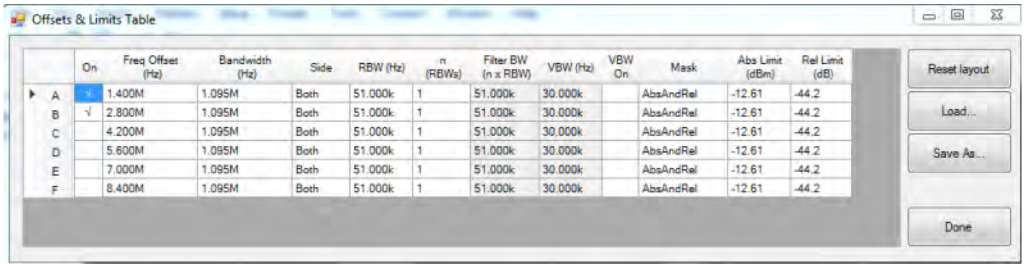
The Offsets and Limits Table tab is used to specify parameters that define Offsets and masks for the LTE ACLR display. The following images show the tab and expanded view of the tab, respectively.

The following image shows the Offsets and Limits Table tab when Real-Time is selected in the Parameters tab.



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).

The following image shows the expanded view of the Offsets and Limits Table (click the **Expand** button to view).



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.

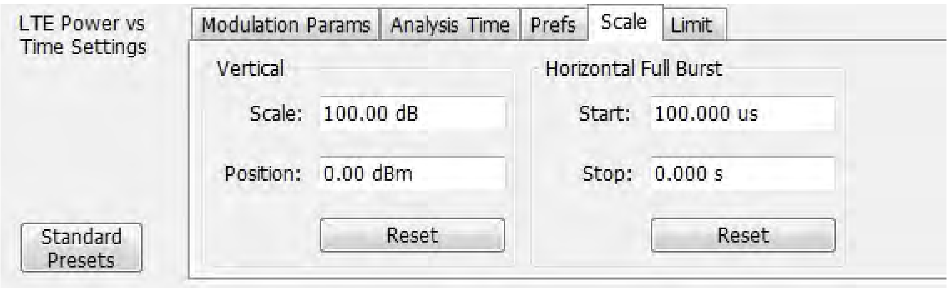
Table continued…

Setting	Description
Buttons	
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.

The following image shows the Scale tab for the LTE Power vs Time display.

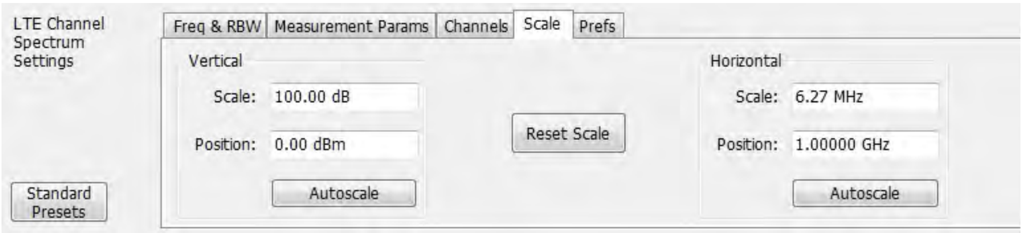


Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale units.
Position	Adjusts the reference level away from top of the graph.
Reset	Resets the scale of the vertical axis to default values.
Horizontal Full Burst	Controls the horizontal span.

Table continued…

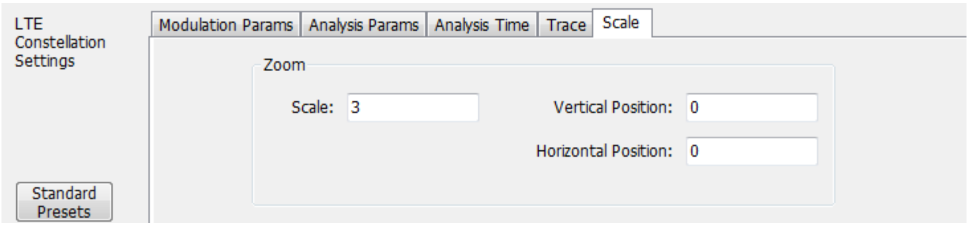
Settings	Description
Start	Specifies the horizontal axis start point.
Stop	Specifies the horizontal axis end point.
Reset	Resets the scale of the horizontal axis to default values.

The following image shows the Scale tab for the LTE Channel Spectrum and LTE ACLR displays.



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.

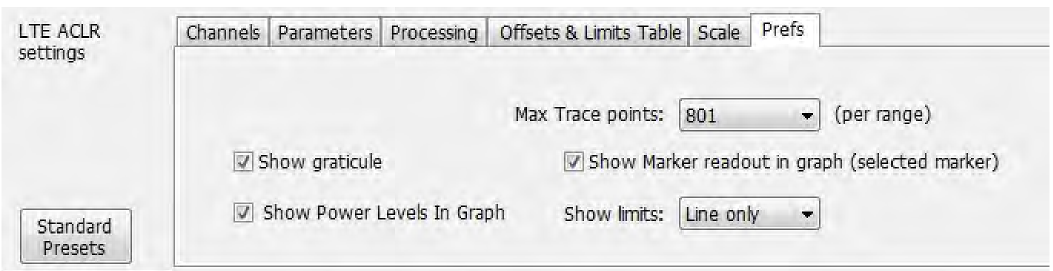


Settings	Description
Zoom	
Scale	Zooms in and out of the constellation. As the scale is increased, it will zoom out.
Vertical Position	Adjusts the vertical position.
Horizontal Position	Adjusts the horizontal position.

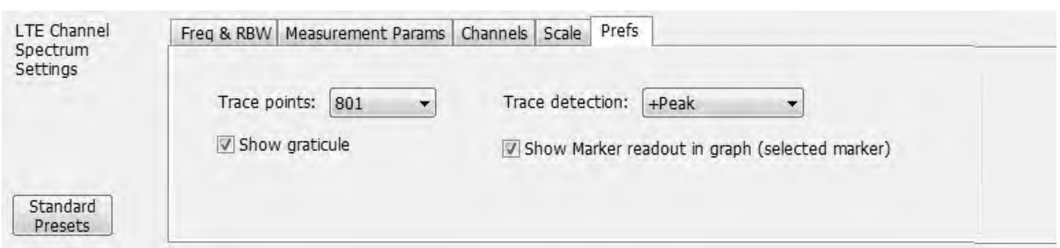
Prefs tab - LTE

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 and switching the graticule display on/off. Some parameters appear with most displays, while others appear with only one display.

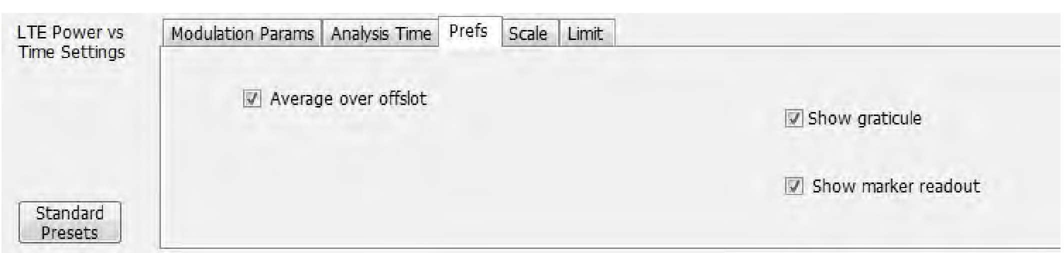
The following image shows the Prefs tab for the LTE ACLR display.



The following image shows the Prefs tab for the LTE Channel Spectrum display.



The following image shows the Prefs tab for the LTE Power vs Time display.



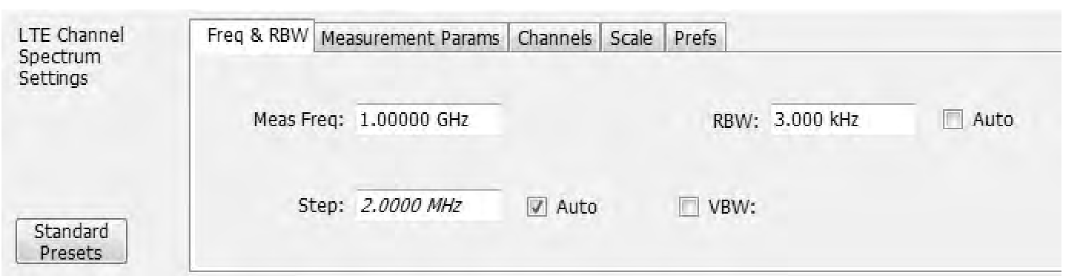
Setting	Description
Show graticule	Shows or hides the graticule.

Table continued…

Setting	Description
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 µs windows in the entire offslot region. If this option is disabled, the off slot power is measured only in the center 70 µs 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.



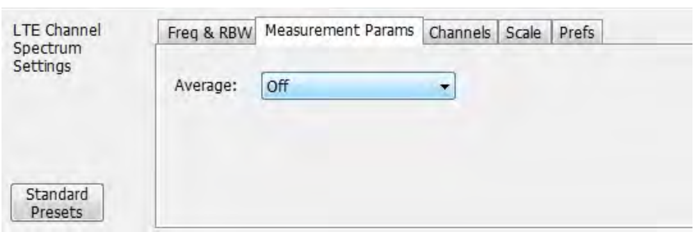
Settings	Description
Meas Freq	Specifies the center/measurement frequency
RBW	Select Auto or Manual. Adjusts the RBW for the entire measurement. This setting is Independent of the Spectrum view's RBW setting. Auto: When Auto is enabled, the step size is adjusted automatically based on the span setting.

Table continued…

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

Measurement Params tab - LTE

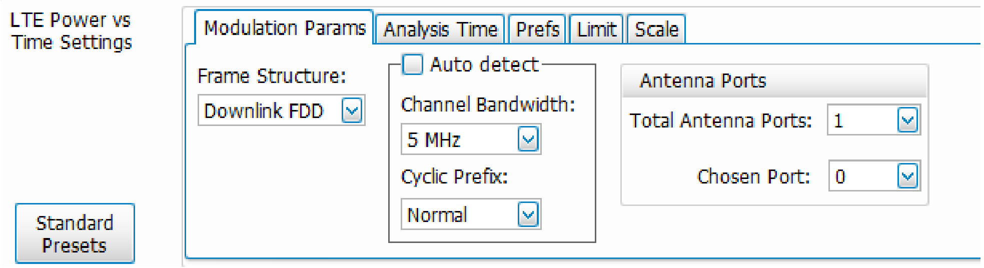
The Measurement Params tab allows you to set parameters that control the ACPR and MCPR measurements. This is available for the LTE Channel Spectrum display.



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

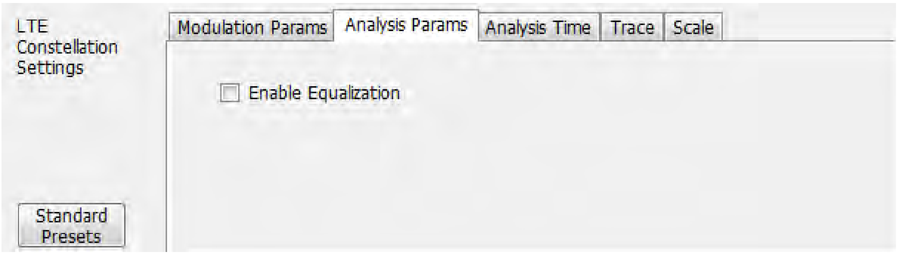
The Modulation Params tab specifies the type of modulation used by the input signal and other parameters that define the signal format. This tab is available for the LTE Constellation and Power vs Time displays.



Settings	Description
Frame Structure	Select the frame structure to set how the demodulation is done.
Downlink FDD	Downlink Frequency Division Duplexing
Downlink TDD	Downlink Time Division Duplexing
Auto Detect	If checked, Channel Bandwidth and Cyclic Prefix are automatically detected. It will also detect the TDD Configuration when Downlink TDD is the selected frame structure.
Channel Bandwidth	Select from 6 bandwidths: 1.4, 3, 5, 10, 15, 20 MHz (If Auto Detect is checked, the channel bandwidth is automatically calculated.)
Cyclic Prefix	Select Normal or Extended.
TDD Configuration	
Uplink-Downlink	Select from 0 to 6. The configuration determines the appropriate downlink to uplink switch periodicity.
Special Subframe	Select from 0 to 9. This configuration determines the number of downlink pilots, guard period, and uplink pilots between uplink to downlink switch.
Antenna Ports	
Total Antenna Ports	Select from 1 to 4. This is the total number of antenna ports.
Chosen Port	Select the antenna port from which the signal is captured.

Analysis Params tab - LTE

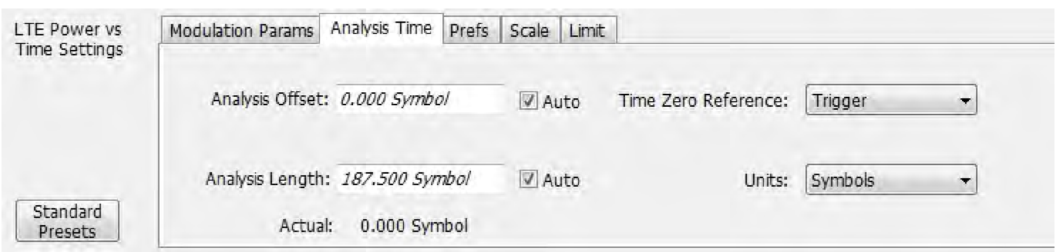
The Analysis Params tab allows you to enable equalization on the demodulated LTE packet. The equalization is based on PSS (Primary Synchronization Signal). This tab is only available for the LTE Constellation display.



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.



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.

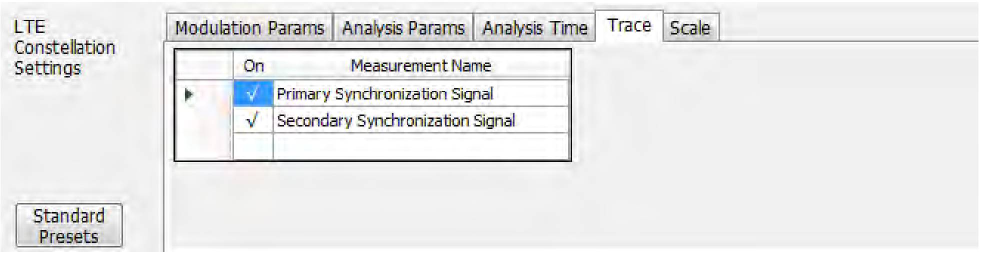
Time Zero Reference

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

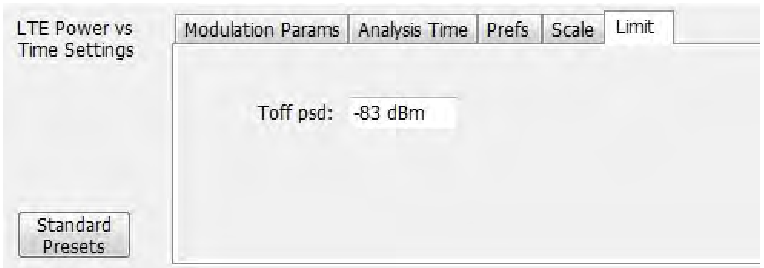
The Trace tab allows you to set the trace display characteristics of the LTE Constellation display.



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 Toff measurement.



Setting	Description
Toff psd	Specifies the limit that is used for comparison against measured values of Toff measurement. Pass/ Fail is determined with this limit.

5GNR Analysis

Overview

The 5GNR RF Measurement Analysis option allows you to evaluate RF signals to ensure that they meet 3GPP measurement specifications. These are described in the Base Station (BS) radio transmission and reception and test specifications Base Station (BS) conformance testing documents version 15. This analysis option supports both Uplink and Downlink frame structures. This analysis option supports the following measurements:

Modulation Accuracy (ModAcc) - It measures the deviation of the received symbol relative to the ideal transmitted symbol. The IQ data is processed to identify the OFDM Symbol boundaries and FFT is performed using the various settings under the Modulation Accuracy tab. The subcarrier data is equalized and then Data and DMRS are extracted to perform various EVM measurements as per the 3GPP specifications and then used for display in Constellation Display. The Estimation tab provides advanced settings related to IQ Impairments and Frequency Offset estimation and corrections.

Channel Power (CHP) - This measurement is used to verify the maximum carrier output power across the frequency range. It includes the measurement of individual carrier power under carrier aggregation mode. The Integrated Bandwidth type can be selected between Channel and Signal Bandwidth to include or remove the Guard Bands between the carriers respectively.

Adjacent Channel Power (ACP) - It measures the power leakage from the carrier channels into the neighboring frequency channels, commonly referred to as offset channels. The RBW, Sweep time, and Spectral Window can be selected from the measurement options tab. By default, two offset channels are enabled for the measurement.

Spectral Emission Mask (SEM) – It measures the spurious emissions of a transmitter in the immediate frequency bands and compares against the limit chosen in the settings. The RBW settings and the width of the bands can be selected from the measurement options tab. The predefined band settings as per 3GPP are also provided in the options.

Occupied Bandwidth (OBW) – The Occupied Bandwidth measures the bandwidth within which 99% of the power transmitted within the measurement bandwidth falls.

Error Vector Magnitude (EVM) – An EVM will give the variation of an EVM over the OFDM symbols. Trace can be selected between RMS and Peak.

Power vs Time (PVT)- The PVT measurement measures the time domain power dynamics of the NR signal. This measurement is also known as Transmit ON-OFF Time Mask measurement.

You can also select these measurements from seven 5GNR 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 test setups are available for this analysis option.

1. Modulation Accuracy
2. ACP
3. CHP
4. SEM
5. OBW
6. EVM
7. PVT

For more detailed information about these test setups, click *here*.

With the 5GNR RF measurement analysis test suite, test engineers can simplify the execution of several transmitter tests while still enabled to modify signal parameters for in-depth signal analysis.

The analysis results give multiple views of 5GNR 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.

5GNR Analysis topics in this Help

The following information about the 5GNR Analysis option is available:

Supported 5GNR measurements

5GNR measurements

5GNR standard preset test setups

5GNR displays

5GNR measurement analysis settings

Supported 5GNR Measurements

The following table gives a brief description of the available 5GNR measurements. More detailed information can be found here.

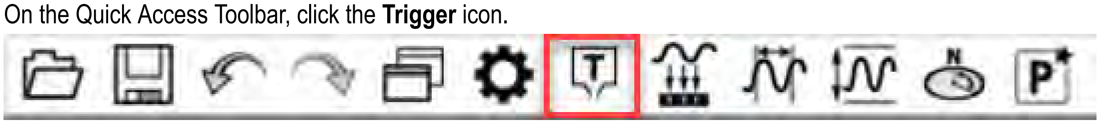
Table 27: 5GNR Measurements

5GNR Measurement	5GNR Standard(s)	Description
Modulation accuracy	Sec 6.5.2 for BS and Sec 6.4.2 for UE.	It measures the deviation of the received symbol relative to the ideal transmitted symbol.
ACP	Sec 6.6.3 for BS and Sec 6.5.2.4 for UE	It measures the power leakage from the carrier channels into the neighboring frequency channels.
CHP	Sec 6.2 for BS and Sec 6.3 for UE	It measures the RMS power within the carrier channel bandwidth.
SEM	Sec 6.6.5 for BS and Sec 6.5 for UE	It measures spurious out-of-band emissions in the immediate neighboring bands of the carrier.
OBW	Sec 6.6.2(38.141) for BS and Sec 6.5.1(38.521) for UE	The Occupied Bandwidth measures the bandwidth within which 99% of the power transmitted within the measurement bandwidth falls.
EVM	Sec 6.5.2 for BS and Sec 6.4.2 for UE	An EVM will give the variation of an EVM over the OFDM symbols. Trace can be selected between RMS and Peak.
PVT	Sec 6.3.3 for UE	It measures the time domain power dynamics of the NR signal. This measurement is also known as Transmit ON-OFF Time Mask measurement.

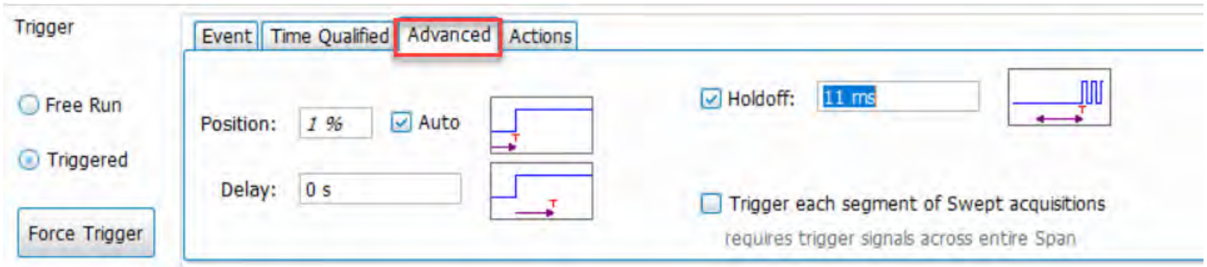
How to avoid false triggering of 5G NR signals on RSA5100B instrument

When you keep the RSA5100B in the continuous acquisition mode, it misses triggering at the rising edges so to avoid this false triggering, follow the procedure given below:

1. Start the Tek RSA5100B application.
2. On the Quick Access Toolbar, click the **Trigger** icon.

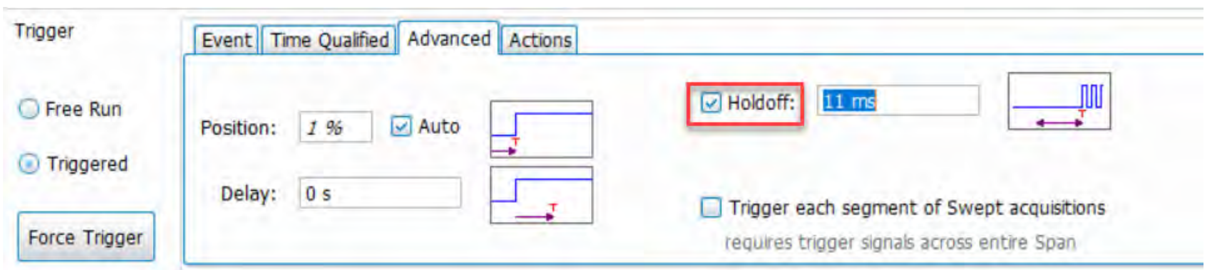


3. On the Trigger settings panel, click the **Advanced** tab.



4. Select the **Holdoff** checkbox and enter the Holdoff time.

⚠ **Note:** The holdoff time should be higher than the Burst time. For ex. If the Burst time is 10 ms then the Holdoff time must be 11 ms.



5GNR Standards Preset Test Setups

Presets > **Standards**

The 5GNR Standards preset allows you to access displays preconfigured for the selected test setup. The test setups load the displays and control setting options suggested by the 5GNR standard to perform the measurements.

There are seven test setups for 5GNR:

Table 28: Test setup presets

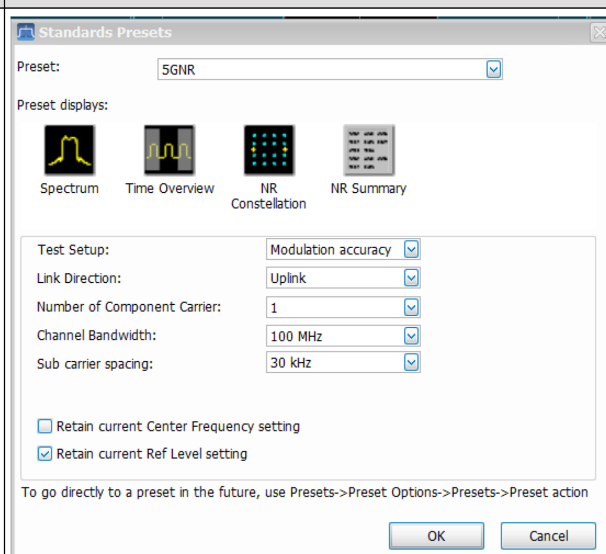
Preset name	Preset image
Modulation Accuracy	

Table continued…

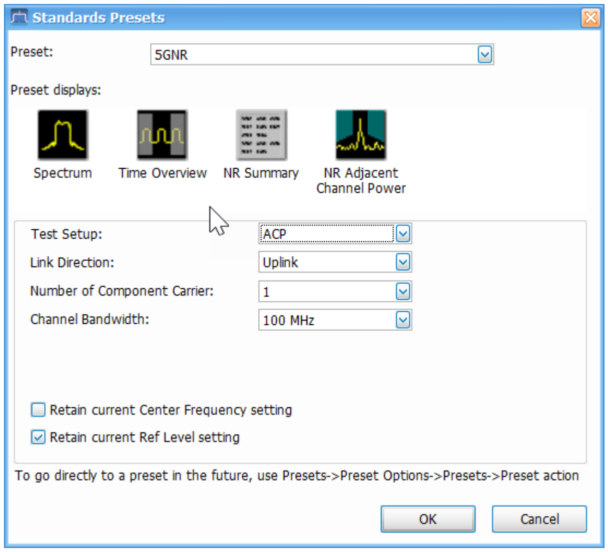
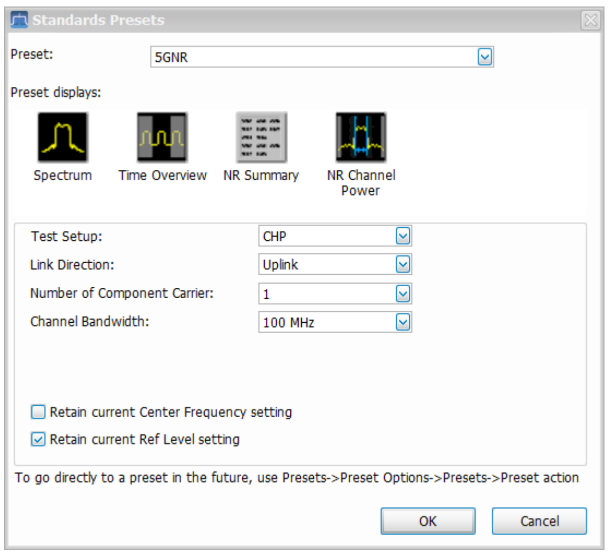
Preset name	Preset image
ACP	
CHP	

Table continued…

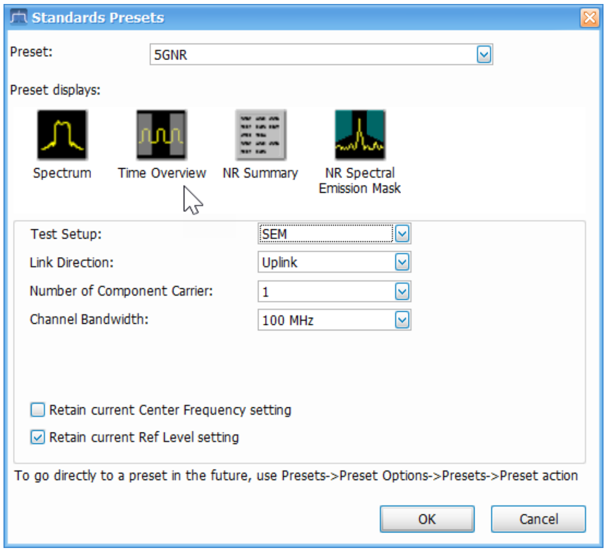
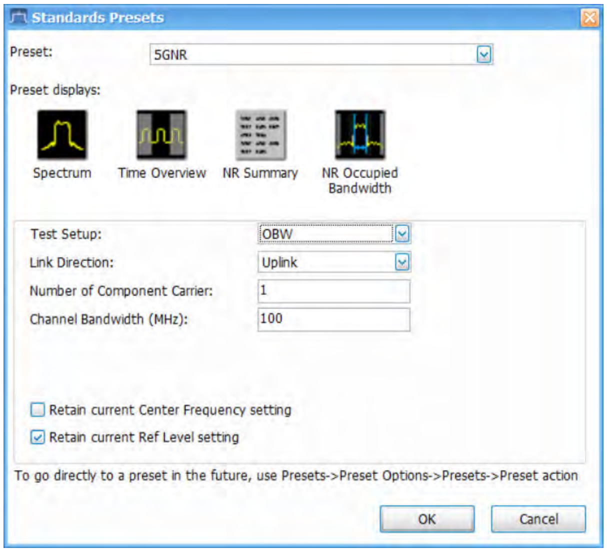
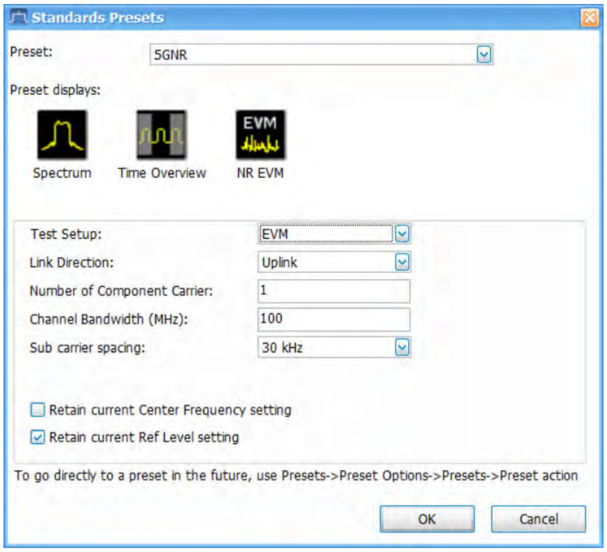
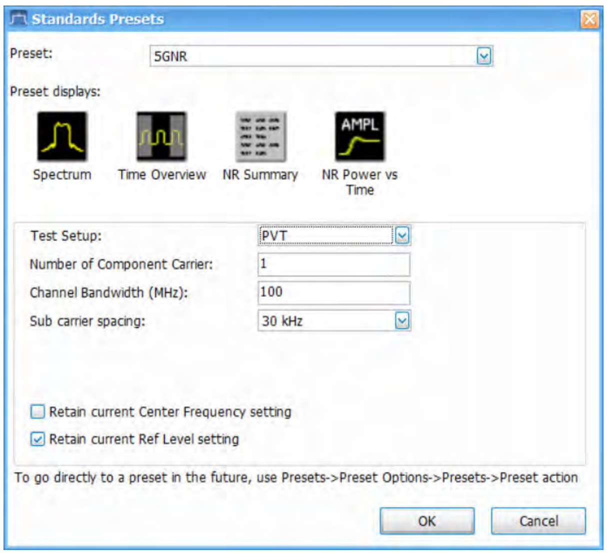
Preset name	Preset image
SEM	
OBW	

Table continued…

Preset name	Preset image
EVM	
PVT	

The following table lists the default configurations loaded with each test setup.

Table 29: 5GNR Preset test setups

Test setup		Displays loaded with preset
Modulation accuracy	Link Direction: • Uplink • Downlink (**Default is Uplink**)	• Spectrum • Time Overview • NR Constellation • NR Summary
	Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8 (**Default is 1**)	
	Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz (**Default is 100 MHz**)	
	Sub Carrier Spacing: 15, 30, 60, and 120 kHz (**Default is 30 kHz**)	
ACP	Link Direction: • Uplink • Downlink (**Default is Uplink**)	• Spectrum • Time Overview • NR Summary • NR Adjacent Channel Power
	Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8 (**Default is 1**)	
	Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz (**Default is 100 MHz**)	

Table continued…

Test setup		Displays loaded with preset
CHP	Link Direction: • Uplink • Downlink (**Default is Uplink**)	• Spectrum • Time Overview • NR Summary • NR Channel Power
	Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8 (**Default is 1**)	
	Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz (**Default is 100 MHz**)	
SEM	Link Direction: • Uplink • Downlink (**Default is Uplink**)	• Spectrum • Time Overview • NR Summary • NR Spectral Emission Mask
	Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8 (**Default is 1**)	
	Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz (**Default is 100 MHz**)	
OBW	Link Direction: • Uplink • Downlink (**Default is Uplink**)	• Spectrum • Time Overview • NR Summary • NR Occupied Bandwidth
	Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8 (**Default is 1**)	
	Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz (**Default is 100 MHz**)	

Table continued…

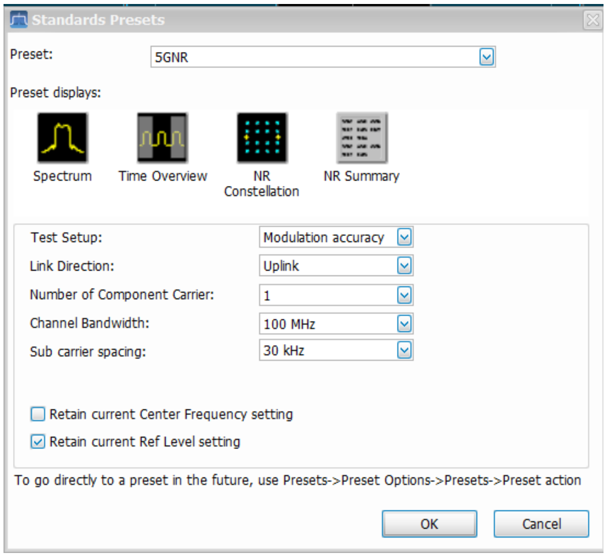
<table>
<tr><th colspan="2">Test setup</th><th>Displays loaded with preset</th></tr>
<tr><td rowspan="4">EVM</td><td>Link Direction:
• Uplink
• Downlink
(Default is Uplink)</td><td rowspan="4">• Spectrum
• Time Overview
• NR EVM</td></tr>
<tr><td>Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8
(Default is 1)</td></tr>
<tr><td>Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz
(Default is 100 MHz)</td></tr>
<tr><td>Sub Carrier Spacing: 15, 30, 60, and 120 kHz
(Default is 30 kHz)</td></tr>
<tr><td rowspan="3">PVT</td><td>Number of Component Carrier: 1, 2, 3, 4, 5, 6, 7, and 8
(Default is 1)</td><td rowspan="3">• Spectrum
• Time Overview
• NR Summary
• NR Power Vs Time</td></tr>
<tr><td>Channel Bandwidth: 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 400 MHz
(Default is 100 MHz)</td></tr>
<tr><td>Sub Carrier Spacing: 15, 30, 60, and 120 kHz
(Default is 30 kHz)</td></tr>
</table>

Retain current Center Frequency and Ref Level settings

The **Retain current Center Frequency setting** appears when the 5GNR Standards Preset is selected. Select the check box to retain the previously used center frequency. By default, the Center Frequency settings box is unchecked.

The **Retain current Ref Level setting** appears when the 5GNR Standards Preset is selected. Select the check box to retain the previously used reference level. By default, the Ref Level settings box is checked.

To activate these settings, select the check box next to the desired setting. The following image shows the **Retain current Ref Level setting** box is selected.



5GNR Displays

The displays in 5GNR Analysis (**Setup** > **Displays** > **Measurements: 5GNR Analysis**) are:

1. *NR Adjacent Channel Power*
2. *NR Channel Power*
3. *NR Constellation*
4. *NR Spectral Emission Mask*
5. *NR Occupied Bandwidth*
6. *NR EVM*
7. *NR Power vs Time*
8. *NR Summary*

5GNR Status Messages

The following status messages may appear. Each message indicates the related condition (Description) shown in the following table.

Status message	Description
Analysis failure	Signal analysis has failed.
Analyzing	Signal analysis is in progress.
Stopped	Acquisition/Analysis stopped.
Acquiring	Signal acquisition is in progress.
Transfer	IQ data is being transferred.
Setup error	Configuration settings error.
Acq BW too small for the current setup	Bandwidth/Span lower than expected.
Analysis length too small for the current setup	Insufficient data.
Trigger position is before the analysis window	The analysis window in the "Time Overview" display does not include the trigger position.
Insufficient Span or Incorrect Data for Analysis	ACP display expects additional span or the data is incorrect.

Table continued…

Status message	Description
Cell ID Detected	Cell ID detected for the Downlink 5GNR waveform in the "Constellation" display.
Not enough samples for the current setup	The current configuration expects more samples.
Analysis failure : Invalid Result	Signal analysis has failed and results are invalid.
Analysis failure : Insufficient BW. Required BW : <x>	Signal analysis has failed due to insufficient bandwidth. The required bandwidth is denoted by the value in <x>.
Analysis failure : Trigger position is before analysis window	Signal analysis has failed due to the trigger position not available within the analysis window.
Analysis failure : Downlink measurement currently unsupported	Signal analysis has failed as the PVT measurement currently doesn't support downlink signals.
Analysis failure : Not enough data before trigger, requires: <x> data before trigger	Signal analysis has failed as the PVT measurement expects <x> time of data before the trigger.
Analysis failure : Invalid Configuration	Signal analysis has failed as there was an incorrect configuration.
Analysis failure : Insufficient Span or Incorrect Data for Analysis	Signal analysis has failed due to incorrect data or insufficient span.
Setup error No channels defined	Configuration settings error indicating that there are no adjacent channels or offsets defined.
Setup error Channels cannot overlap	Configuration settings error indicating that there are adjacent channels or offset that overlap each other.
Setup error Channel BW too wide for hardware	Configuration settings error indicating that the bandwidth requirements are not supported by hardware.
Setup error : Channel BW too wide for hardware, required BW = <x> including RBW	Configuration settings error indicating that the bandwidth requirements are not supported by hardware. The value in <x> determines the required bandwidth, including the resolution bandwidth.
RBW limited by Acq BW to <x>	The actual RBW achieved is less than requested, because the user requested RBW is too large compared to the current acquisition span for the measurement. The final RBW value is denoted by <x>.

NR Adjacent Channel Power Display

The NR Adjacent Channel Power (ACP) display shows the power leakage from the carrier channels into the neighboring frequency channels, known as offset channels.

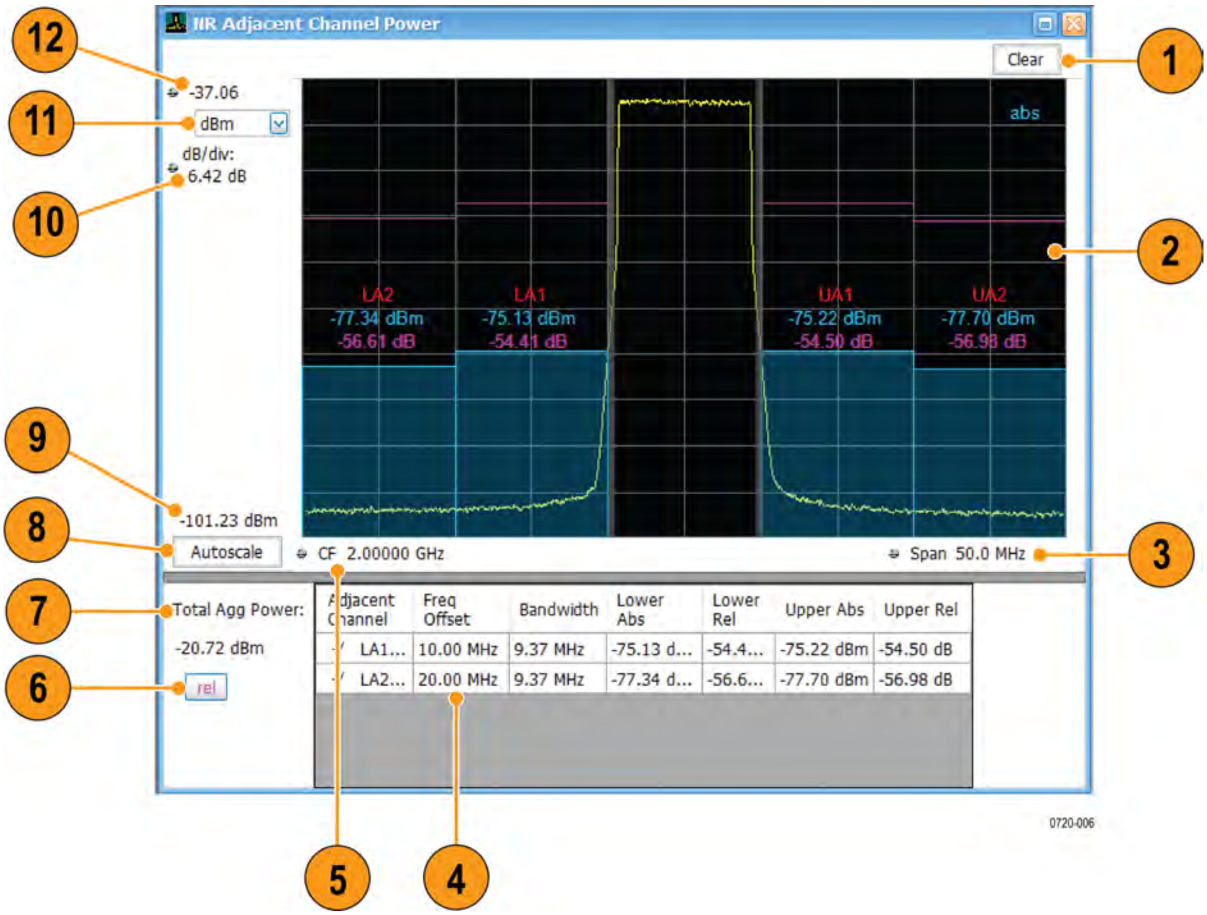
To view the NR ACP display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Adjacent Channel Power icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR ACP display.



Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Plot	Displays the reference channel(s) and adjacent channel(s) 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.
3	Span	Adjust the span of the graph in symbols.
4	Results table	Tabulates the results in each adjacent band. The table shows the offset, bandwidth, Integrated Absolute and Relative power in the upper and lower adjacent channel regions.
5	CF	Center Frequency at which the measurement is performed.
6	rel	Opens relative adjacent channel power color palette.
7	Total Agg Power	Displays the total aggregated power of all subblocks.
8	Autoscale	Adjusts the adjacent channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
9	Lower limit in the display graph	Displays the lower limit of the channel power in the graph.
10	dB/div	Shows the dB per each division in the vertical axis of the plot.

Table continued…

Item	Display element	Description
11	Units of adjacent channel power	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
12	Upper limit of the display graph	Displays the upper limit of the channel power in the graph.

NR Adjacent Channel Power Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

The NR Adjacent Channel Power display settings control panel allows you to configure the settings of the NR adjacent channel power display.

Settings tab	Description
ACP	Allows you to configure the ACP-specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR Channel Power Display

The NR Channel Power display shows the spectrum of the input signal across one channel. The channel power measures the RMS power in the carrier channel in dBm. Other units can be selected from the Units tab of the Analysis control panel.

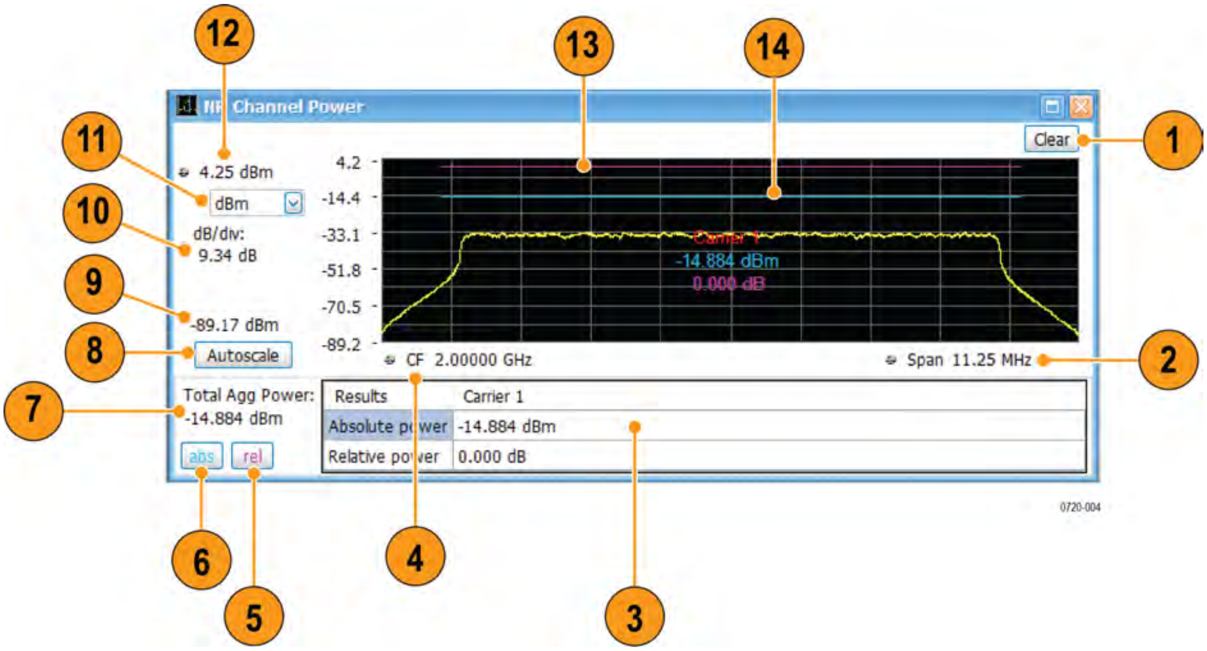
To view the NR Channel Power display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Channel Power icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR Channel power display.



Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Span	Adjust the frequency span of the graph in symbols.
3	Results table	Displays each component carrier's absolute and relative channel power.
4	CF	Center Frequency at which the measurement is performed.
5	rel	Opens relative channel power color palette
6	abs	Opens absolute channel power color palette
7	Total Agg Power	Displays total aggregated power of all the subblocks.
8	Autoscale	Adjusts the channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
9	Lower Limit in the display graph	Displays the lower limit of the channel power in the graph
10	dB / div	Shows the channel power per division in the vertical axis of the plot.
11	Units for Channel Power	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
12	Upper Limit in the display graph	Displays the upper limit of the channel power in the graph
13	Rel power level	Displays the relative power level as a horizontal line in the user-selected color from the palette
14	Abs power level	Displays the absolute power level as a horizontal line in the user-selected color from the palette

NR Channel Power Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

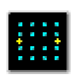
The NR Channel Power display control panel allows you to configure the settings of the NR Channel power display.

Settings tab	Description
CHP	Allows you to configure the CHP specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR Constellation Display

Displays the demodulated and equalized OFDM subcarrier symbols. The same display area is shared for plotting Data (PUSCH/PDSCH) and DMRS. The plot at a single instance shows a constellation graph for a single component carrier. You can select between different component carriers.

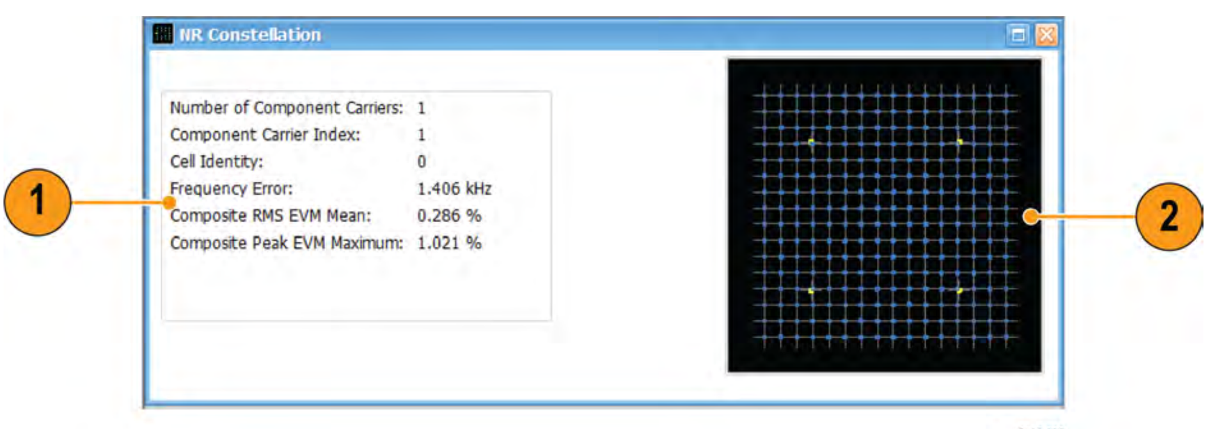
To view the NR Constellation display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Constellation icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the Display

The following image shows the NR Constellation display.



Item	Display element	Description
1	Scalar results	Displays the selected component carriers Cell ID, Frequency Error, and EVM.
2	Plot	Displays data (PUSCH / PDSCH) and DMRS.

NR Constellation Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

The NR Constellation display control panel allows you to configure the settings of the NR Constellation display.

Settings tab	Description
Modulation Accuracy	Allows you to configure the modulation accuracy-specific properties.
Estimation	Allows you to configure the modulation accuracy Estimation properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Traces	Allows you to set the display characteristics of the traces.
Prefs	Allows you to show/hide graticule and marker readouts.

NR Spectral Emission Mask display

The NR Spectral Emission Mask (SEM) display shows the margin of the emission level from the limit and reports the measurement status. Spectral emission mask measurements measure out-of-band emissions in the neighboring bands of the carrier.

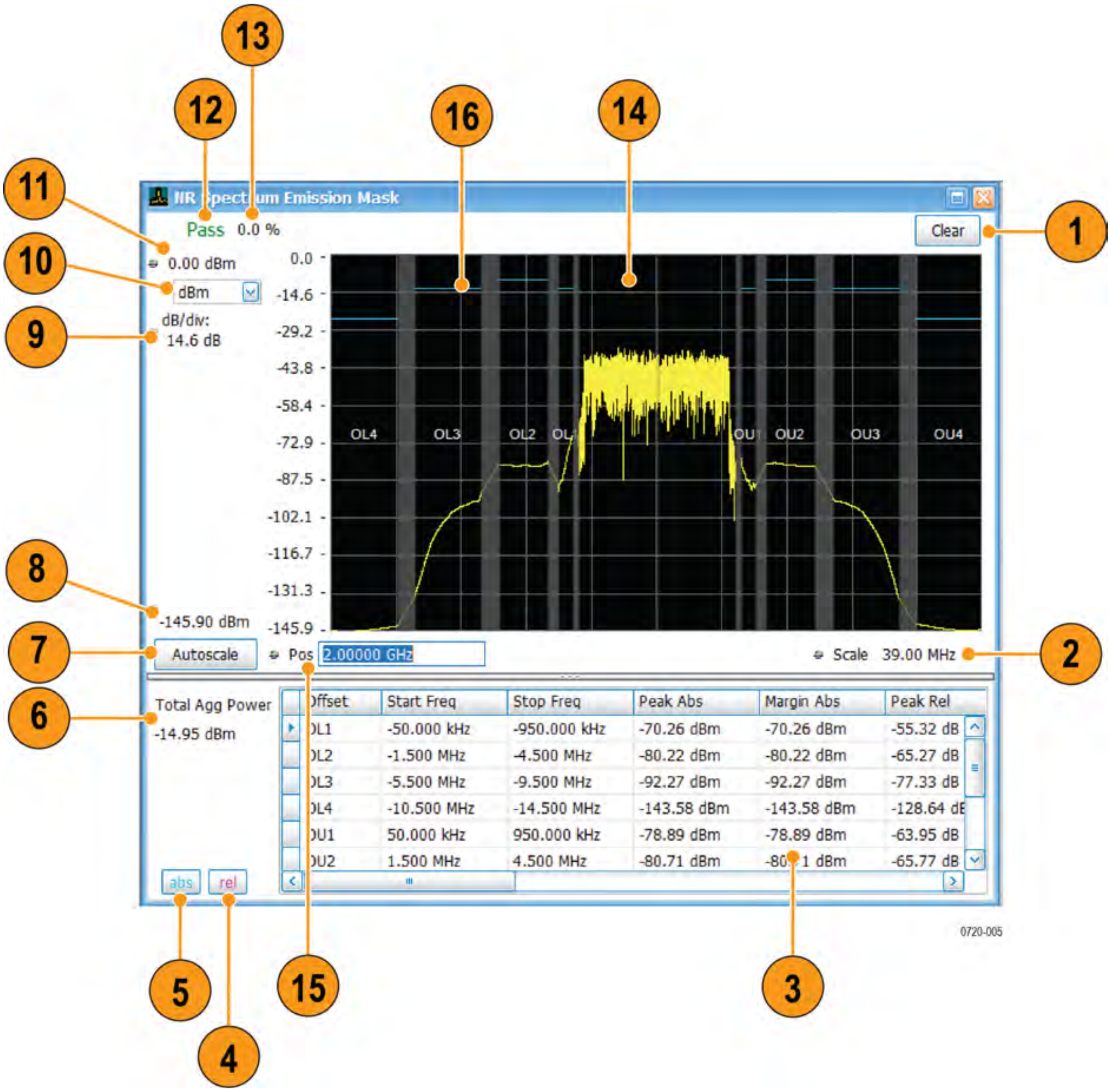
To view the NR SEM display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Spectral Emission Mask icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR SEM display.



Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Scale	Adjusts the frequency span of the graph.
3	Results table	Displays the spectral emission mask results.
4	rel	Displays the relative power SEM color palette
5	abs	Displays the absolute power SEM color palette
6	Total Agg Power	Displays the total aggregated power of all subblocks
7	Autoscale	Adjusts the channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
8	Lower limit in the display graph	Displays the lower limit in the graph.

Table continued…

Item	Display element	Description
9	dB/div	Displays the channel power per division in the vertical axis of the plot.
10	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the units tab of the amplitude control panel.
11	Upper limit in the display graph	Displays the upper limit in the graph.
12	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 settings control panel.
13	Pass/Fail %	Gives Pass/Fail offset regions to total offset regions in terms of percentage
14	Plot	Shows the spectral emission offsets, masks, and the power in the offset region. The absolute limit lines are also shown.
15	Pos	Position in the frequency domain at which the measurement is performed.
16	Limit line (Blue in the plot)	Displays the mask limit lines for the SEM measurement.

NR Spectral Emission Mask Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

The NR Spectral Emission Mask display control panel allows you to configure the settings of the NR Spectral Emission Mask display.

Settings tab	Description
SEM	Allows you to configure SEM specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR Occupied Bandwidth Display

The NR OBW display shows the bandwidth in which 99% of the power transmitted within the measurement bandwidth falls.

To view the NR OBW display:

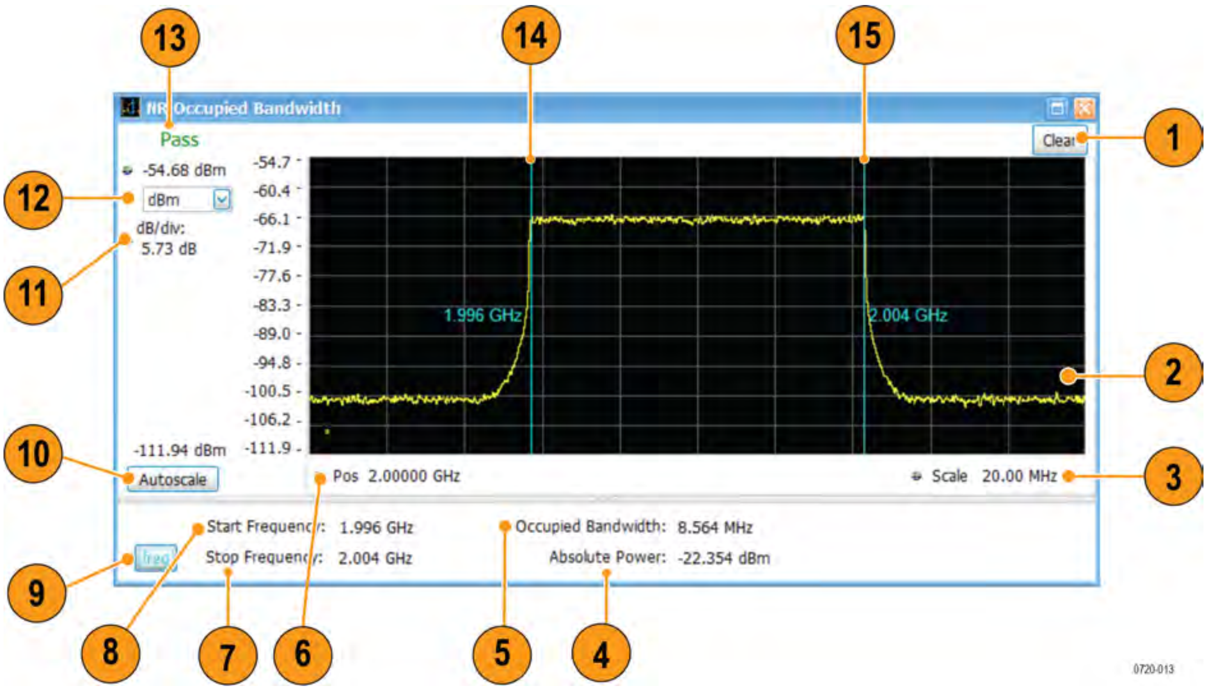
1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Occupied Bandwidth icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.

8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR OBW display.



Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Plot	Displays Start Frequency and Stop Frequency of the occupied bandwidth.
3	Scale	Adjusts the frequency span of the graph.
4	Absolute Power	Displays the absolute power value.
5	Occupied Bandwidth	Displays the occupied bandwidth value.
6	Pos	Position in the center frequency at which measurement is performed.
7	Stop Frequency	Displays the Stop Frequency value.
8	Start Frequency	Displays the Start Frequency value.
9	freq	Displays the frequency color palette.
10	Autoscale	Adjusts the channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
11	dB/div	Displays the channel power per division in the vertical axis of the plot.
12	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the units tab of the amplitude control panel.
13	Pass/Fail	Displays the result (Pass or Fail) based on the limit set in the OBW settings tab.
14	Start Frequency Indicator Line	Displays the Start Frequency line.
15	Stop Frequency Indicator Line	Displays the Stop Frequency line.

NR Occupied Bandwidth Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

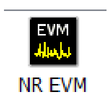
The NR Occupied Bandwidth display control panel provides access to settings that control parameters of the NR Occupied Bandwidth display.

Settings tab	Description
OBW	Allows you to configure the OBW specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR EVM Display

The NR EVM displays the variation of an EVM over the OFDM symbol. Trace can be selected between RMS and Peak. Here EVM can either be the Peak value of EVM for each symbol or the RMS of each Symbol.

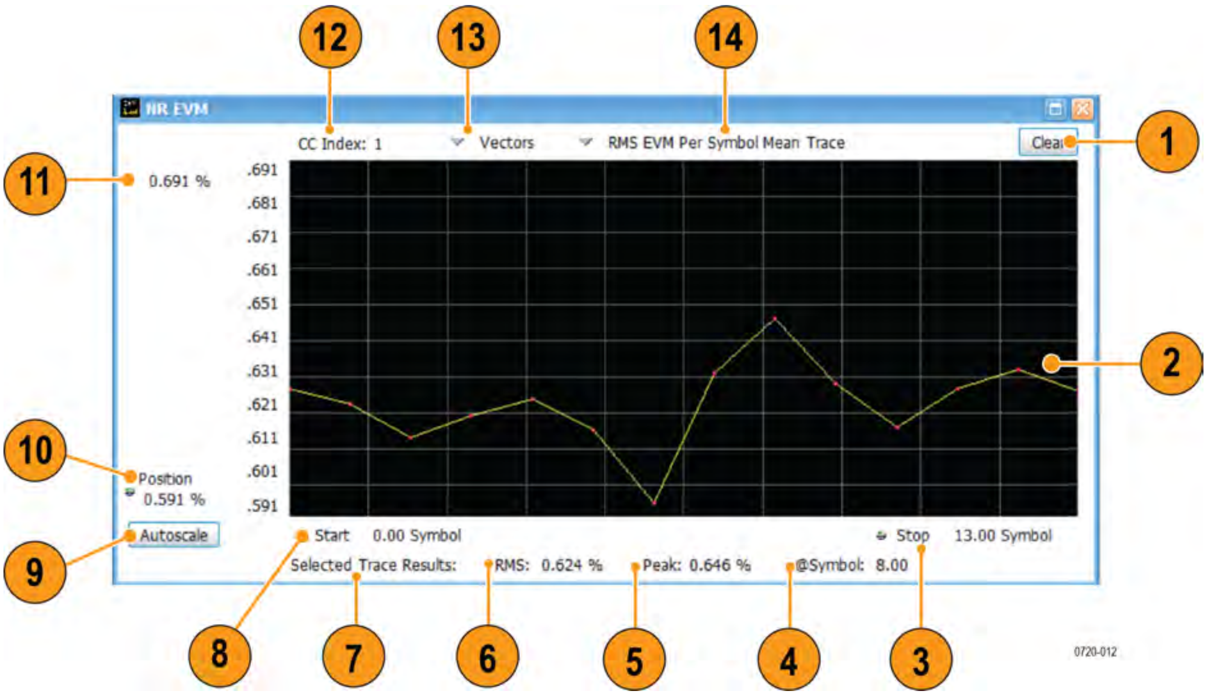
To view the NR EVM display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR EVM icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR EVM display.



Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Plot	Displays the data symbol's EVM values versus symbol.
3	Stop symbol	Displays the stop symbol value.
4	@Symbol	Displays the symbol index at which the peak EVM occurred out of the entire set of symbols within the defined measurement length.
5	Peak	Displays the maximum value of peak EVMs calculated over measurement length.
6	RMS	Displays the mean value of RMS EVMs calculated over measurement length.
7	Selected Trace Results	Displays selected trace results.
8	Start symbol	Displays the start symbol value.
9	Autoscale	Adjusts the channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
10	Position	Position in the frequency domain at which measurement is performed.
11	Peak EVM	Displays the peak EVM value.
12	CC Index	Displays the selected CC index. **Available values:** Depends on number of CCs.
13	Trace drawing	Allows to select the trace drawing mode. **Available values:** Vectors and Points.
14	Trace selection	Allows to select trace selection. **Available values:** RMS EVM Per Symbol Mean Trace, Peak EVM Per Symbol Maximum Trace

NR EVM Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar: 

The NR EVM display control panel provides access to settings that control parameters of the NR EVM display.

Settings tab	Description
Modulation Accuracy	Allows you to configure the modulation accuracy-specific properties.
Estimation	Allows you to configure the modulation accuracy Estimation properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR Power vs Time Display

The NR Power vs Time display shows the signal power amplitude versus time.

To view the NR Power vs Time display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.
4. In the Available displays box, double-click 

. This moves the NR Power vs Time icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

The following image shows the NR Power vs Time display.

Item	Display element	Description
1	Clear	Resets the measurement and clears all the values.
2	Plot	Displays the signal power amplitude versus time.
3	Scale	Adjust the span of the graph.
4	Burst width level	Displays the burst width as a horizontal line.
5	Burst Width	Displays burst width value.
6	Abs On Power	Displays absolute on power value.
7	Position	Position in the frequency domain at which measurement is performed.
8	Abs Off Power After	Displays absolute off power after value.
9	Abs Off Power Before	Displays absolute off power before value.
10	Autoscale	Adjusts the channel power magnitude and frequency scale settings so that the entire trace fits in the graph.
11	dB/div	Displays the channel power per division in the vertical axis of the plot.
12	Units	Sets the global amplitude units for all the views in the analysis window. This will change the amplitude selection in the units tab of the amplitude control panel.
13	Pass/Fail	Displays the result (Pass or Fail) based on absolute and relative limits set.
14	Limit Trace	Displays the transmit ON/OFF time mask.

NR Power vs Time Settings

Main menu bar: **Setup** > **Settings**

Favorites toolbar: 

The NR Power vs Time display control panel provides access to settings that control parameters of the NR Power vs Time display.

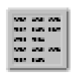
Settings tab	Description
PVT	Allows you to configure the PVT specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

NR Summary Display

Consolidated display of all the results from selected measurements like Modulation Accuracy, CHP, SEM, ACP, OBW and PVT. It provides an option to save all the results to a ".csv" file. Additional results related to the Modulation Accuracy measurement are available here.

To show the NR Summary display:

1. Select **File** > **Recall** to analyze a stored data file or go to the next step.
2. Select **Setup** > **Displays**.
3. In the Select Displays window, select **5GNR Analysis** in the Measurements box.

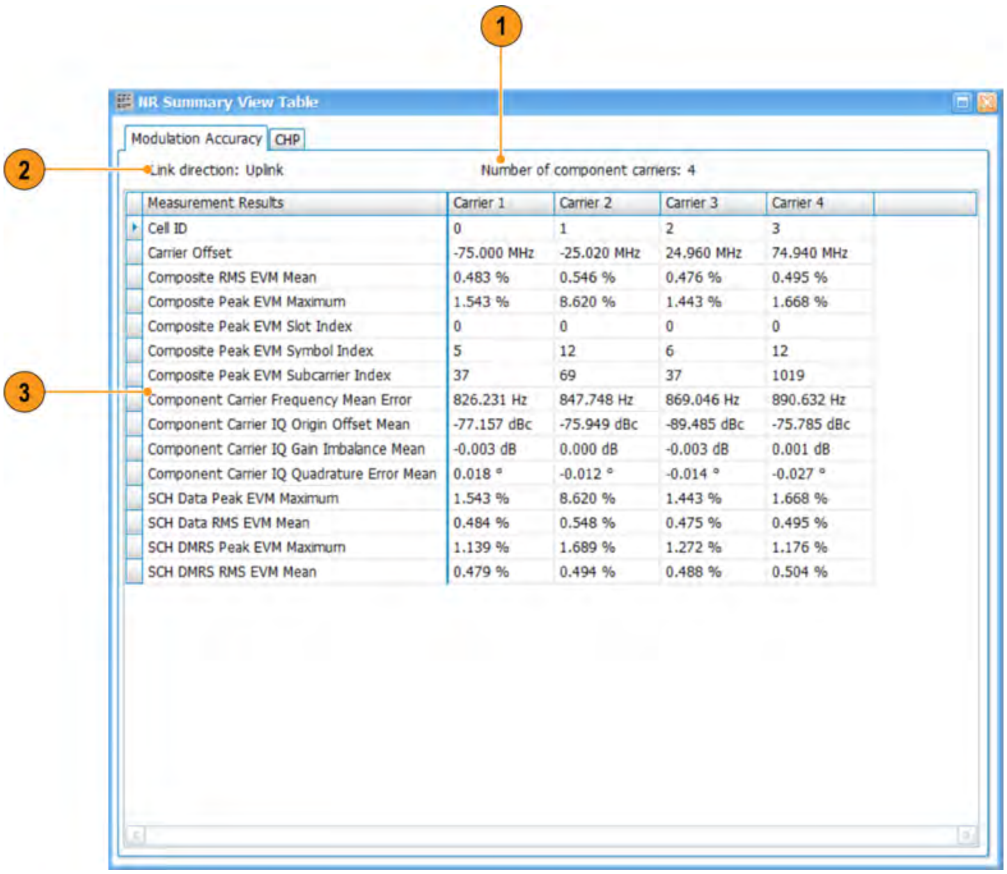


4. In the Available displays box, double-click NR Summary. This moves the NR Summary icon to the selected displays box.
5. Click **OK** to view the display.
6. Select **Setup** > **Settings** to display the control panel.
7. Select **Replay/Run** to take measurements on the acquired data.
8. If you are analyzing a data file, click **Replay** to take measurements on the recalled acquisition data file.

Elements of the display

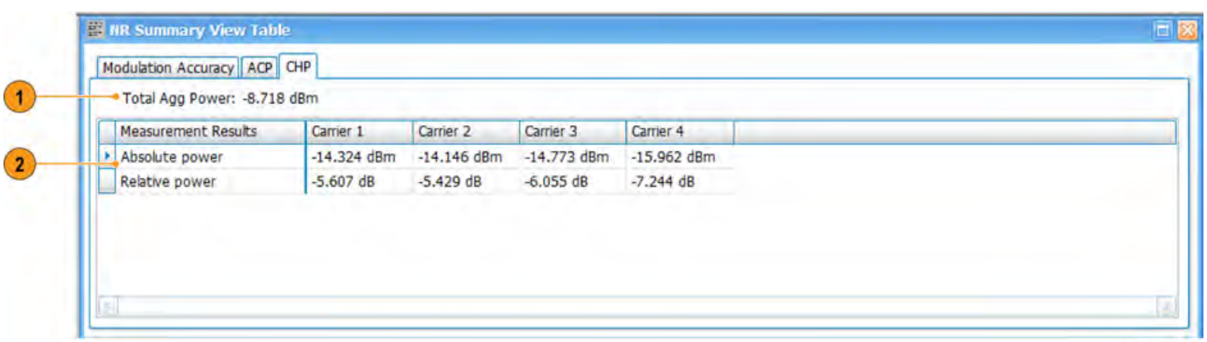
The following images show the NR Summary display.

Summary view for Modulation Accuracy:



Item	Display element	Description
1	Number of component carriers	Displays the number of component carriers.
2	Link direction	Displays the link direction.
3	Results table	Displays the modulation accuracy results.

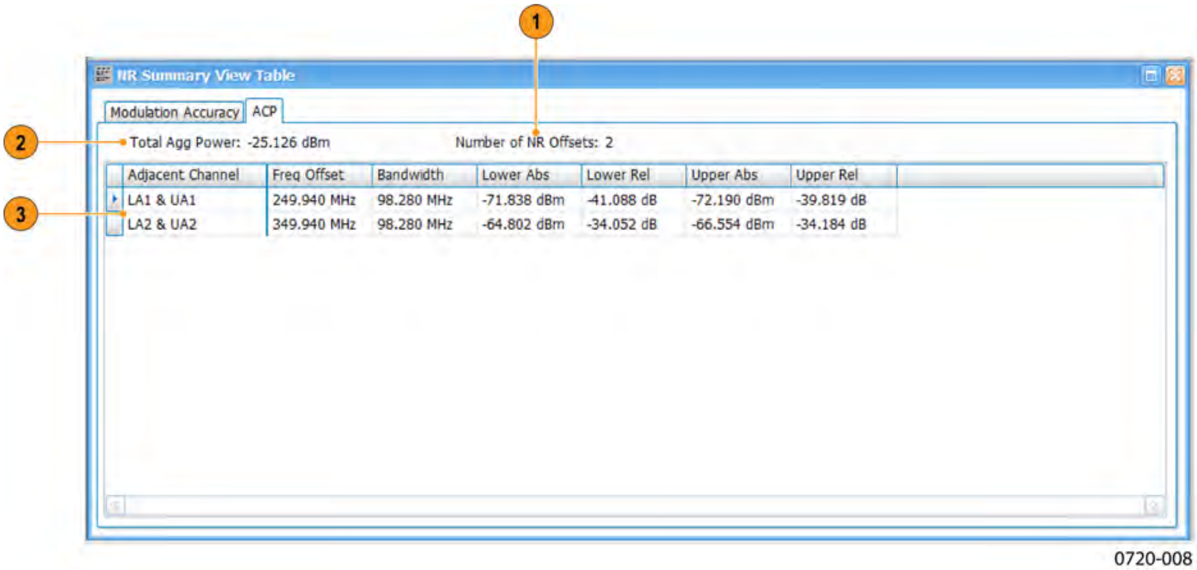
Summary view for CHP:



0720-009

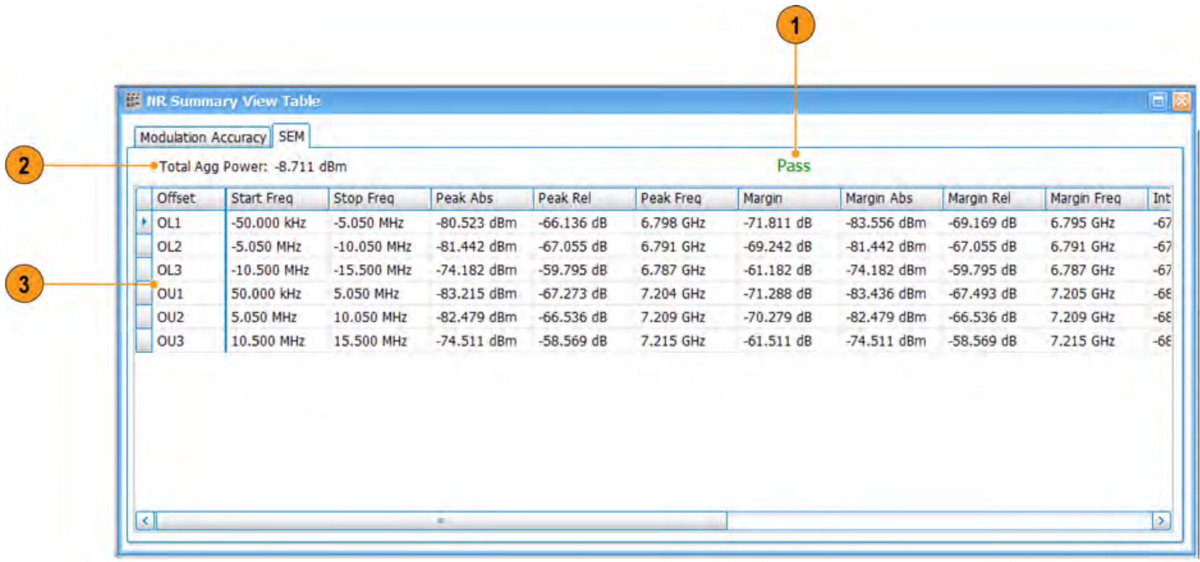
Item	Display element	Description
1	Total Agg Power	Displays the total aggregated power.
2	Results table	Displays the CHP results.

Summary view for ACP:



Item	Display element	Description
1	Number of NR Offsets	Displays the number of NR Offsets.
2	Total Agg Power	Displays the total aggregated power.
3	Results table	Displays the ACP results.

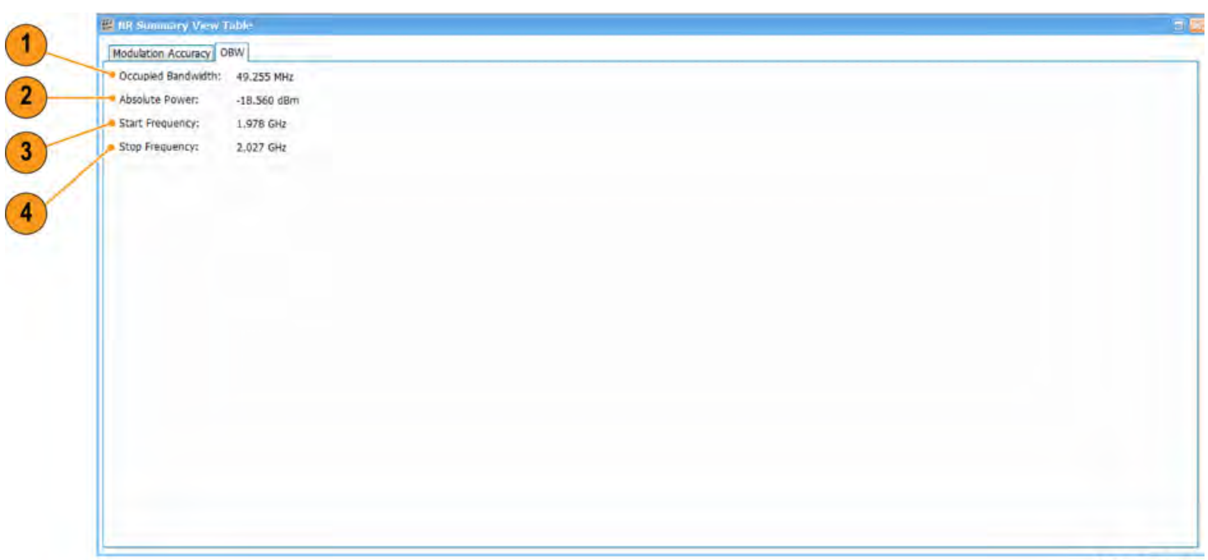
Summary view for SEM:



0720-007

Item	Display element	Description
1	Pass/Fail	Displays Pass/Fail result based on absolute and relative limits set by the user.
2	Total Agg Power	Displays the total aggregated power.
3	Results table	Displays the SEM results.

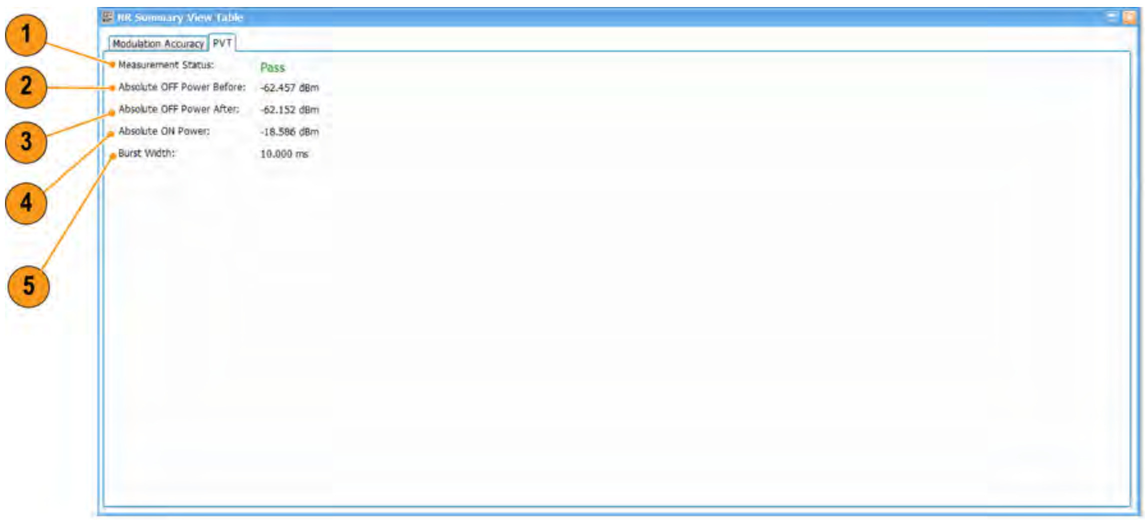
Summary view for OBW:



0720-014

Item	Display element	Description
1	Occupied Bandwidth	Returns the bandwidth that occupies the specified percentage of the total power of the signal. This value is expressed in Hz.
2	Absolute Power	Returns the total power measured in the spectrum acquired by the measurement. This value is expressed in dBm.
3	Start Frequency	Returns the Start Frequency of the occupied bandwidth of carrier/subblock. This value is expressed in Hz.
4	Stop Frequency	Returns the Stop Frequency of the occupied bandwidth of carrier/subblock. This value is expressed in Hz.

Summary view for PVT:



0720-015

Item	Display element	Description
1	Measurement Status	Returns the measurement status indicating whether the off power before and after is within the standard defined limit.
2	Absolute OFF Power Before	Returns the OFF power in the segment before the captured burst. The segment is defined as one slot prior to a short transient segment and the burst. This value is expressed in dBm.
3	Absolute OFF Power After	Returns the OFF power in the segment after the captured burst. The segment is defined as one slot after the burst and a short transient segment. This value is expressed in dBm.
4	Absolute ON Power	Returns the power of the slots within the captured burst. This value is expressed in dBm.
5	Burst Width	Returns the width of the captured burst. This value is expressed in seconds.

NR Summary Display Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar:

The NR Summary display control panel allows you to configure the settings of the NR Summary display.

Settings tab	Description
Modulation Accuracy	Allows you to configure the modulation accuracy-specific properties.
ACP	Allows you to configure the ACP-specific properties.
CHP	Allows you to configure the CHP specific properties.
SEM	Allows you to configure SEM specific properties.
OBW	Allows you to configure the OBW specific properties.
PVT	Allows you to configure the PVT specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.

NR Analysis Measurement Settings

Main menu bar: **Setup** > **Settings**

Front Panel: Settings

Favorites toolbar:

The control panel tabs in this section are shared between the displays in 5GNR 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.

Controls for 5GNR Analysis displays

Settings tab	Description
Modulation Accuracy	Allows you to configure the modulation accuracy-specific properties.
ACP	Allows you to configure the ACP-specific properties.
CHP	Allows you to configure the CHP specific properties.
SEM	Allows you to configure SEM specific properties.
OBW	Allows you to configure the OBW specific properties.
PVT	Allows you to configure the PVT specific properties.
Signal Configuration	Allows you to configure the signal properties.
Subblock Configuration	Allows you to configure the properties needed to analyze a subblock in 5GNR signal.
Carrier Configuration	Allows you to configure the carrier properties.
Averaging	Allows you to configure the averaging parameters.
Traces	Allows you to set the display characteristics of the traces. **Available for the NR Constellation display only.**
Prefs	Allows you to configure settings required to show/hide graticule, marker readouts, and readouts.

ACP Tab

The **ACP** tab allows you to configure the settings required for the adjacent channel power measurement.

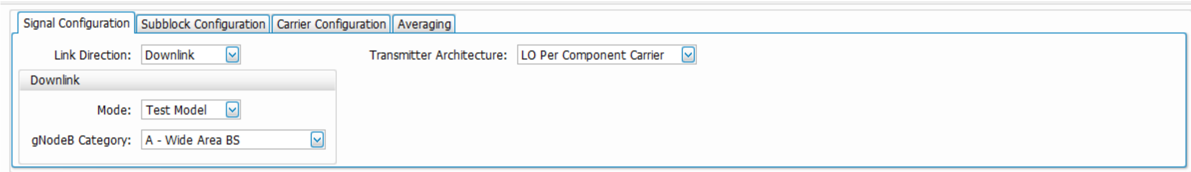
The following image is of the **ACP** tab for the NR adjacent channel power display.

Setting	Available options	Description
Sweep Time	1 zs to 20 ms	Specifies the sweep time or the total analysis time for the ACP measurement. To manually specify the sweep time, uncheck **Auto**. **Default value: 1.000 ms**
FFT Window		Specifies the Fast Fourier Transform (FFT) window method. **Default value: None**
	None	No FFT window.
	• Flat Top • Hanning • Hamming • Gaussian • Blackman • Blackman-Harris • Kaiser-Bessel	Select reduce spectral leakage.
NR Offset	0, 1, 2, 3, 4, 5, 6	Specifies the number of offsets to be displayed and ACP measurement to be run. **Default value: 2**
Resolution Bandwidth		
RBW		Displays the Resolution Bandwidth (RBW) for NR measurements. To manually specify the RBW, uncheck Auto. **Default value: 30 kHz**
RBW Filter		Specifies the RBW filter method used for the transform. **Default value: FFT Based**
	Flat	Specifies the RBW filter with a flat response.
	FFT Based	No RBW filtering is performed.
	Gaussian	Specifies the RBW filter with a gaussian response.

Signal Configuration Tab

The Signal Configuration tab allows you to configure the signal settings like link direction and transmitter architecture required for the 5GNR measurements. In downlink mode, it allows you to select the mode and the gNodeB category.

The following image is of the Signal Configuration tab available for the NR adjacent channel power, NR channel power, NR constellation, NR spectral emission mask, and NR summary displays.

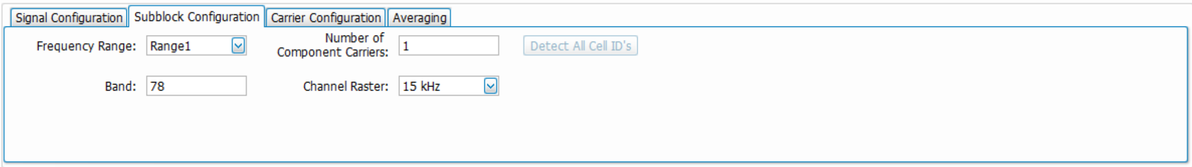


Setting	Available options	Description
Link Direction		Specifies the Link Direction of the signal. You can set to Uplink or Downlink depending on the signal type. **Default value: Uplink**
	Uplink	Unidirectional radio link for the transmission of signals from the user equipment to a base station, from a mobile station to a mobile base station, or from a mobile base station to a base station.
	Downlink	Unidirectional radio link for the transmission of signals from a base station to user equipment. Also, in general, the direction from network to user equipment.
Downlink		
Mode		Specifies downlink channel configuration mode. **Default value: Test Model**
	Test Model	A test model needs to be selected that will configure all the signals and channels automatically according to the specifications.
	User Defined	Select to manually configure the signals, subblocks, and channels.
gNodeB Category	A - Wide Area BS	Specifies the Downlink gNodeB category **Default value: A - Wide Area BS**
	B (Option 1) - Wide Area BS	The gNodeB type is Wide Area Base Station - Category B Option1.
	B (Option 2) - Wide Area BS	The gNodeB type is Wide Area Base Station - Category B Option2.
	Local Area BS	The gNodeB type is Local Area Base Station.
	Medium Range BS	The gNodeB type is Medium Range Base Station.
Transmitter Architecture		Specifies the RF architecture at the transmitter in case of multi-carrier. Each carrier can have a separate Local Oscillator (LO) or one common for the entire subblock. **Default value: Lo Per Component Carrier**
	Lo Per Component Carrier	Local oscillator per component carrier.
	Lo Per SubBlock	Local oscillator per subblock.

Subblock Configuration Tab

The Subblock Configuration tab allows you to analyze a subblock in 5GNR signal.

The following image is of the Subblock Configuration tab available for the NR adjacent channel power, NR channel power, NR constellation, NR spectral emission mask, and NR summary displays.

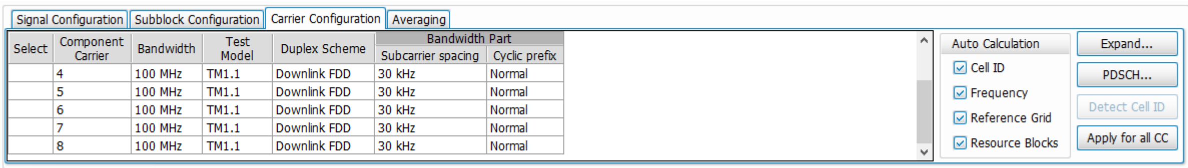


Setting	Available options	Description
Frequency Range		Specifies whether to use band, channel bandwidth, and subcarrier spacing configuration supported in the frequency range 1 or the frequency range 2. **Default value: Range 1**
	Range 1	The measurement uses the band, channel bandwidth, and the subcarrier spacing configuration supported in frequency range 1.
	Range2	The measurement uses the band, channel bandwidth, and the subcarrier spacing configuration supported in frequency range 2.
Band		Specifies the E-UTRA or NR operating frequency of a subblock. The band determines the spectral flatness mask and spectral emission mask. **Default value: 78**
	1, 2, 3, 5, 7, 8, 12, 20, 25, 28, 34, 38, 39, 40, 41, 50, 51, 66, 70, 71, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, and 86	Bands supported for frequency range 1
	257, 258, 260, and 261	Bands supported for frequency range 2
Number of Component Carriers		Specifies the number of component carriers in a subblock. **Default value: 1**
	1	Set to 1 for a single carrier.
	2 to 8	Number of component carriers in a subblock (greater than 2 for multiple component carriers in a subblock)
Channel Raster	15 kHz, 60 kHz, 100 kHz	Specifies the subblock channel raster which is used for computing nominal spacing between aggregated carriers. The value is expressed in Hz. The channel raster defines a subset of RF reference frequencies that can be used to identify the RF channel position in the uplink and downlink. The RF reference frequency for an RF channel maps to a resource element on the carrier. **Default value: 15 kHz**
Detect All Cell ID’s		Select to detect all carrier's cell id. This is enabled when Link direction is set as Downlink and Downlink configuration mode is set to User Defined.

Carrier Configuration Tab

The Carrier Configuration tab allows you to configure the component carrier settings of the 5GNR signal. Each component carrier is represented by its row in the table. The corresponding PDSCH/PUSCH configurations are available through a button click at the right side of the table.

The following image is of the Carrier Configuration tab available for the NR adjacent channel power, NR channel power, NR constellation, NR spectral emission mask, NR Power vs Time, NR Occupied Bandwidth, NR EVM, and NR summary displays.



Setting	Available options	Description
Select		Allows to select the component carrier, which helps to : • Configure all component carriers with the selected component carrier configurations. • Detect selected component carrier Cell ID. • Configure parameters related to PUSCH/PDSCH for selected component carriers.
Component carrier		Specifies which component carrier is being configured.
Bandwidth		Specifies component carrier's channel bandwidth. **Default value:** 100MHz **Available values in MHz for Range 1:** 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 **Available values in MHz for Range 2:** 50, 100, 200, 400
Frequency Offset		Specifies the offset of the component carrier from the subblock center frequency. **Default value:** 0
Test Model		Specifies the NR downlink test models. This can be configured when the Link direction is Downlink and Downlink configuration mode is set to Test model. **Default value:** TM1.1 **Available values:** TM1.1, TM1.2, TM2, TM2a, TM3.1, TM3.1a, TM3.2, TM3.3
Duplex scheme	Downlink FDD, Downlink TDD	Specifies the duplexing technique of the signal being measured. FDD refers to Frequency-Division duplexing. TDD refers to Time-Division duplexing. This can be configured when the Link direction is Downlink and Downlink configuration mode is Test model. **Default value: Downlink FDD**
Cell ID	0 to 1007	Specifies the physical layer cell identity. This can be configured when Auto calculation cell ID is deselected. **Default value: 0**

Table continued…

Setting	Available options	Description
Reference grid	Subcarrier spacing	Specifies the subcarrier spacing of the reference resource grid. This should be the largest subcarrier spacing used in the component carrier. **Default value: 30 kHz** **Available values for Range 1: 15 kHz, 30 kHz, 60 kHz** **Available values for Range 2: 60 kHz and 120 kHz**
	Start	**Default value: 0** **Available values: 0 to 275**
Bandwidth part	Subcarrier spacing	**Default value: 30kHz** **Available values for Range1: 15 kHz, 30 kHz, 60 kHz** **Available values for Range 2: 60 kHz and 120 kHz**
	cyclic prefix	Specifies the cyclic prefix (CP) duration and the number of symbols in a slot for the signal being measured. **Default value: Normal** **Available values: Normal**
	Bandwidth part Grid start	Specifies the resource grid starts relative to reference point A in terms of resource block offset. **Default value: 0**
	RB offset	Specifies the resource block offset of a bandwidth part relative to the resource grid start the property. **Default value: 0**
	RBs	Specifies the number of consecutive resource blocks in a bandwidth part. **Default value: 0**
Auto Calculation		Deselection of any of these parameters enables manual mode which allows to configure them manually.
	Cell ID	Deselect to configure the cell ID manually.
	Frequency	Deselect to configure the Frequency manually.
	Reference Grid	Deselect to manually configure the Reference Grid Subcarrier spacing and Reference Grid Start values.
	Resource Block	Deselect to manually configure the RB offset and RBs values.
Expand		Click to view the table in a separate window. You can also configure the table.
PDSCH		Click to configure the PDSCH parameters. **PDSCH button is enabled when link direction is selected as Downlink.**
PUSCH		Click to configure the PUSCH parameters. **PUSCH button is enabled when link direction is selected as Uplink.**
Detect All Cell ID’s		Select to manually identify the Cell ID of the signal. **This button is enabled when link direction is configured as Downlink and Downlink.**

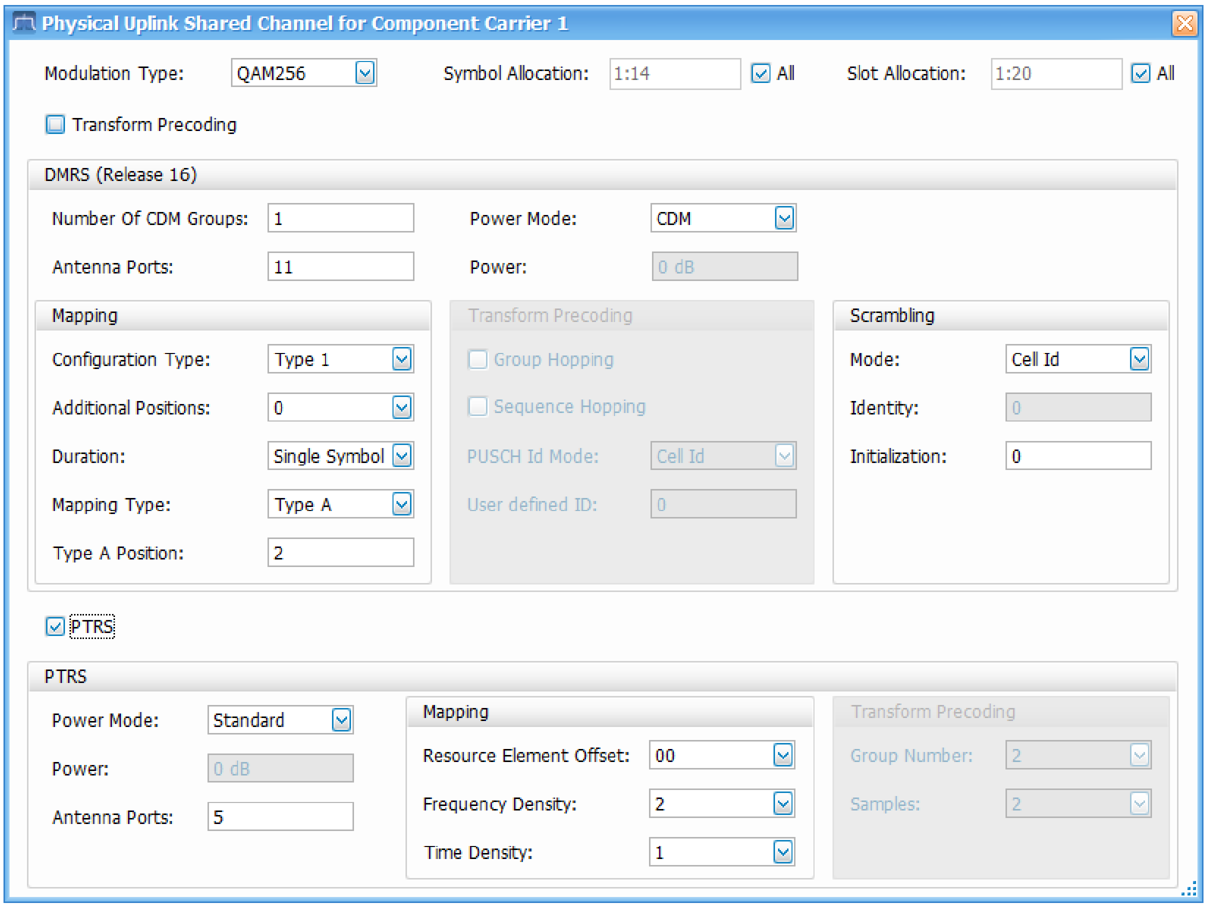
Table continued…

Setting	Available options	Description
Apply for All CC		Click to apply all the selected component carrier to all component carriers, except the Cell ID.

Physical Uplink Shared Channel for Component Carrier 1 Window

The **Physical Uplink Shared Channel for Component Carrier 1 Window** allows you to configure the PUSCH settings for the selected component carrier. The DMRS and PTRS settings related to the corresponding PUSCH are also configurable through this window.

The following image is of the **Physical Uplink Shared Channel for Component Carrier 1 Window** available in the carrier configuration tab.



Setting	Available options	Description
Modulation Type		Specifies the modulation scheme used in the physical uplink shared channel (PUSCH) of the signal being measured. **Default value: QAM256**
	PI/2 BPSK, QPSK, QAM16, QAM64, QAM256, QAM1024	Specifies a PI/2 BPSK modulation scheme. Specifies a QPSK modulation scheme. Specifies a 16 QAM modulation scheme. Specifies a 64 QAM modulation scheme. Specifies a 256 QAM modulation scheme. Specifies a 1024 QAM modulation scheme.
Symbol Allocation	1:14	Specifies the symbol allocation of each slot. Valid values are from 1 to 14, inclusive. The format is defined by range format specifiers. The range format specifier is a comma separated list of entries. ⚠ **Note:** If incorrect value is entered in symbol allocation, the value will be highlighed in red color Examples: 2,4 will expand to {2,4} 1:3,7 will expand to {1,2,3,7}. To manually specify the symbol allocation, uncheck All.
Slot Allocation	1:20	Specifies the slot allocation in NR Frame. This defines the indices of the allocated slots. Valid values are from 1 to maximum number of slots in the frame max number of slots is dependent on numerology within the specifications The format is defined by range format specifiers. The range format specifier is a comma-separated list of entries. ⚠ **Note:** If incorrect value is entered in slot allocation, the value will be highlighed in red color Examples: 2,4 will expand to {2,4} 1:3,7 will expand to {1,2,3,7}. To manually specify the slot allocation, uncheck All.
DMRS (Release 16)		

Table continued…

Setting	Available options	Description
Power Mode		Specifies whether the value of PUSCH DMRS Pwr property is calculated based on the PUSCH DMRS number of CDM Groups value or specified by the user (user-defined). Select to calculate the PUSH DRMS Pwr value based on PUSCH DMRS number of CDM Groups value or by user-defined method. **Default value: CDM**
	User Defined	Specifies the DMRS power manually.
Antenna Ports		Specifies the antenna ports used for DMRS transmission.
Power		Specifies the factor which boosts the PUSCH DMRS REs. This value is expressed in dB. This property is ignored if you set the “Power Mode” value to CDM Groups.
Number of CDM Groups		Specifies the number of CDM groups, when you set the PUSCH “Transform Precoding” value to False, otherwise, it is set to 2.
Mapping		
Configuration Type		Specifies the DMRS configuration type. **Default value: Type 1**
	• Type 1 • Type 2	• One DMRS subcarrier alternates with one data subcarrier. • Two consecutive DMRS subcarriers alternate with four consecutive data subcarriers.
Duration		Specifies whether the DMRS is single-symbol or double-symbol.. **Default value: Single Symbol**
	Single Symbol	There are one or more non-consecutive DMRS symbols in a slot.
	Double Symbol	There are one or more sets of two consecutive DMRS symbols in the slot.
Type A Position	2,3	Specifies the position of the first DMRS symbol in a slot when you set the PUSCH "Mapping Type" value to Type A. 2: The first DMRS symbol index in a slot is 2. 3: The first DMRS symbol index in a slot is 3.
Additional Positions		Specifies the number of additional sets of consecutive DMRS symbols in a slot. **Default value: 0**
	0,1,2,3	0: No additional DMRS symbol set is present in the slot. 1: One additional DMRS symbol set is present in the slot. 2: Two additional DMRS symbol sets are present in the slot. 3: Three additional DMRS symbol sets are present in the slot.

Table continued…

Setting	Available options	Description
Mapping Type		Specifies the mapping type of DMRS. **Default value: Type A**
	Type A	The first DMRS symbol index in a slot is either 2 or 3 based on PUSCH DMRS "Type A Position" value.
	Type B	The first DMRS symbol index in a slot is the first active PUSCH symbol.
Scrambling		
Mode		Specifies whether the configured Scrambling ID is honored or the Cell ID is used for reference signal generation. **Default value: Cell ID**
	Cell ID	The value of the PUSCH DMRS Scrambling ID is based on the Cell ID property.
	User Defined	Select this to configure the Scrambling ID manually.
Identity	0 to 65535	Specifies the value of scrambling ID. This property is valid only when you set the PUSCH "Transform Precoding" value to False.
Initialization		Specifies the DMRS nSCID used for reference signal generation.
Transform Precoding		Enable or disable Transform precoding configurations.
Group Hopping		Specifies whether the group hopping is enabled. This parameter is valid only when you set the PUSCH "Transform Precoding" value is set to True.
Sequence Hopping		Enable or disable Sequence hopping.
PUSCH ID Mode		Specifies whether PUSCH DMRS PUSCH ID is based on Cell ID or user-defined. This parameter is valid only when you set the PUSCH "Transform Precoding" value is set to True. **Default value: Cell ID**
	Cell Id	The value of PUSCH DMRS PUSCH ID is based on the Cell ID property.
	User Defined	The value of the PUSCH DMRS PUSCH ID is specified by the user.
User Defined ID	0 to 1007	Specifies the value of PUSCH DMRS PUSCH ID used for reference signal generation. This property is valid only when you set the PUSCH "Transform Precoding" value to True and PUSCH DMRS "PUSCH ID Mode" value to User Defined.
PTRS		Enable or disable PTRS.
Power Mode	Standard, User Defined	Specifies the DMRS antenna ports associated with PTRS transmission. This property is valid only if you set the PTRS Enabled property to True. **Default value: Standard**
Power		Specifies the factor by which the PUSCH PTRS REs are boosted. This value is expressed in dB. This property is valid only if you set the PTRS Enabled property to True.
Antenna Ports		Specifies the DMRS antenna ports associated with PTRS transmission. This property is valid only if you set the PTRS Enabled property to True .
Mapping		

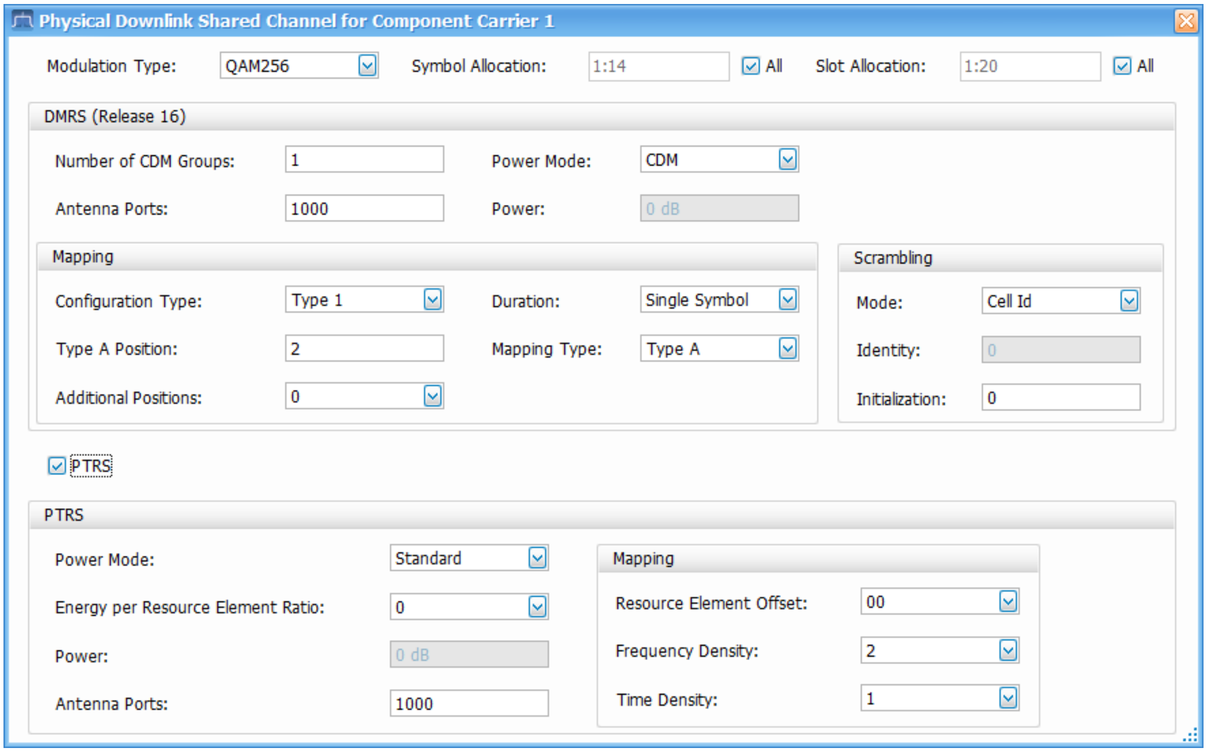
Table continued…

Setting	Available options	Description
Resource Element Offset	00, 01, 10, 11	Specifies the RE offset to be used for transmission of PTRS. This property is valid only if you set the PTRS Enabled property to True and Transform Precoding Enabled property to False. **Default Value: 00**
Frequency Density	2, 4	Specifies the density of PTRS in frequency domain. This property is valid only if you set the PTRS Enabled property to True and Transform Precoding Enabled property to False. **Default Value: 2**
Time Density	1, 2, 4	Specifies the density of PTRS in time domain. This property is valid only if you set the PTRS Enabled property to True. **Default Value: 1**
Transform Precoding		Enable or disable Transform precoding configurations.
Group Number	2, 4, 8	Specifies the number of PTRS groups per OFDM symbol. This property is valid only if you set the PTRS Enabled property to True and Transform Precoding Enabled property to True. **Default Value: 2**
Samples	2, 4	Specifies the number of samples per each PTRS group. This property is valid only if you set the PTRS Enabled property to True and Transform Precoding Enabled property to True. **Default Value: 2**

Physical Downlink Shared Channel for Component Carrier 1 Window

The **Physical Downlink Shared Channel for Component Carrier 1 Window** allows you to configure the PDSCH settings for the selected component carrier. The DMRS and PTRS settings related to the corresponding PDSCH are also configurable through this window.

The following image is of the **Physical Downlink Shared Channel for Component Carrier 1 Window** available in the carrier configuration tab.



Setting	Available options	Description
Modulation Type		Specifies the modulation type used in the physical downlink shared channel (PDSCH) channel of the signal being measured. **Default value: QAM256**
	QPSK, QAM16, QAM64, QAM256, QAM1024	Specifies a QPSK modulation scheme. Specifies a 16 QAM modulation scheme. Specifies a 64 QAM modulation scheme. Specifies a 256 QAM modulation scheme. Specifies a 1024 QAM modulation scheme.
Symbol Allocation	1:14	Specifies the symbol allocation of each slot. To manually specify the symbol allocation, uncheck All.
Slot Allocation	1:20	Specifies the number of PDSCH slot configurations. To manually specify the slot allocation , uncheck All.
DMRS (Release 16)		
Power Mode	CDM	Specifies whether the DMRS power is calculated based on several CDM groups or manually entered by a user **Default value: CDM**
	User Defined	Specifies the DMRS power manually.

Table continued…

Setting	Available options	Description
Antenna Ports		Specifies the Antenna ports used for DMRS transmission. **Default value: 1000**
Power		Specifies the DMRS power. **Default value: 0**
Number of CDM Groups		Specifies the number of CDM groups. **Default value: 1**
Mapping		
Configuration Type		Specifies the DMRS configuration type. **Default value: Type 1**
	• Type 1 • Type 2	• One DMRS subcarrier alternates with one data subcarrier. • Two consecutive DMRS subcarriers alternate with four consecutive data subcarriers.
Duration		Specifies whether the DMRS is a single symbol or double symbol. **Default value: Single Symbol**
	Single Symbol	There are one or more non-consecutive DMRS symbols in a slot.
	Double Symbol	There are one or more sets of two consecutive DMRS symbols in the slot.
Type A Position		Specifies the position of the first DMRS symbol in a slot for Type A configurations. **Default value: 2**
Additional Positions	0	Specifies the number of additional sets of consecutive DMRS symbols in a slot. **Default value: 0**
	1,2,3	Different additional DMRS symbols are set in the slot.
Mapping Type		Specifies the mapping type of DMRS. **Default value: Type A**
	Type A	The first DMRS symbol index in a slot is either 2 or 3
	Type B	The first DMRS symbol index in a slot is 0.
Scrambling		
Mode	Cell ID	Specifies the configured Scrambling ID is based on Cell ID or specified by the user. **Default value: Cell ID**
	User Defined	Select this to configure Scrambling ID manually.
Identity		Specifies the scrambling ID used for reference signal generation. **Default value: 0**

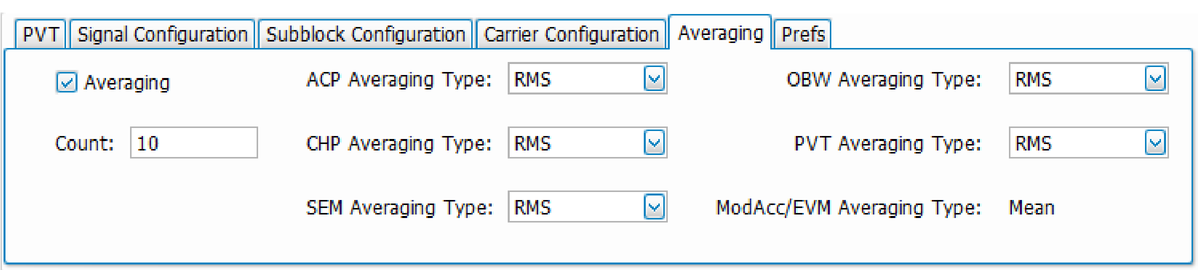
Table continued…

Setting	Available options	Description
Initialization		Specifies the DMRS nSCID used for reference signal generation. **Default value: 0**
PTRS		Enable or disable PTRS.
Power Mode	Standard, User Defined	Specifies whether the configured PTRS Power is calculated as per standard specification or configured by you. **Default value: Standard**
Energy per Resource Element Ratio	0, 1	Specifies the EPRE Ratio Port used to determine the PDSCH PT-RS RE power scaling when you set the PTRS Power Mode property to Standard. **Default Value: 0**
Power		Specifies the factor by which the PDSCH PTRS REs are boosted, compared to PDSCH REs. This value is expressed in dB. The value of this property is taken as an input when you set the Power Mode property to User Defined. If you set the PDSCH PTRS Power Mode property to Standard, the value is computed from other parameters.
Antenna Ports	1000	Specifies the DMRS Antenna Ports associated with PTRS transmission.
Mapping		
Resource Element Offset	00, 01, 10, 11	Specifies the RE Offset to be used for transmission of PTRS. **Default Value: 00**
Frequency Density	2, 4	Specifies the density of PTRS in frequency domain. **Default Value: 2**
Time Density	1, 2, 4	Specifies the density of PTRS in time domain. **Default Value: 1**

Averaging Tab

The Averaging tab allows you to configure the settings for averaging 5GNR measurements. The number of acquisitions and the averaging type for different measurements (modulation accuracy is always mean) is configurable in this tab.

The following image is of the Averaging tab available for the NR adjacent channel power, NR channel power, NR constellation, NR spectral emission mask, NR EVM, NR Occupied Bandwidth, NR Power vs Time, and NR summary displays.



Setting	Available options	Description
Averaging		Specifies whether the averaging parameters are available to configure.

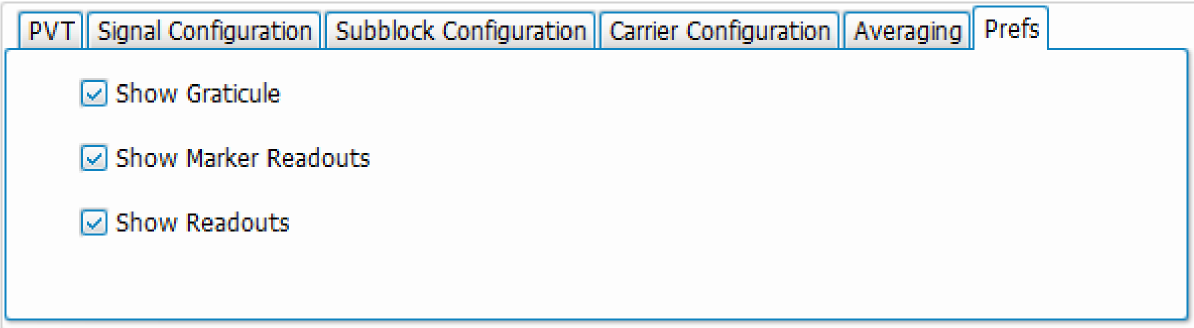
Table continued…

Setting	Available options	Description
Count		Specifies the number of acquisitions used for averaging. **Default value: 10**
ACP Averaging Type		Specifies the averaging type for averaging spectral acquisitions. **Default value: RMS**
	RMS	Spectral acquisitions are averaged linearly.
	Log	Spectral acquisitions are averaged on a logarithmic scale.
	Scalar	Square root of spectral acquisitions is averaged.
	Max	The maximum power in the spectrum at each frequency bin is retained from one acquisition to the next.
	Min	The lowest power in the spectrum at each frequency bin is retained from one acquisition to the next.
CHP Averaging Type	RMS, Log, Scalar, Max, Min	Specifies the averaging type for averaging spectral acquisitions. **Default value: RMS**
SEM Averaging Type	RMS, Log, Scalar, Max, Min	Specifies the averaging type for averaging spectral acquisitions. **Default value: RMS**
OBW Averaging Type	RMS, Log, Scalar, Max, Min	Specifies the averaging type for averaging spectral acquisitions. **Default value: RMS**
PVT Averaging Type	RMS, Log	Specifies the averaging type for averaging spectral acquisitions. **Default value: RMS**
ModACC Averaging Type		Specifies the averaging type for averaging spectral acquisitions. **Default value: Mean**

Prefs Tab

The Prefs tab allows you to configure settings required to show/hide graticule, marker readouts and readouts.

The following image is of the Prefs tab available for the NR adjacent channel power, NR channel power, NR constellation, NR spectral emission mask, NR EVM, NR Occupied Bandwidth, and NR Power vs Time displays.

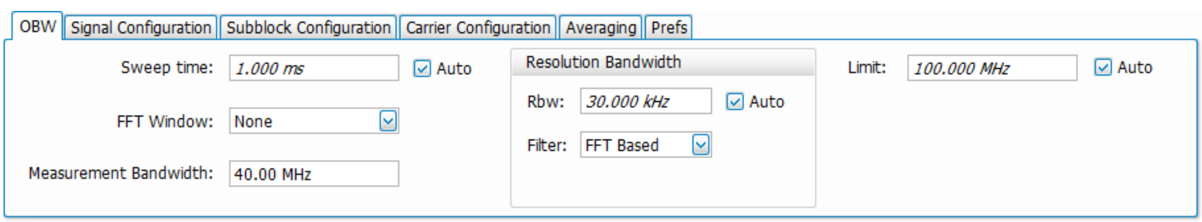


Setting	Available options	Description
Show Graticule		It controls the visibility of graticule in the plot.
Show Marker Readouts		It controls the visibility of marker readouts in the plot.
Show Readouts		It controls the visibility of readouts in the plot.

OBW Tab

The OBW tab allows you to configure the settings required for the occupied bandwidth measurement.

The following image shows the OBW tab for the NR Occupied Bandwidth display.



Setting	Available options	Description
Sweep Time		To manually specify the Sweep Time, uncheck Auto. **Default Value: 1.000 ms**
FFT Window	None Flat Top Hanning, Hamming, Gaussian, Blackman, Blackman-Harris, Kaiser-Bessel	Fast Fourier Transform (FFT) window type. Select to reduce the spectral leakage. **Default Value: None**

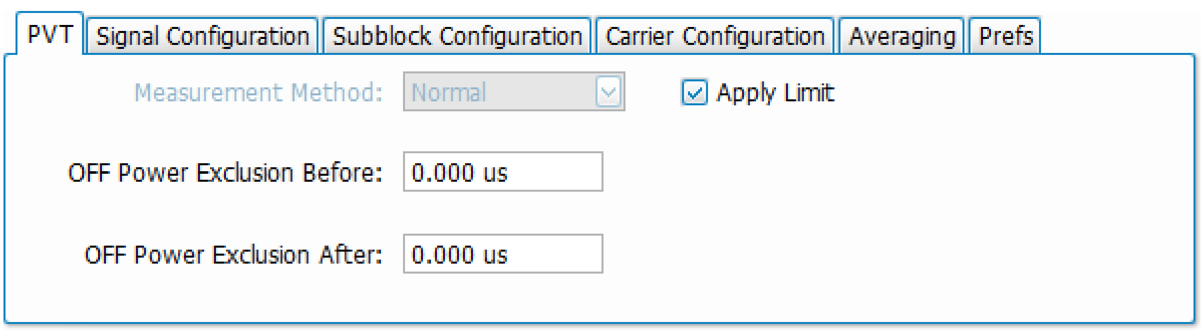
Table continued…

Setting	Available options	Description
Measurement Bandwidth		Specifies the frequency range around the sub-block center frequency, which is used to find the sub-block occupied bandwidth. **Default Value: 1.000 GHz**
RBW		Displays the Resolution Bandwidth (RBW) for NR measurements. To manually specify the RBW, uncheck Auto. **Default Value: 30 kHz**
RBW Filter		Specifies the windowing method used for the transform. **Default Value: FFT Based**
	FFT Based	No RBW filtering is being performed.
	Gaussian	Specifies the RBW filter with a gaussian response.
	Flat	Specifies the RBW filter with a flat response.
Limit		To manually specify limit to check Pass/Fail condition of OBW measurement. If 'Auto' button checked OBW is compared if it is less than or equal to sub-block bandwidth of the signal. If 'Auto' button unchecked user can give limit to compare with OBW. **Default Value: 100 MHz**

PVT Tab

The PVT tab allows you to configure the settings required for the Power Vs Time measurement.

The following image shows the PVT tab for the NR Power Vs Time display.



Setting	Available options	Description
Measurement Method		Specifies the measurement method. **Default Value: Normal**
Off Power Exclusion Before		Specifies the time excluded from the Off region before the burst. The value is expressed in seconds. **Default value: 0.00 us**
Off Power Exclusion After		Specifies the time excluded from the Off region after the burst. This value is expressed in seconds. **Default value: 0.00 us**

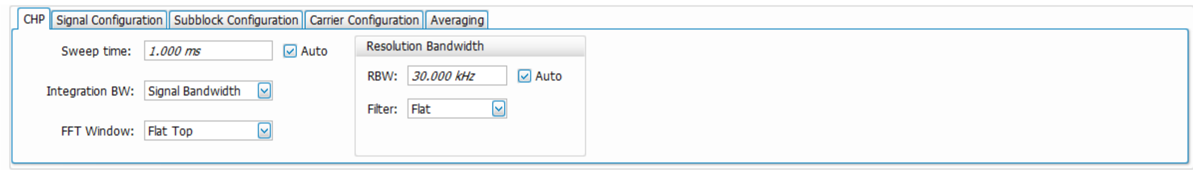
Table continued…

Setting	Available options	Description
Apply Limit		IT enables pass/fail result and limit trace.

CHP Tab

The CHP tab allows you to configure the settings required for the channel power measurement.

The following image shows the CHP tab for the NR channel power display.

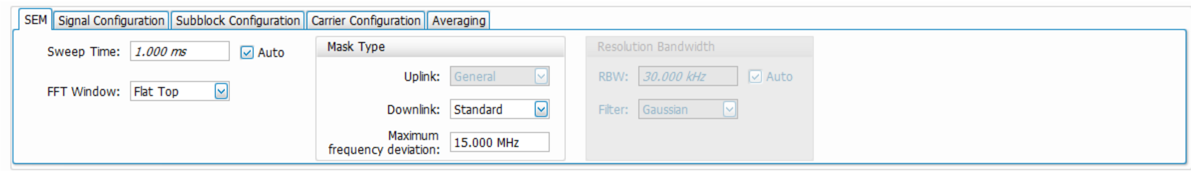


Setting	Available options	Description
Sweep Time		Specifies the sweep time or the total analysis time for the CHP measurement. To manually specify the sweep time, uncheck Auto. **Default value: 1.000 ms**
Integration BW		Specifies the type of integration bandwidth to measure the power of the acquired signal. **Default value: Signal Bandwidth**
	Signal Bandwidth	Excludes the guard bands at the edges of the carrier or subblock.
	Channel bandwidth	Includes the guard bands at the edges of the carrier or subblock.
FFT Window		Fast Fourier Transform (FFT) window. Specifies the FFT window type. **Default value: None**
	None	No FFT window.
	Flat Top, Hanning, Hamming, Gaussian, Blackman, Blackman-Harris, Kaiser-Bessel	Select to reduce spectral leakage.
Resolution Bandwidth		
RBW		Displays the Resolution Bandwidth (RBW) for NR measurements. To manually specify the RBW, uncheck Auto. **Default value: 30 kHz**
Filter		Specifies the RBW filter method used for the transform. **Default value: FFT Based**
	Flat	Specifies the RBW filter with a flat response.
	FFT Based	No RBW filtering is being performed.
	Gaussian	Specifies the RBW filter with a gaussian response.

SEM Tab

The SEM tab allows you to configure the settings required for the spectral emission mask measurement.

The following image is of the SEM tab for the NR spectrum emission mask display.



Setting	Available options	Description
Sweep Time		Specifies the sweep time or the total analysis time for the SEM measurement. To manually specify the sweep time, uncheck Auto. **Default value: 1.000 ms**
FFT Window		Fast Fourier Transform (FFT) window. Specifies the FFT window type. **Default value: None**
	None	No FFT window.
	Flat Top, Hanning, Hamming, Gaussian, Blackman, Blackman-Harris, Kaiser-Bessel	Select to reduce spectral leakage.
Resolution Bandwidth		
RBW		Displays the Resolution Bandwidth (RBW) for SEM measurements. To manually specify the RBW, uncheck Auto. **Default value: 30 kHz**
Filter		Specifies the RBW filter method used for the transform. **Default value: Gaussian**
	Flat	Specifies the RBW filter with a flat response.
	FFT Based	No RBW filtering is being performed.
	Gaussian	Specifies the RBW filter with a gaussian response.
Mask Type		

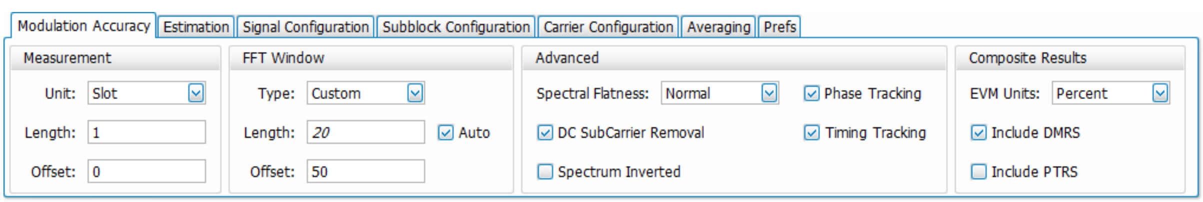
Table continued…

Setting	Available options	Description
Uplink		Specifies the spectrum emission mask used in the measurement when the link direction is uplink. **Default value: General**
	NS_35, NS_03, NS_04, NS_06, NS_21	Selection of the different SEM masks as defined in specifications for uplink.
	Custom	Define a custom SEM mask for uplink.
Downlink	Standard	Specifies the spectrum emission mask used in the measurement when the link direction is downlink. **Default value: Standard**
	Custom	Define a custom SEM mask for downlink.
Maximum frequency Deviation		Specifies the maximum frequency deviation of the offsets when the link direction is downlink and downlink mask type is set to standard. **Default value: 15 MHz**

Modulation Accuracy Tab

The Modulation Accuracy tab allows you to configure the settings needed to measure modulation accuracy. This tab contains important parameters related to OFDM symbol demodulation and EVM computation.

The following image shows the Modulation Accuracy tab for the NR constellation and NR EVM display.



Setting	Available options	Description
Measurement		
Unit	Slot	Specifies the units for measurement offset and measurement length. **Slot**: Length and offset are specified in units of slots. **Default value: Slot**
	Time	Measurement offset and measurement length are specified in seconds.
Length		Measurement length in units specified by the unit property. **Default value: 1**

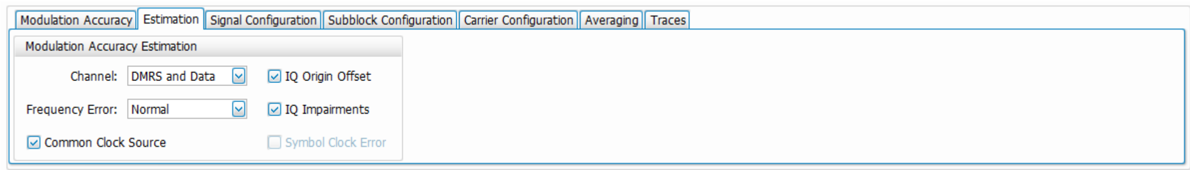
Table continued…

Setting	Available options	Description
Offset		Measurement offset to skip from the synchronization boundary. **Default value: 0**
FFT Window		
Type	Custom	Specifies FFT window type used for EVM calculation. The FFT window offset is used when set to custom, and the window length is set to 3GPP OFDM FFT size internally. **Default value: Custom**
	3GPP	The FFT window length is used when set to 3GPP, and the window offset is set as per 3GPP specs internally.
Length		Specifies the FFT window length as a percentage of cyclic prefix. This value is used when window type is set to 3GPP. To manually specify the length, uncheck Auto. **Default value: 20**
Offset		The starting position of the FFT window as a percentage of cyclic prefix is used to calculate the EVM when the FFT window type is set to custom. **Default value: 50**
Advanced		
Spectral Flatness	Normal	Specifies the test condition for spectral flatness measurement as per normal conditions in 3GPP Standard. **Default value: Normal**
	Extreme	Specifies the test condition for spectral flatness measurement as per extreme conditions in 3GPP Standard.
Phase Tracking		Enables or disables the phase tracking method.
DC Subcarrier Removal		Specifies whether the DC subcarrier is removed or not from the EVM results.
Spectrum Inverted		Specifies whether the spectrum of the signal should be inverted before analysis of modulation accuracy. This option can be utilized while analyzing down-converted IQ data.
Timing Tracking		Specifies whether to enable or disable timing tracking.
Composite Results		
EVM Units	dB	Specifies the units of EVM results. EVM is reported in dB. **Default value: Percent**
	Percent	EVM is reported in percentage.
Include DMRS		Specifies whether DMRS resource elements are included for composite EVM, magnitude and phase error results, and traces.
Include PTRS		Specifies whether PTRS resource elements are included for composite EVM, magnitude and phase error results, and traces.

Estimation Tab

The Estimation tab allows you to configure advanced modulation accuracy measurement estimation. It includes parameters needed to configure IQ impairments while using direct conversion architecture and timing related parameters.

The following image is of the Estimation tab for the NR constellation display.

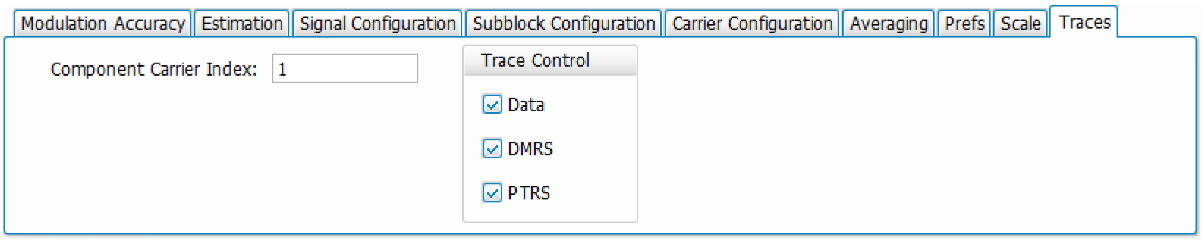


Setting	Available options	Description
Modulation Accuracy Estimation		
Channel	DMRS and Data	Select to improve the estimation of equalizer coefficients under high SNR conditions. **Default value: DMRS and Data**
	DMRS	Select to estimate the equalizer coefficients exclusively using DMRS symbols under any SNR condition.
Frequency Error	Normal	Specifies the mode of carrier frequency error estimation. When normal is selected, the range of estimation is limited to +/- half the sub-carrier spacing. **Default value: Normal**
	Disable	Used to disable the estimation and correction of carrier frequency offset.
	Wide	When selected, frequency error estimation range is +/- half resource block when auto RB detection enabled is true, or range is +/- number of guard subcarrier when auto RB detection enabled is false.
Common Clock Source		Specifies whether the same reference clock is used for local oscillator and digital-to-analog converter. When the same reference clock is used, the carrier frequency offset is proportional to the sample clock error or/and digital-to-analog converter
IQ Origin Offset		Enables or disables estimation of IQ origin offset.
IQ Impairments		Enables or disables estimation of IQ gain and imbalance.
Symbol Clock Error		Enables or disables estimation of symbol clock error

Traces Tab

The Traces tab allows you to configure the display of constellation traces.

The following image is of the Traces tab for the NR constellation display.



Setting	Available options	Description
Component Carrier Index	1, 2, 3, 4, 5, 6, 7, and 8	Select the component carrier index to display the component carriers demodulated data and DMRS. Also, the scalar results in the constellation display are modified accordingly. **Default value: 1**
Trace Control		
Data		Enables or disables plotting the constellation of data symbols.
DMRS		Enables or disables plotting the constellation of DMRS symbols.
PTRS		Enables or disables plotting the constellation of PTRS symbols.

Bluetooth Analysis

Overview

There are two Bluetooth Analysis options: Bluetooth (SV27) and Bluetooth 5 (SV31). These options allow you to evaluate short range RF signals to ensure that they meet Bluetooth standard per Bluetooth Special Interests Group (SIG) Test Specifications for version 5. This analysis option enables measurements and supports detection, demodulation, and decoding of packet information for the following three standards: Basic Rate, Low Energy (LE), and Enhanced Data Rate (EDR).

- Basic Rate with uncoded data at 1 Mb/s
- Low Energy (the following three variants are supported):
  - Low Energy 1M (LE 1M), with uncoded data at 1 Mb/s
  - Low Energy 2M (LE 2M), with uncoded data at 2 Mb/s (Requires Option SV31NL or SV31FL)
  - Low Energy Coded (LE Coded) with S=2 (500 Kb/s) or S=8 (125 Kb/s) (Requires Option SV31NL or SV31FL)
- Enhanced Data Rate (EDR) with 2 Mb/s or 3 Mb/s

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 Bluetooth Analysis is available:

- *Bluetooth key features* on page 525
- *Reference table of supported Bluetooth measurements*
- *Bluetooth measurements and test setups* on page 529
- *Bluetooth Status Messages* on page 533
- *Bluetooth Standards presets* on page 526
- *Bluetooth displays* on page 529
- *Bluetooth Analysis Measurement Settings* on page 557

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, LE 1M, LE 2M, and LE coded.
- In-band Emission measurement preset with capability to compare results against recommended or user defined limits for Basic Rate, LE 1M, LE 2M, and LE coded.
- 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
- 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.

Supported automated Bluetooth measurements

Bluetooth measurement	Bluetooth standard(s)
Modulation characteristics	Basic Rate LE 1M, LE 2M, LE coded
Carrier frequency offset and drift	Basic Rate LE 1M, LE 2M, LE coded
Output power	Basic Rate LE 1M, LE 2M, LE coded
In-band emission /ACPR	Basic Rate LE 1M, LE 2M, LE coded
Out-of-band spurious emission	Basic Rate LE 1M, LE 2M, LE coded
20 dB bandwidth	Basic Rate
Frequency range	Basic Rate
Power density	Basic Rate
Relative power	Enhanced Data Rate (EDR)

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 *here*..

There are four test setups for the LE 1M, LE 2M, and LE coded 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.

Table 30: Bluetooth standards, test setups, and Preset displays

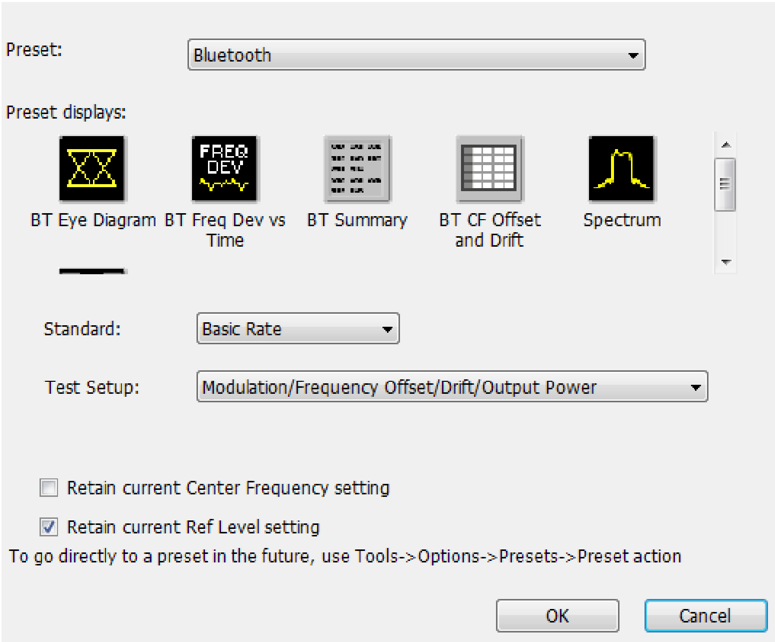
Standard	Test setup	Displays loaded with preset
LE 1M	Modulation/Frequency Offset/Drift/Output Power	BT Eye Diagram, BT Freq Dev vs Time, BT Summary, BT CF Offset and Drift, Spectrum, Time Overview
	In-band Emissions	BT InBand Emission, Spectrum, Time Overview
	Non-compliance	BT Freq Dev vs Time, BT Constellation, BT Summary, Spectrum, Spectrogram, Time Overview
LE 2M LE Coded (Requires Option SV31NL or SV31FL)	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

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.



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.

Table 31: Default center frequencies for Bluetooth test setups

Standard	Test setup	Center frequency
Basic Rate LE 1M LE 2M LE Coded	Modulation/Frequency Offset/Drift/Output Power	2.441 GHz
Basic Rate LE 1M LE 2M LE Coded	In-band Emissions	2.441 GHz
Basic Rate LE 1M LE 2M LE Coded	Out-of-band Spurious Emissions	2.441 GHz
Basic Rate	Tx Output Spectrum — 20dB Bandwidth	2.441 GHz
Basic Rate	Tx Output Spectrum — Power Density	2.441 GHz

Table continued…

Standard	Test setup	Center frequency
Basic Rate LE 1M LE 2M LE Coded	Non-compliance	2.441 GHz
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 display* on page 552
- *Bluetooth Carrier Frequency Offset and Drift display* on page 539
- *Bluetooth Constellation display* on page 534
- *Bluetooth Eye Diagram display* on page 536
- *Bluetooth Frequency Dev vs Time display* on page 549
- *Bluetooth InBand Emission display* on page 555
- *Bluetooth Summary display* on page 541
- *Bluetooth Symbol Table display* on page 545
- *Time Overview Display*

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, LE 1M, LE 2M, LE Coded)

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 for Basic Rate, LE 1M, and LE 2M; and 11001100 or 11110000 for LE Coded. 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 . 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 for LE 1M and LE 2M, and 11001100 for LE Coded, then the maximum frequency deviation is calculated in every bit interval within an octet and recorded as Δfmax. The Δfmax results are averaged to give Δf2avg. The percentage of Δfmax 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 Δf1avg. The ratio of Δf2avg and Δf1avg 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 (Δf1avg, 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, LE 1M, LE 2M, LE Coded)

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 *Table 30* on page 527. 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). Calculated in 8 bits for LE 1M (f0),16 bits for LE 2M (f0) and 80 bits for LE Coded. For LE Coded the 80 bits preamble is split into five 16 bits parts(f0-f4).
  - For LE Coded there is an option to select only first 8 bits of f4. (Selection available in Analysis Params). This will ensure that frequency offset computed in the interval f4 is not biased.
  - Frequency offset in Payload (calculated in 10 bit intervals for LE 1M, 20 bits for LE 2M, and 16 bits for LE Coded in payload).
  - Drift (the difference in frequency offset calculated in Payload from that calculated in Preamble).
  - The drift is measured by taking the difference in frequency offset between two fixed intervals. For LE 1M, the interval length is 10 bits and the difference between intervals is 50 μs (5 intervals away). For LE 2M, the interval length is 20 bits and the interval difference is 50 μs (5 intervals away). For LE Coded, the interval length is 16 bits and fhs interval difference is 48 μs (3 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).
- Drift between two 10 and 20 bits intervals is denoted as fn-fn-5 for LE 1M and LE 2M. For LE Coded, it is denoted as fn-fn-3, which is 48 μs away. The Maximum interval difference at which these values occur is shown in Frequency Drift display.

- 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, LE 1M, LE 2M, LE Coded)

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 *Table 30* on page 527.
- 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, LE 1M, LE 2M, LE Coded)

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 *Table 30* on page 527.

- 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 *Table 30* on page 527.
- 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: $f = |fH - fL| \leq 1.0$ MHz.

  If the highest power value measured in step d) is lower than 0 dBm: $f = |fH - fL| \leq 1.5$ 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, LE 1M, LE 2M, LE Coded)

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 *Table 30* on page 527.

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: LE 1M Sequence Detected	Shown in the status bar when the LE 1M standard is detected in Automatic Standard Detection mode.
Bluetooth Analysis: LE 2M Sequence Detected	Shown in the status bar when the LE 2M standard is detected in Automatic Standard Detection mode.
Bluetooth Analysis: LE Coded Sequence Detected	Shown in the status bar when the LE Coded 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.

Table continued…

Status message	Description
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

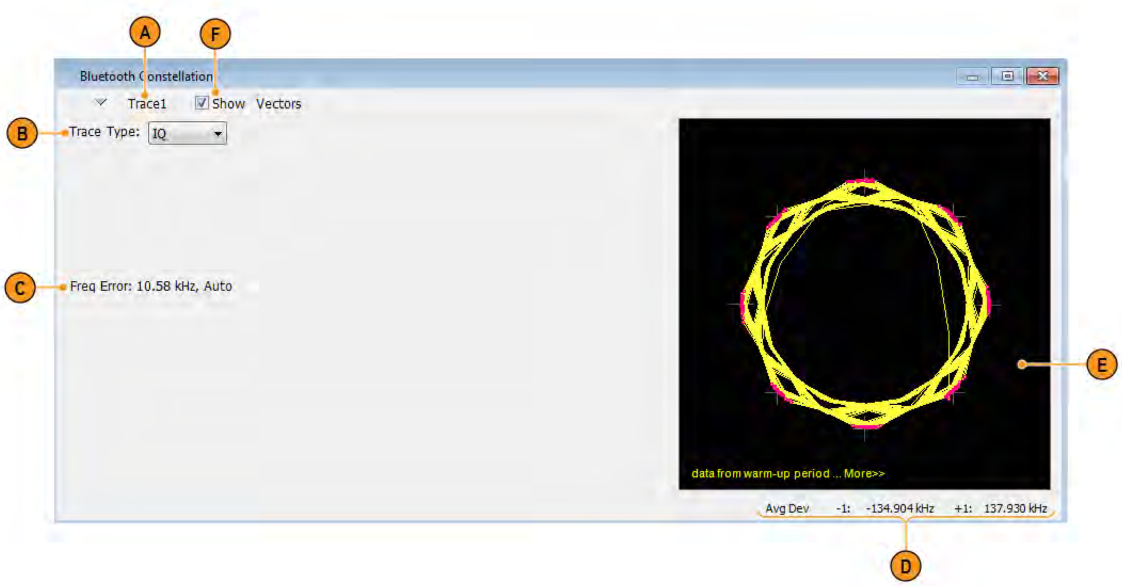
The BT Constellation display shows a digitally modulated signal in constellation form. The constellation can be viewed either as IQ or Freq Dev. The default view is Freq Dev. The frequency deviation result that is shown in the Constellation display is compensated for the frequency error (shown as readout).

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.

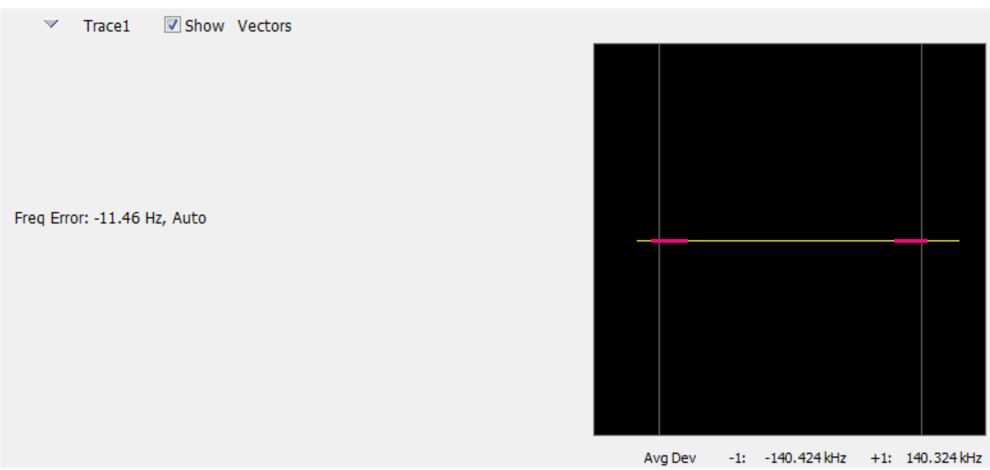
Elements of the Display

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.
B	Trace Type	Specifies Trace type (choice between Freq Dev and IQ). This option appears only when EDR signal is detected.
C	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

Main menu bar: Setup > Settings

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, reference 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.
Traces	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

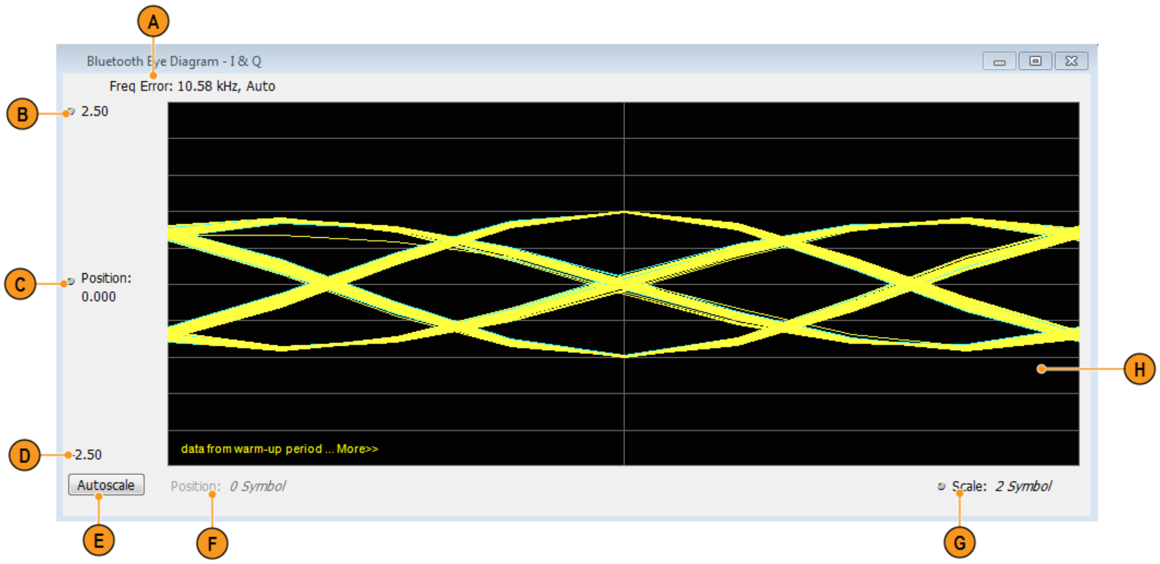
The BT Eye Diagram display shows a digitally modulated signal overlapped on itself to reveal variations in the signal.

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.

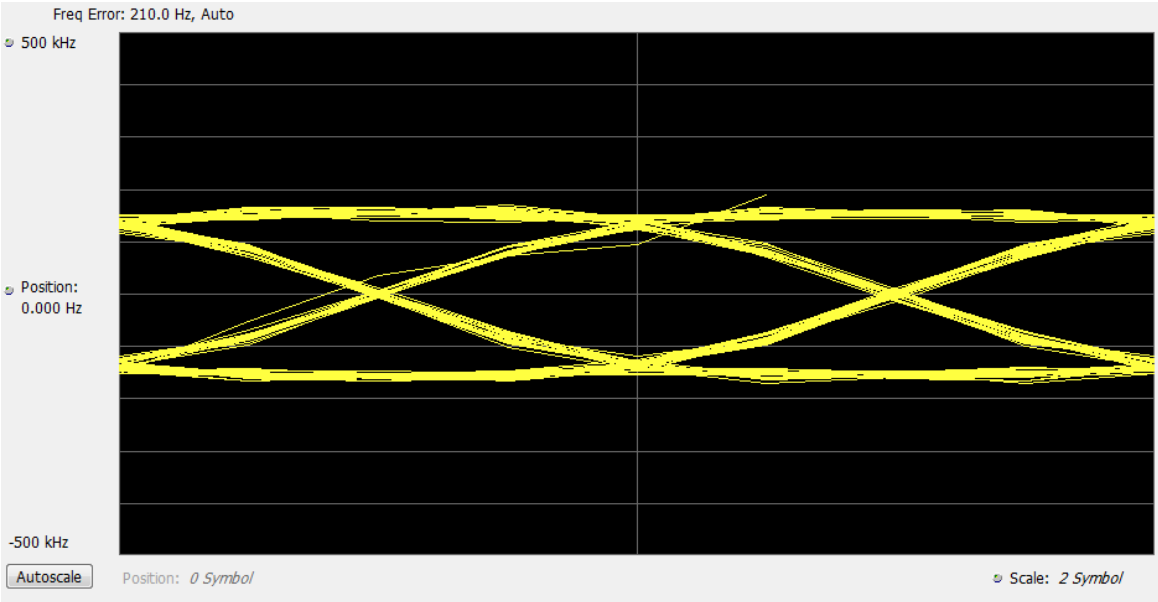
Elements of the Display

The following image shows the BT Eye display of a basic rate signal with Trace Type set to IQ.



Item	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.
B	Top of graph	The vertical scale is normalized with no units (for IQ) and with Hz (for Freq Dev).
C	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.
H	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

Main menu bar: Setup > Settings

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, reference 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.
Traces	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 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.

Elements of the Display

The following image shows the frequency offset and drift values of a basic rate (first image) and LE Coded signal in the BT Freq Offset and Drift display.

Interval#	Frequency offset (Hz) Limits fn (-150.0kHz to +150.0kHz)	Drift from f0 (Hz) Limits fn-f0 (-40.0kHz to +40.0kHz) f1-f0 (-20.0kHz to +20.0kHz)	Drift - 50us (Hz) Limits fn-f(n-5) (-20.0kHz to +20.0kHz)
0 (Preamble)	6434.094		
1	6422.583	-11.51074	
2	5296.85	-1137.244	
3	6478.38	44.28564	
4	6880.799	446.7051	
5	5173.156	-1260.938	
6	5455.798	-978.2959	-966.7852
7	5832.239	-601.855	535.3892
8	6631.489	197.395	153.1094
9	5221.211	-1212.883	-1659.588
10	4814.595	-1619.499	-358.5605
11	6111.346	-322.748	655.5479
12	6569.333	135.2388	737.0938
13	4871.332	-1562.763	-1760.158

Freq Offset Preamble: 6.434 kHz
Max Freq Offset (Payload): 7.826 kHz @ 131
Drift f1-f0: -11.51 Hz
Max Drift fn-f0: -4.080 kHz @ 115
Max Drift fn-f(n-5): 3.696 kHz @ 208

Interval#	Frequency offset (Hz) Limits fn (-150.0kHz to +150.0kHz)	Drift from f0 (Hz) Limits fn-f0 (-50.0kHz to +50.0kHz)	Drift - 48us (Hz) Limits f0-f3 (-19.2kHz to +19.2kHz) f1-f4 (-19.2kHz to +19.2kHz) fn-f(n-3) (-19.2kHz to +19.2kHz)
0 (Preamble)	258.2126		
1 (Preamble)	-74.10534	-332.318	
2 (Preamble)	-289.2607	-547.4733	
3 (Preamble)	233.2176	-24.99501	24.99501
4 (Preamble)	15082.45	14824.24	-15156.55
5	-67.59009	-325.8027	
6	18.36853	-239.8441	
7	-228.1871	-486.3997	
8	-197.742	-455.9546	-130.1519
9	-47.53453	-305.7472	-65.90306
10	164.5431	-93.66956	392.7302
11	-333.5484	-591.7611	-135.8065
12	285.7397	27.5271	333.2743
13	-131.973	-390.1856	-296.5161
14	41.5774	-216.6353	375.1258
15	-388.7002	-646.9128	-674.4399
16	205.0563	-53.15637	337.0293
17	8.140196	-250.0724	-33.4372
18	-203.3326	-461.5452	185.3676
19	-213.4553	-471.668	-418.5116
20	63.34568	-194.867	55.20549
21	2.224886	-255.9878	205.5575

Freq Offset Preamble:	3.042 kHz		Max Drift fn-f0:	14.82 kHz	@ 4	Drift f1-f4:	-15.157 kHz	
Max Freq Offset (Payload):	2.947 kHz	@ 122	Drift f0-f3:	24.995 Hz		Max Drift fn-f(n-3):	-15.16 kHz	@ 4

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 µs for LE 1M, LE 2M and 48 µs for LE Coded duration.
Column 4	Shows the drift of offset over a 50 µs for LE 1M, LE 2M and 48 µs for LE Coded 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.)

Table continued…

Display element	Description
Scalar results	The scalar results show below the table. They are as follows: Freq Offset Preamble Max Freq Offset (Payload) For LE 1M, LE 2M: Drift f_1-f_0 Max Drift f_n-f Max Drift f_n-f($_{n-5}$) For LE Coded: Drift f_0-f_3 Max Drift f_1-f_4 Max Drift f_n-f($_{n-3}$)

BT CF Offset and Drift Settings

Main menu bar: Setup > Settings

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.

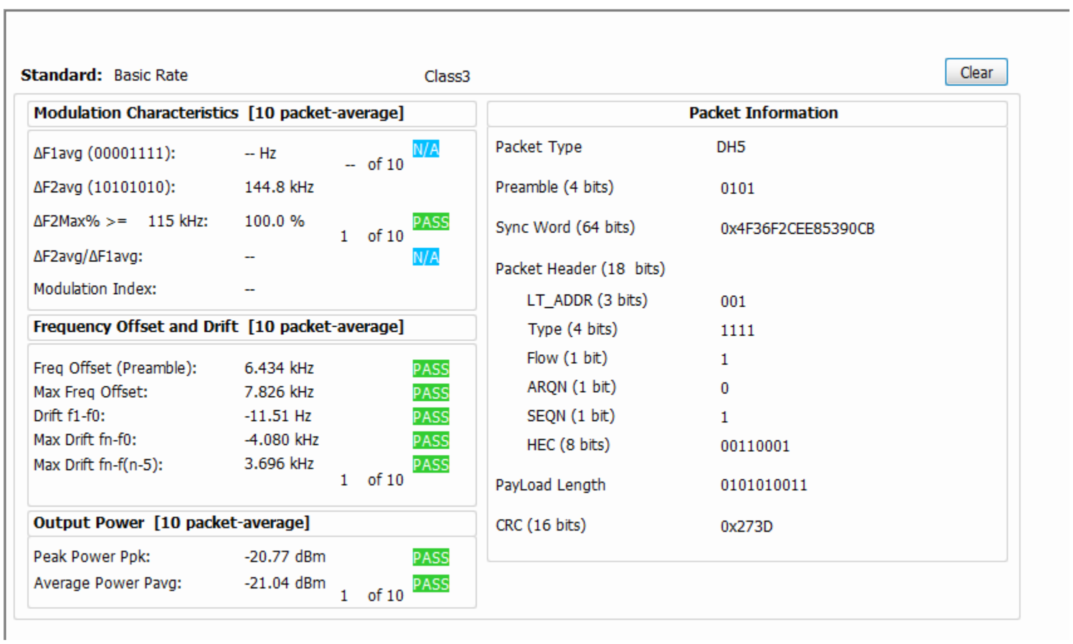
The results presented in the BT Summary display include scalar results of modulation characteristics, frequency offset and drift and, output power measurements (these are averaged over the last 10 acquired packets). The display also shows packet related information for the current acquired packet.

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*.



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).

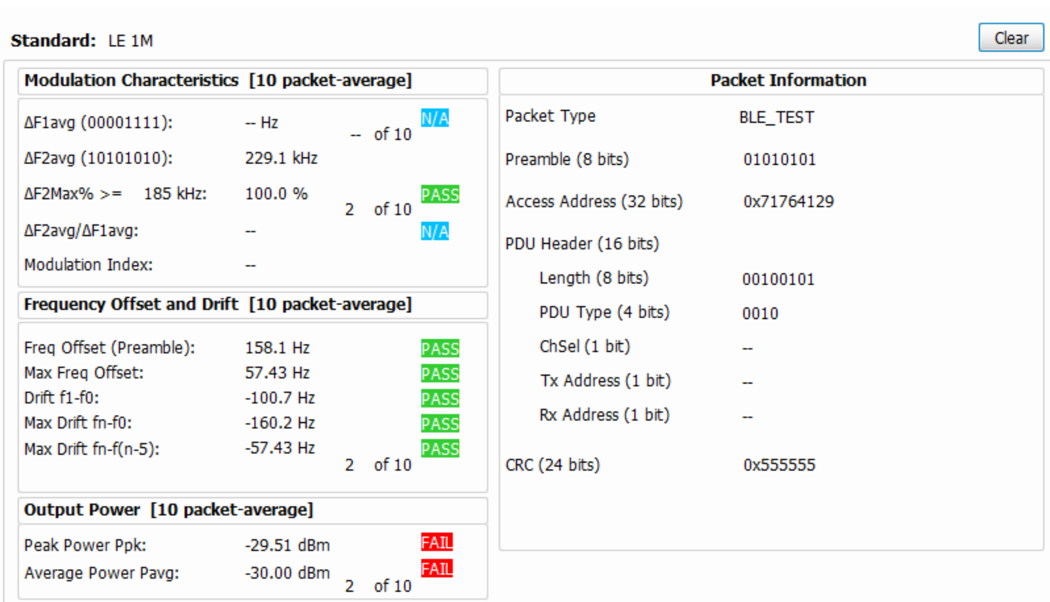
Table continued…

Element	Description
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: Δf1avg is calculated when analyzed test pattern (payload) is 11110000. Δf2avg and the percentage of Δf2max value (greater than a given limit) are calculated only when analyzed test pattern (payload) is 10101010 for LE 1M and LE 2M, and 11001100 for LE Coded. The ratio of Δf2avg and Δf1avg 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*.
Modulation index	The Modulation index denotes if the transmitter of a BLE Packet is Stable or Standard. If it is Stable, the modulation index will be between 0.495 and 0.505. If it is Standard, the modulation index will be between 0.475 and 0.525. If neither of these conditions is satisfied, then no text is shown.
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 eight scalar results are: Preamble offset. Maximum offset in Payload (calculated over 10 bit intervals for LE 1M, 20 bit intervals for LE 2M, and 16 bit intervals for LE Coded). Drift (f_1-f_0) Max Drift (f_n-f_0). Max Drift (f_n-f_n-5) for LE 1M, LE 2M Drift (f_0-f_3) Max Drift (f_1-f_4) Max Drift (f_n-f_n-3) for LE Coded For more information about this measurement, see the *Carrier frequency offset and drift (Basic Rate, LE 1M, LE 2M, LE Coded)* on page 530 topic in *Bluetooth Measurements and test setups*.

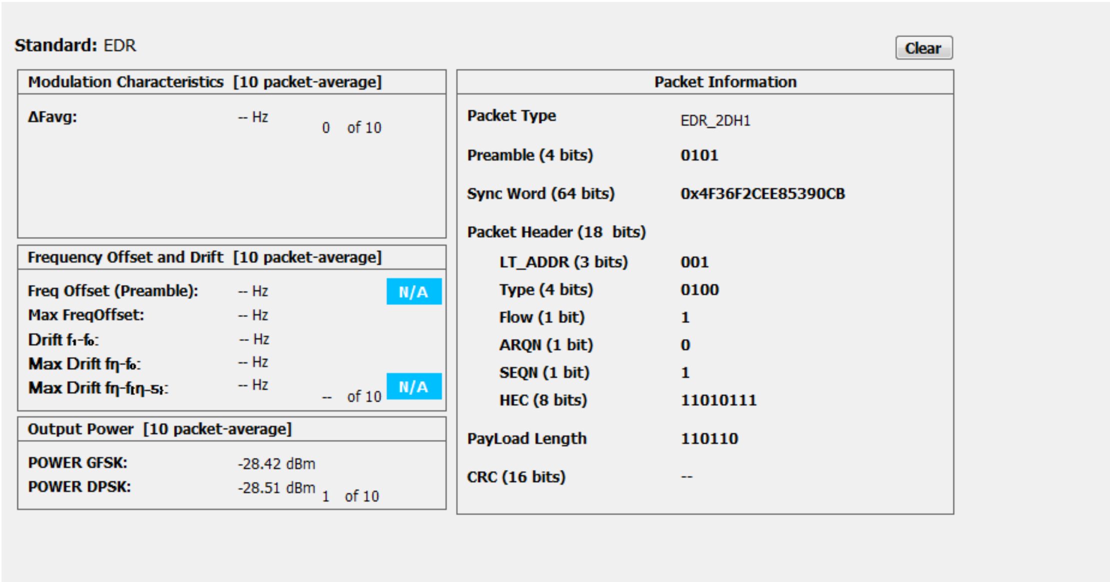
Table continued…

Element	Description
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 *Output Power (Basic Rate, LE 1M, LE 2M, LE Coded)* on page 531 topic in *Bluetooth Measurements and test setups*.
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 LE 1M< LE 2M, and LE Coded signal in the BT Summary display.



The following image shows all average scalar results and packet information for an EDR signal in the BT Summary display.



BT Summary Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Standard Params	Select the standard, measurement filters, reference 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.

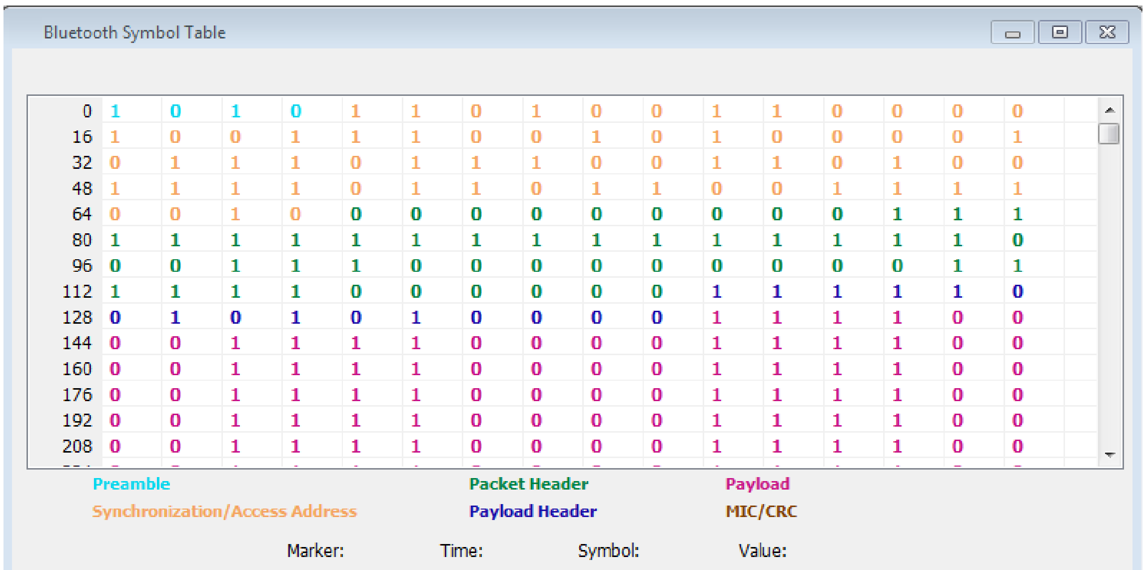
To show the BT Symbol Table display:

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.



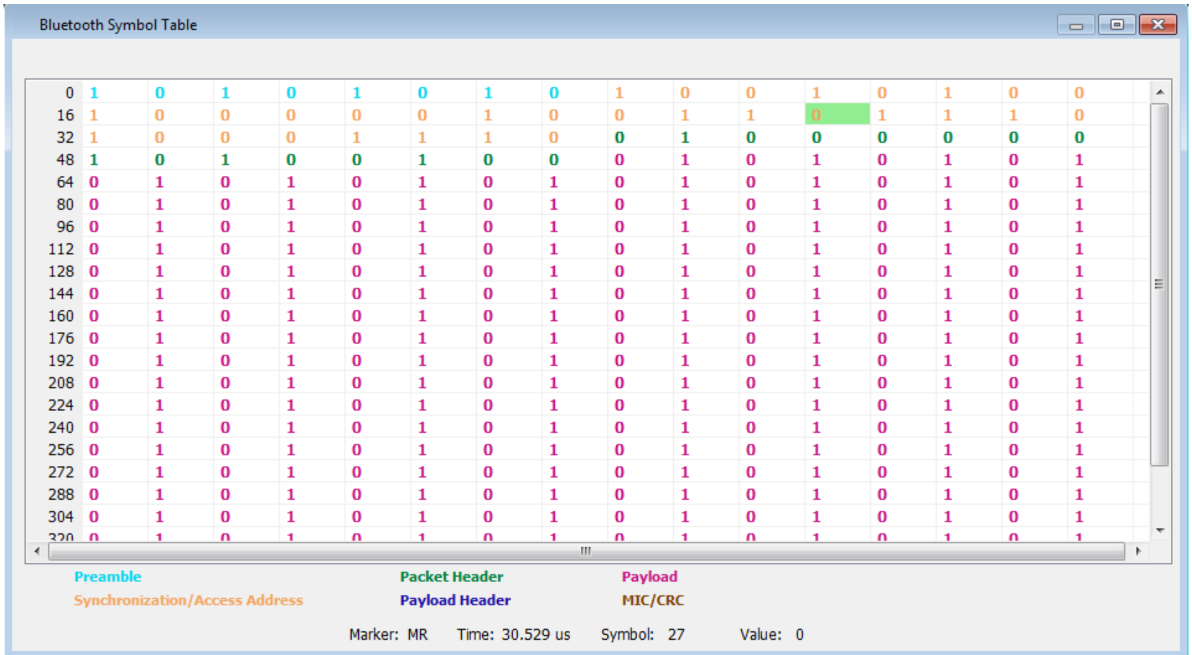
0	1	0	1	0	1	1	0	1	0	0	1	1	0	0	0	0
16	1	0	0	1	1	1	0	0	1	0	1	0	0	0	0	1
32	0	1	1	1	0	1	1	1	0	0	1	1	0	1	0	0
48	1	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1
64	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1
80	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
96	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1
112	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	0
128	0	1	0	1	0	1	0	0	0	0	1	1	1	1	0	0
144	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
160	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
176	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
192	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0
208	0	0	1	1	1	1	0	0	0	0	1	1	1	1	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)

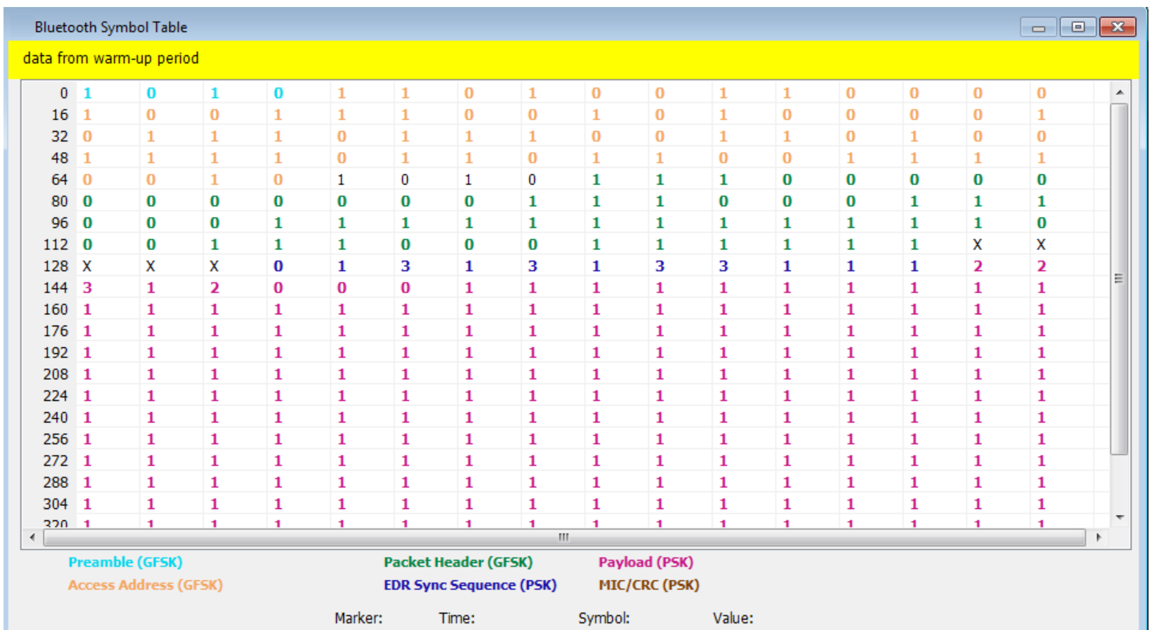
Table continued…

Packet standard	Associated regions
LE 1M	8-bit preamble 32-bit access address / synchronization word 16-bit payload header Variable length payload data (2–257 bytes) 24-bit CRC (Cyclic Redundancy Check)
LE 2M	8-bit preamble 32-bit access address / synchronization word 16-bit payload header Variable length payload data (32–257 bytes) 24-bit CRC (Cyclic Redundancy Check)
LE Coded	80-bit preamble 256-bit access address / synchronization word 16-bit payload header Variable length payload data (16–2057 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.



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

Main menu bar: Setup > Settings

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

Settings tab	Description
Standard Params	Select the standard, measurement filters, reference 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

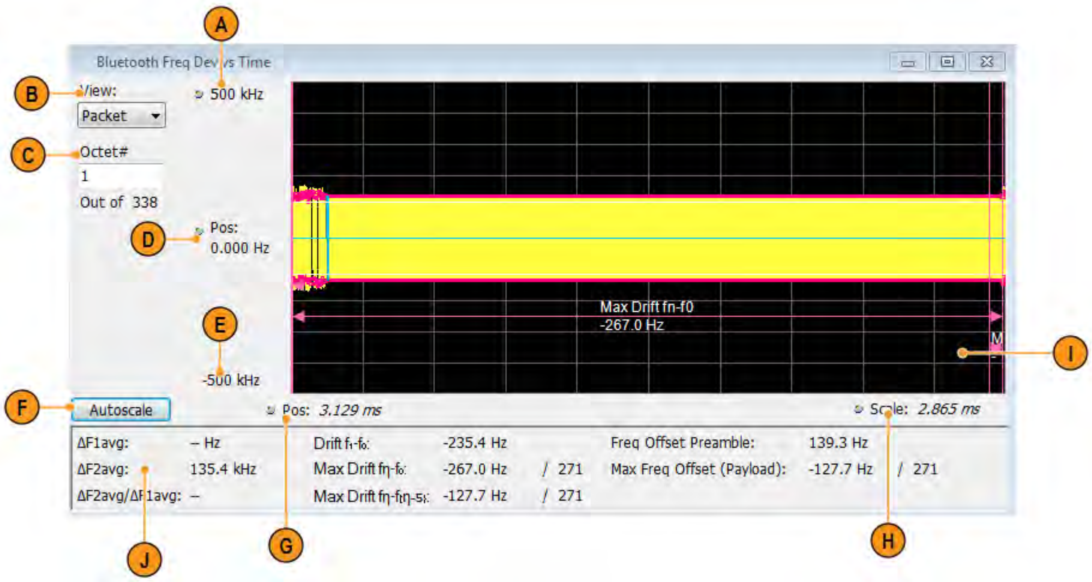
The BT Freq Dev vs. Time display shows how the signal frequency varies with time.

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.



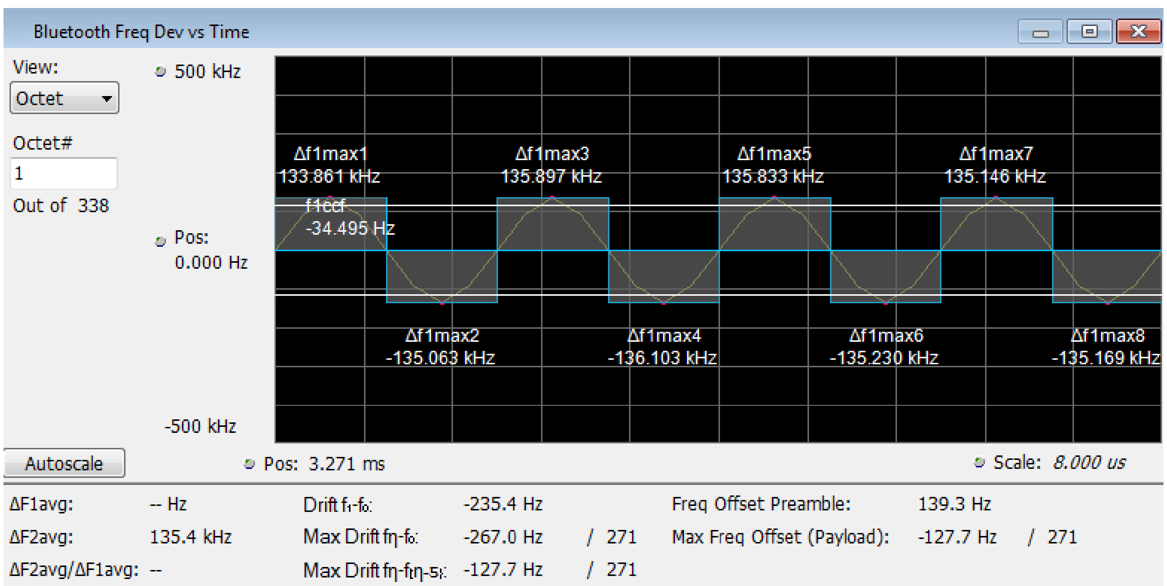
Item	Display element	Description
A	Top of graph	The vertical scale is normalized with Hz.
B	View	(This option is visible only when Preamble is detected.) Select one of the following: Packet: view frequency deviation for an entire packet. Octet: view frequency deviation for a specified octet duration (8 μs). The Octet is specified in the Octet # field.
C	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. For 10101010 LE 1M and LE 2M, and 11001100 for LE Coded (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.
H	Scale	Adjusts the horizontal scale (time).

Table continued…

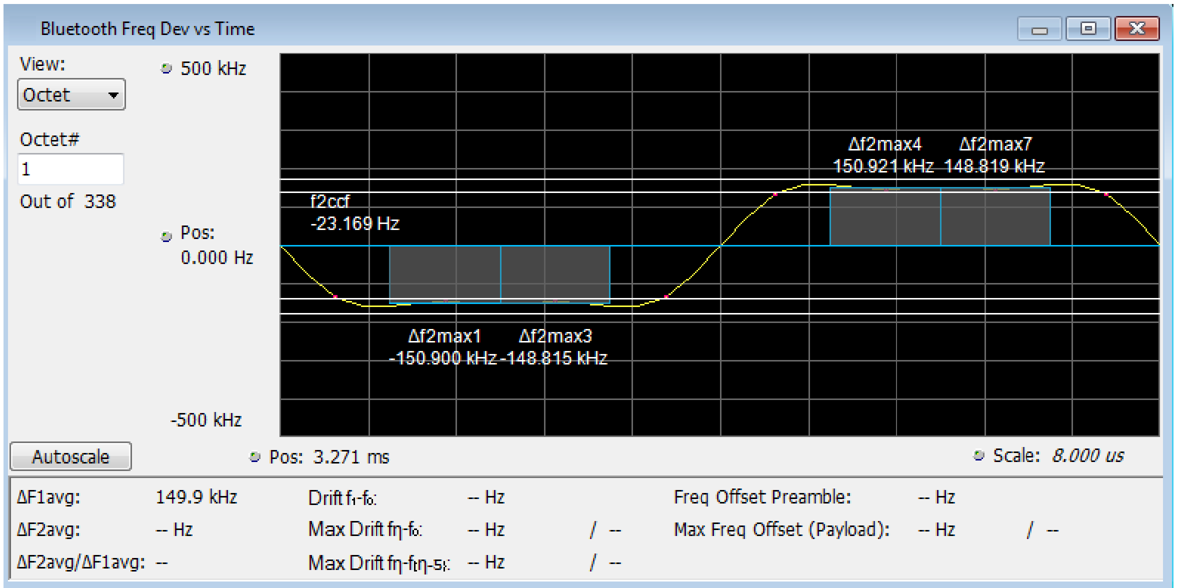
Item	Display element	Description
I	Plot	Displays the last analyzed complete packet or the selected octet (Octet zoom view) of the signal. Markings are shown for Preamble offset and for Maximum Drift from preamble and Maximum Drift for 50 µs.
J	Scalar results	The Scalar results for Modulation Characteristics 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 for LE 1M and LE 2M, and 11001100 for LE Coded. ΔF1avg or ΔF2avg is shown only when the detected test pattern payload is (10101010) for LE 1M and LE 2M or (11001100) for LE Coded.

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).



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

Main menu bar: Setup > Settings

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, reference 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

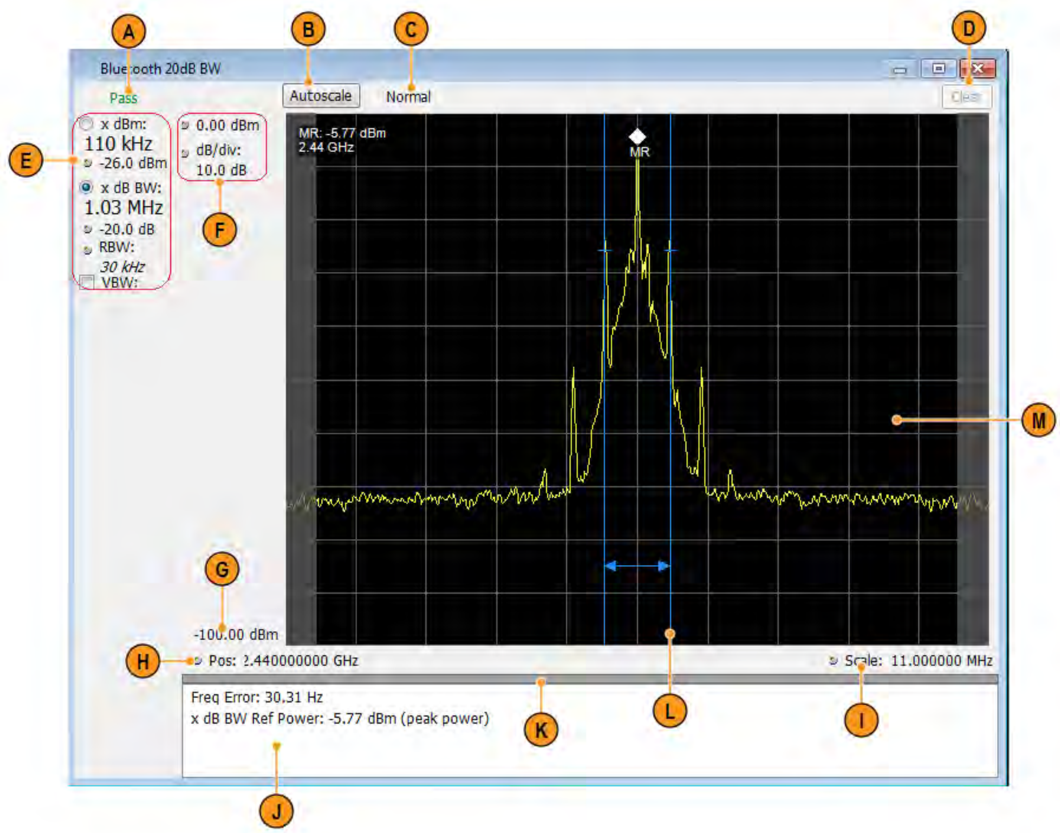
The BT 20dB BW display shows the results of two Bluetooth measurements: 20dB Bandwidth and Frequency Range. When the xdB BW is chosen, the display shows the x dB bandwidth from the peak power. More detailed information about this measurement is available *here*.

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.



Item	Display element	Description
A	PASS / FAIL	Indicates Pass or Fail for the 20 dB BW measurement.
B	Autoscale	Adjusts the vertical and horizontal settings so that the entire trace fits in the graph.
C	Normal / MaxHold	Indicates whether the measurement is done with a MaxHold or a Normal condition.

Table continued…

Item	Display element	Description
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 Units (not shown) Fix. Slugger 2	Position sets the top of graph value. The dB/div setting is the vertical scale value. Set the global Amplitude units for all the views in the analysis window using the drop down menu that appears when you click on the box. This will change the amplitude selection in the Units tab of the Amplitude control panel.
G	Bottom readout	Displays the value indicated by the bottom of graph.
H	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.
K	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.
M	Plot	Displays the input signal. Shaded areas indicate the measurement bandwidth (Settings > Parameters tab > Measurement BW).

BT 20dB BW settings

Main menu bar: Setup > Settings

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.

Table continued…

Settings tab	Description
Parameters	Allows you to specify the x dB level, Measurement Direction, Measurement BW, xdBm level, xdBm Range, count, and to enable averaging and the Max Hold function.
Scale	Allows you to define the vertical and horizontal axes.
Prefs	Allows you to select show or hide the graticule and marker readouts.

Bluetooth InBand Emission display

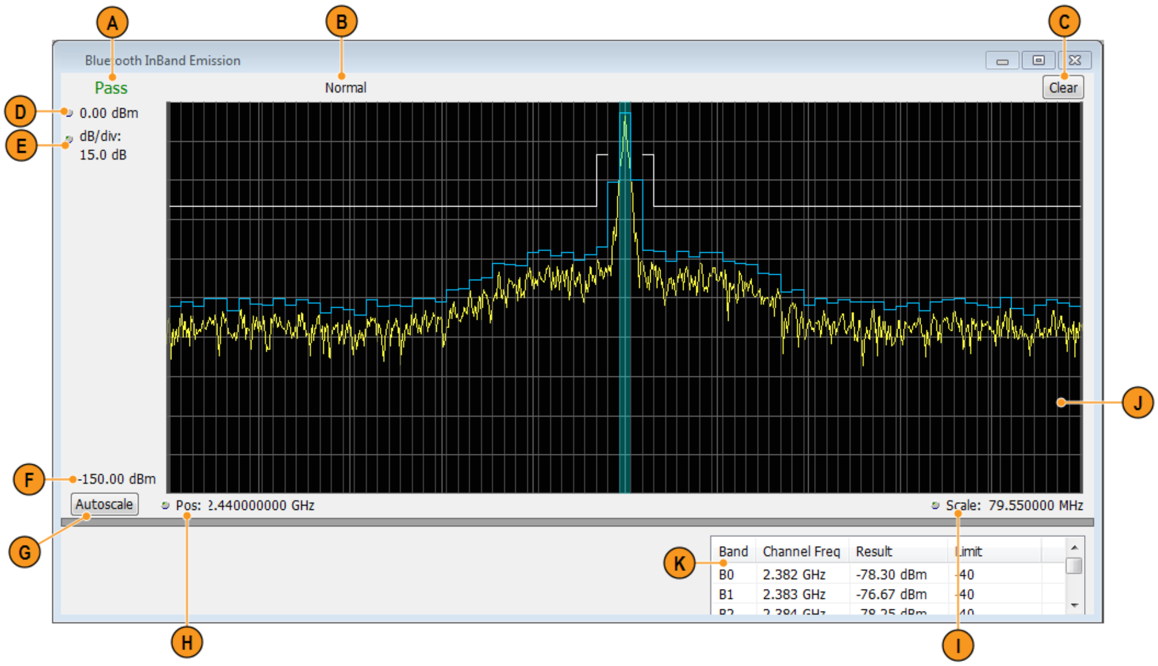
The BT InBand Emission display verifies whether the emissions inside the operating frequency range are within limits. The power in adjacent channels of 1 MHz bandwidth around the frequency of transmission are calculated and compared against limits. The integrated power in the 1 MHz band for the adjacent 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).



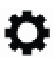
Item	Display element	Description
A	PASS / FAIL	Indicates Pass or Fail based on the number of adjacent channels that are below an upper limit. A maximum of 3 adjacent channels can have integrated power higher than an upper limit (Pass); otherwise, Fail is reported.
B	Normal	Displays Average Count if Average is turned on (set to Time Domain or Frequency Domain) from the Measurement Params tab in the Settings control panel.
C	Clear	Resets measurement. Clears all values.
D	Top of graph	The vertical scale is normalized with appropriate power units.
(not shown)	Units	Sets the global Amplitude units for all the views in the analysis window. This will change the amplitude selection in the Units tab of the Amplitude control panel.
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.
H	Position	Displays the horizontal position of the trace on the graph display.
I	Scale	Adjust the span of the graph in symbols.

Table continued…

Item	Display element	Description
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 *Show power levels in graph* 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.
K	Results table	Reports the integrated power results (Channel frequency, Integrated power, and Limits) from the display in a table.

Bluetooth Analysis Measurement Settings

Main menu bar: Setup > Settings



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.

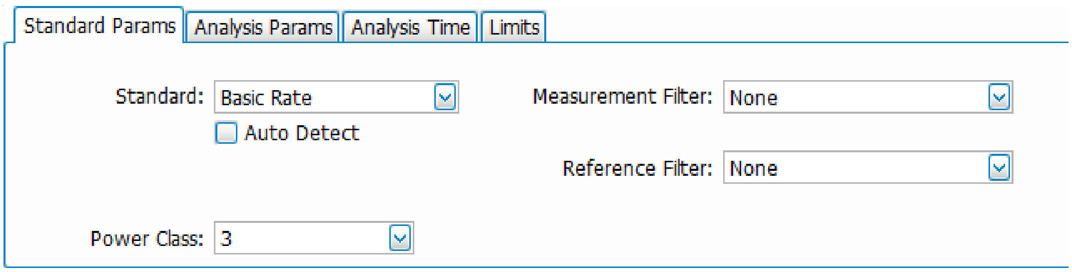
Table 32: Common controls for Bluetooth Analysis displays

Settings tab	Description
Standard Params	Specifies the input signal standard and additional user-settable signal parameters.
Analysis Params	Specifies parameters used by the application 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) for Bluetooth Analysis displays.
Trace	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	Allows preferences with Radix display and marker readouts.
Scale	Defines the vertical and horizontal axes.
Parameters	Specifies parameters used to analyze the signal.
Freq & RBW	Allows you to set Frequency and RBW settings for the BT 20 dB BW display.
Limits	Allows you to define limits for pass/fail comparison with calculated values. The default values are as recommended in the test specification.
Measurement Params	Allows you to set average (Time Domain, Off, or Frequency Domain) and to correct for noise floor.

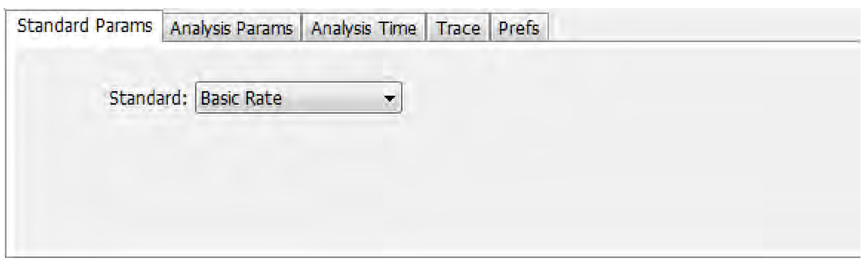
Standard Params tab - BT

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.



The following image shows the tab for the BT InBand Emission display.



Settings	Description
Standard	Select the appropriate standard: Basic Rate, LE 1M, LE 2M, LE Coded, or Enhanced Data 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 Energy 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
LE 1M	LE-Recommended	None
LE 2M	LE-Recommended	None
LE Coded	LE-Recommended	None
Enhanced Data Rate	BR-Recommended	None

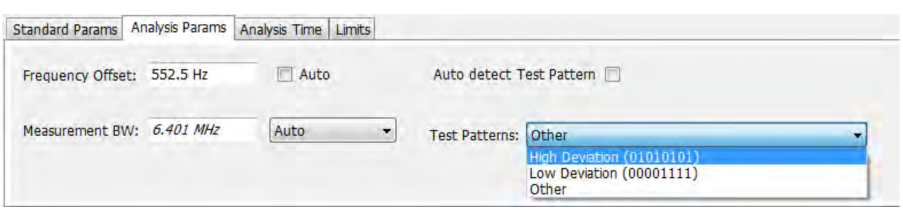
How to select filters

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

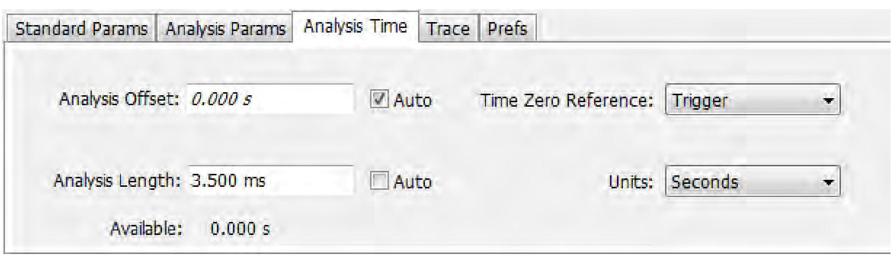
The Analysis Params tab contains parameters that control the analysis of the input signal. The Test Patterns menu only appears when the Auto Detect Test Pattern is not checked. This tab is available for all displays except for the BT 20dB BW and the BT InBand Emission displays.



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 Δfavg 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.
Use 8 bits for f4 preamble interval	This option allows you to select only the first 8 bits of f4 for LE Coded. This ensures that the frequency offset computed in the interval f4 is not biased.

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.



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.
Available	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.

Table continued…

Settings	Description
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.

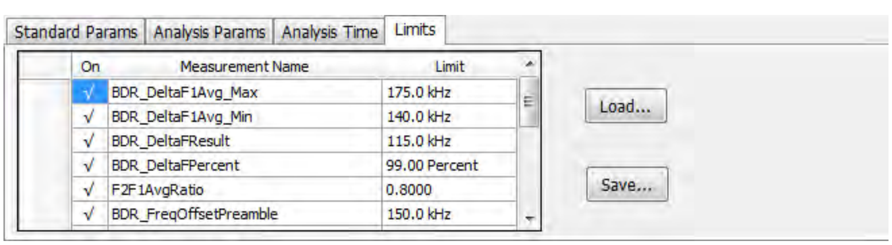
Parameter	Description
Acquisition Start	Time zero starts from the point at which the acquisition begins.
Trigger	Time zero starts from the trigger point.

Limits tab - Bluetooth

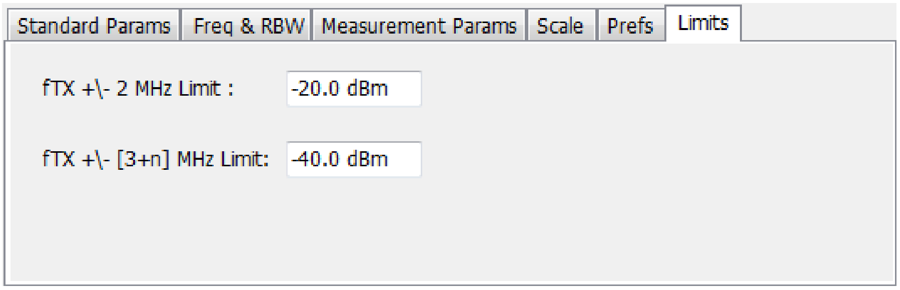
This tab is only available for the BT CF Offset and Drift, BT InBand Emission, and BT Summary displays. It enables you to load an existing limits table, save a limits table, or edit limits values. The content under Measurement Name varies based on the chosen standard and power class.

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.



The following image shows the Limits tab for the BT InBand Emission display.



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

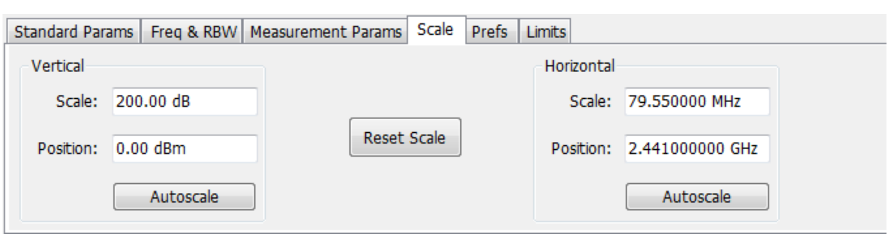
To directly edit measurement limits in the table, click on the value in the Limit column that you want to change. The following table describes the parameters that are set in the Limits Table.

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.

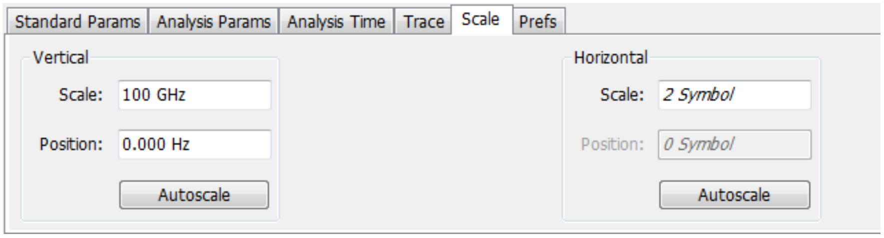
Scale tab - Bluetooth

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.

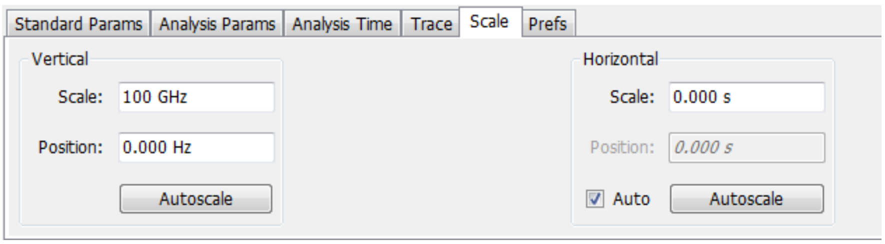
The following image shows the Scale tab for the BT 20dB BW and BT InBand Emission displays.



The following image shows the Scale tab for the BT Eye Diagram display.



The following image shows the Scale tab for the BT Freq Dev vs Time display.



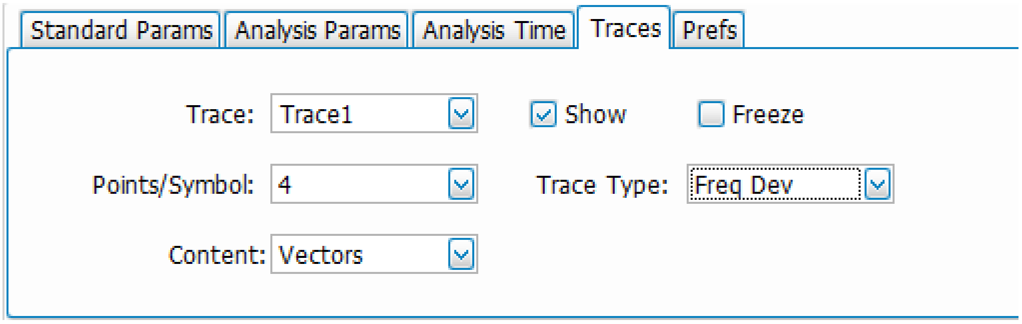
Settings	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale of the graph.
Position	Adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the 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.

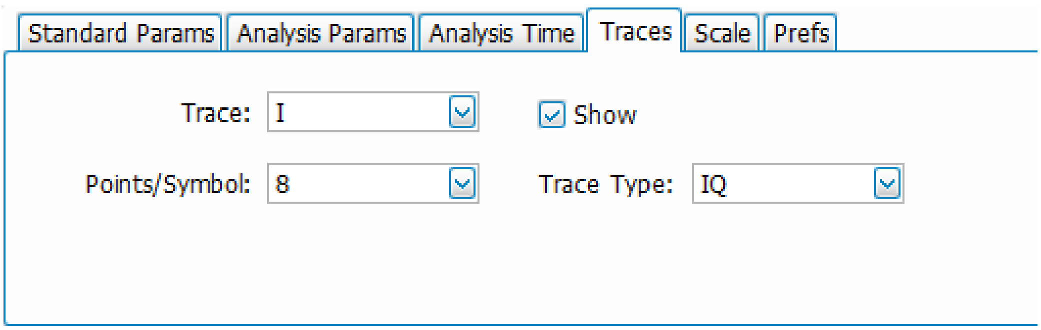
Traces tab - Bluetooth

The Traces 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.

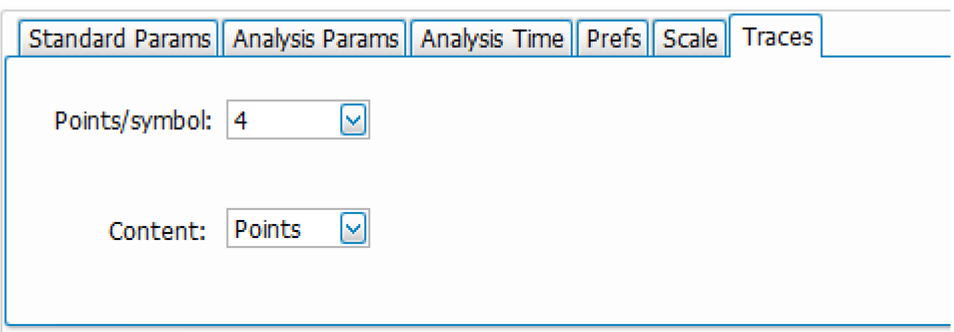
The following image shows the tab for the BT Constellation display.



The following image shows the tab for the BT Eye Diagram display.



The following image shows the tab for the BT Freq Dev vs Time display.



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.

Table continued…

Setting	Description
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:

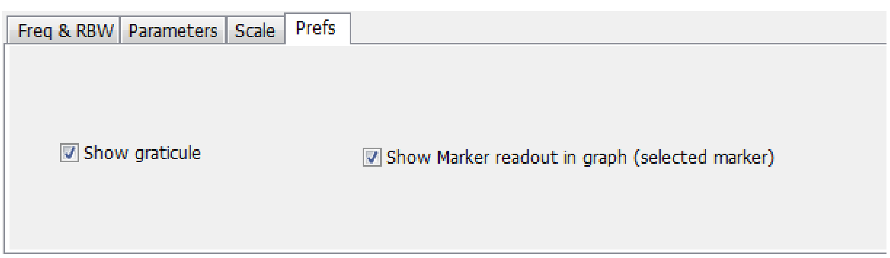
1. If more than one display is present, select the BT Constellation display to ensure it is the selected display.
2. Click .
3. Select the Trace tab.
4. Select Trace 2 from the Trace drop-down list.
5. Click the Show check box so that it is checked.
6. Specify the Content as desired.

The Trace 2 lines will appear in blue to help you distinguish Trace 2 from Trace 1.

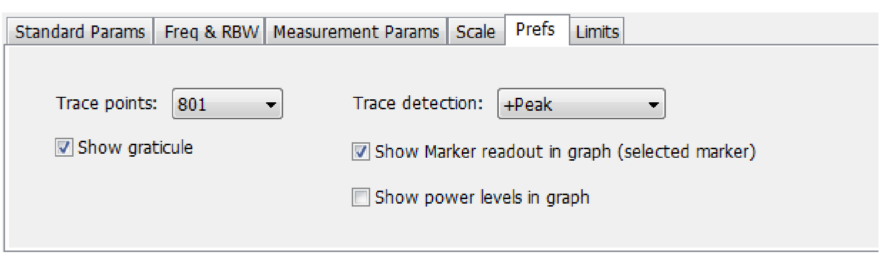
Prefs tab - Bluetooth

The Prefs tab enables you to change appearance characteristics of some of the Bluetooth Analysis displays.

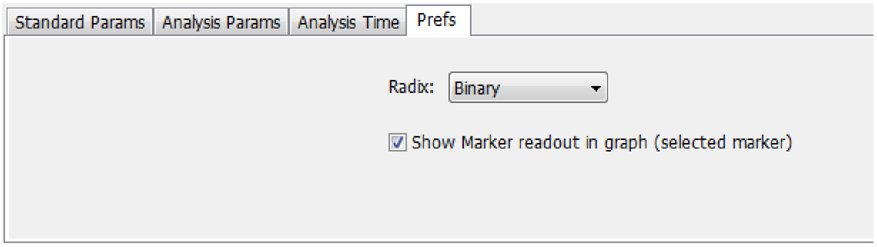
The following image shows the Prefs tab for the BT 20dB BW, BT Freq Dev vs Time, BT Eye Diagram, and BT Constellation displays.



The following image shows the Prefs tab for the BT InBand Emission display.



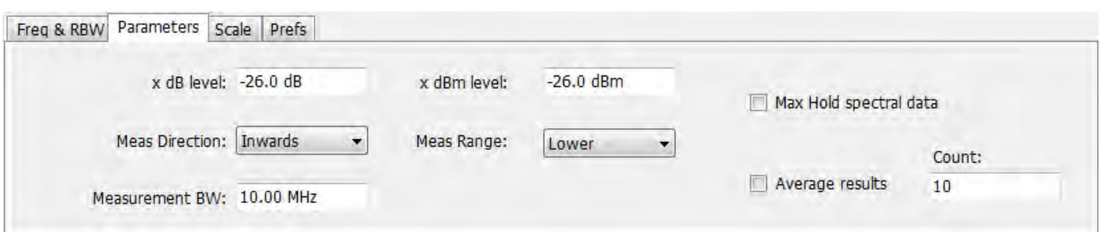
The following image shows the Prefs tab for the BT Symbol Table display.



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.



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.

Table continued…

Setting	Description
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.

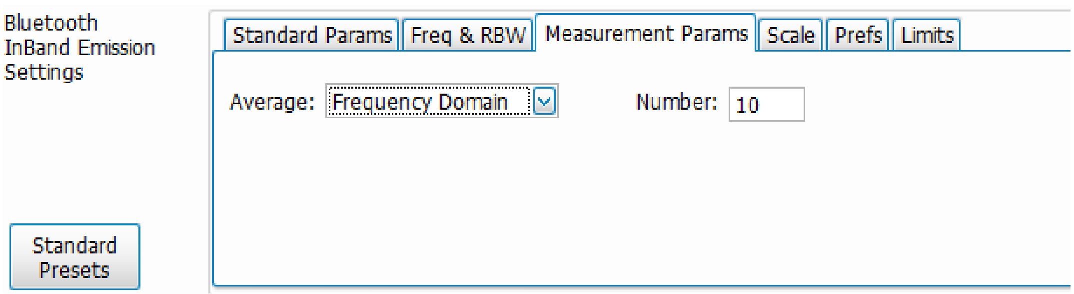
Freq & RBW tab - Bluetooth

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.

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.



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.

Audio Analysis and Demodulation

Overview

Audio Analysis (Option 10) 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

Item	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

Main menu bar: Setup > Settings

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

Settings tab	Description
Params1 Tab on page 573	Specifies signal type, Audio Bandwidth, RBW, RBW filter, and Ref Audio Frequency.
Params2 Tab on page 574	Specifies Harmonics and Non-Harmonics measurement parameters.
Audio Filters Tab on page 575	Specifies the audio filter characteristics.

Table continued…

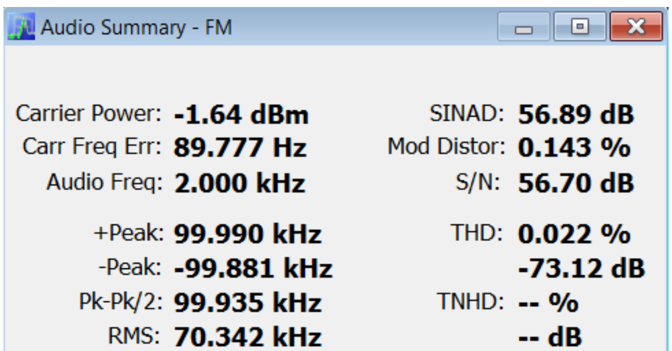
Settings tab	Description
Scale Tab on page 182	Sets vertical and horizontal scale and position parameters.
Prefs Tab on page 579	Specifies vertical units, and whether on not some features are displayed in the graph.

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 33: Audio Summary Measurements

Signal type	Item	Description
AM, FM, PM	Carrier Power	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)[3]
	-Peak	-Peak modulation excursion (where the modulation excursion readout depends on the signal type)[3]
	Peak-Peak/2	Half peak-peak modulation excursion (where the modulation excursion readout depends on the signal type)[3]

Table continued…

3 For AM signal types, modulation excursion is "% Modulation Depth". For FM signal types, modulation excursion is "Frequency Deviation". For PM signal types, modulation excursion is "Phase Deviation". For Direct, there is no modulation excursion, it is actually "signal excursion".

Signal type	Item	Description
	RMS	RMS modulation excursion (where the modulation excursion readout depends on the signal type)[3]
	SINAD	Signal to noise and distortion
	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	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.)

Audio Summary Settings

Main menu bar: Setup > Settings

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

Settings tab	Description
Params1 Tab on page 573	Specifies signal type, Audio Bandwidth, RBW, RBW filter, and Ref Audio Frequency.
Params2 Tab on page 574	Specifies Harmonics and Non-Harmonics measurement parameters.
Audio Filters Tab on page 575	Specifies the audio filter characteristics.
Hum & Noise Tab	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).

Table 34: Common controls for Audio Analysis displays

Settings tab	Description
Params1 Tab on page 573	Specifies characteristics about the audio signal and how measurements are made.
Params2 Tab on page 574	Specifies parameters that control how measurements are made on harmonics.

Table continued…

Settings tab	Description
Audio Filters Tab on page 575	Specifies characteristics of filters applied to the signal before measurements are taken.
Scale Tab on page 182	Sets vertical and horizontal scale and position parameters.
Prefs Tab for Audio Analysis	The Prefs tab enables you to change appearance characteristics of the 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.

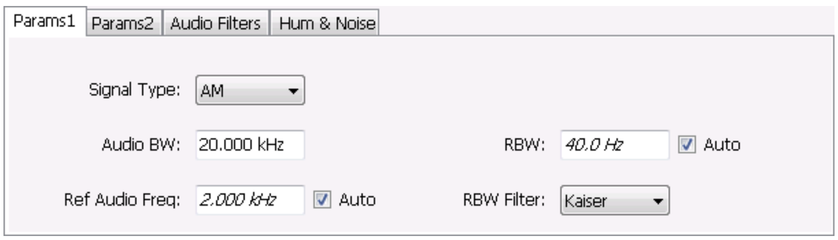


Figure 76: Params1 tab for AM signal types

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 manually, be aware that the automated detection is still performed, but it is limited to a frequency range of ±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 ≥ 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 ≥ 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 ≥ Audio BW (Direct) or ≥ 2 × 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 x 5 kHz = 50 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 x 3 kHz = 30 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

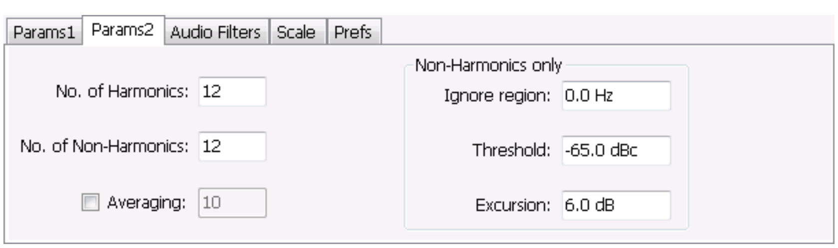
```
PMFreqDeviation = PMPhaseDeviationInRadians x FundamentalFreq
```

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.



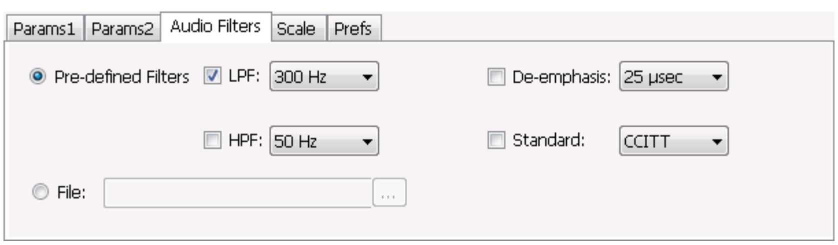
Setting	Description
No. of Harmonics	Specifies the number of harmonics to detect. The detected harmonics are tagged with a number on the spectrum trace. The available range is 1–20.
No. of Non-Harmonics	Specifies the number of non-harmonics to detect. The detected non-harmonics are tagged with a number 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 ignore non-harmonics.
Non-Harmonic Threshold	Specifies the level which a spectrum peak must exceed to be declared a non-harmonic 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.



Predefined 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 predefined filters:

1. Select the **Predefined 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 **Predefined Filters** option button.
2. Deselect all four filter check boxes.

Table 35: Predefined audio filters

Filter type	Available settings
LPF (Low Pass Filter) (5th-order Butterworth response)	300 Hz
	3 kHz
	15 kHz
	30 kHz
	80 kHz
	300 kHz
	User[4]
HPF (High Pass Filter) (5th-order Butterworth response)	20 Hz
	50 Hz
	300 Hz
	400 Hz
	User[4]
De-emphasis (FM only)	25 µs
	50 µs
	75 µs
	750 µs
	User. Range: 25 µs to 10 ms
Standard	CCITT
	C-message

4 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
...	...

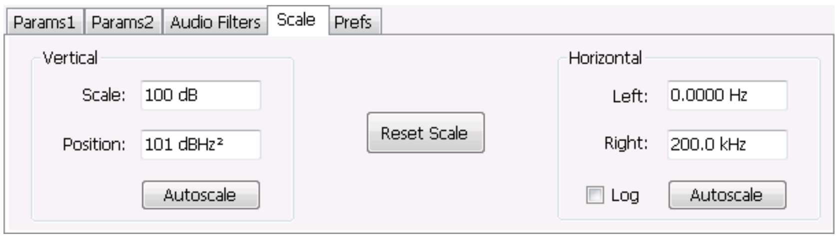
Format and rule-checking on custom audio filter files is performed as follows:

- 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

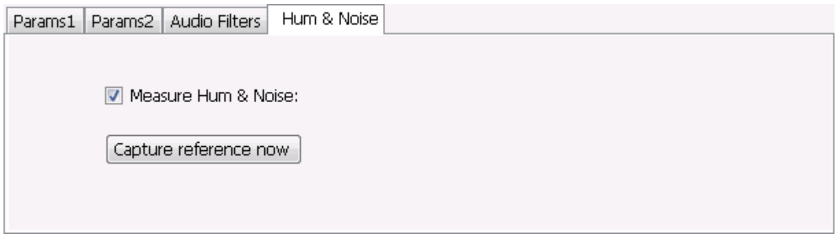
The Scale tab allows you to change the vertical and horizontal scale settings. Changing the scale settings changes how the trace appears on the display but does not change acquisition control settings. In effect, these controls operate like pan and zoom controls.



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.
Reset 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.



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.

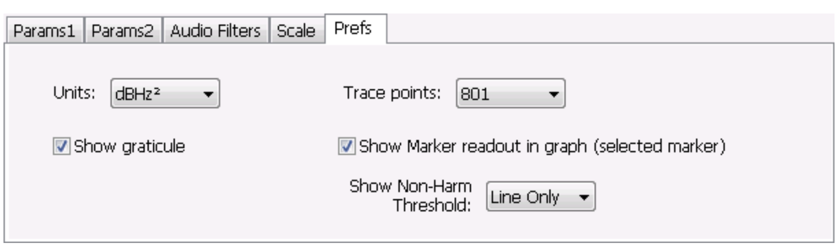
For AM, FM, and PM signal types, the RMS modulation value (related to Modulation Depth, Frequency Deviation or Phase Deviation) is captured and compared. The Diff measurement is:

20 x $\log_{10}$ (RMS(current)/RMS(Ref))

in dB.

Prefs Tab

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



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.

Table continued…

Setting	Description
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.

GP Digital Modulation

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 163,800 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.

Table continued…

Measurement	Description
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.

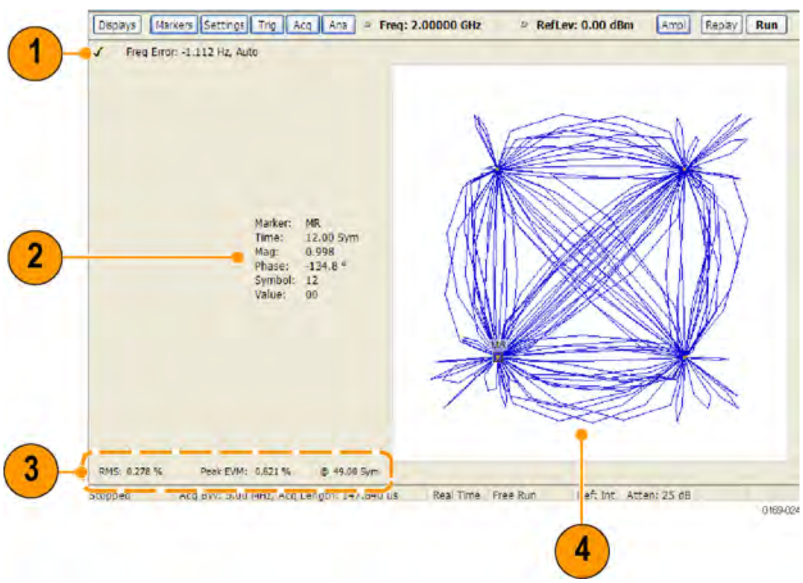
Constellation Display

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



Item	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.

Table continued…

Item	Display element	Description
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

Constellation Settings

Main menu bar: Setup > Settings

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* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation, symbol rate, and filters to be used in demodulating the input signal.
Freq & BW	Sets values for frequency error/offset, measurement bandwidth, and frequency deviation (not every control is present for every modulation type).
Equalizer Tab on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters that are less frequently used.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Prefs Tab on page 619	Enables you to set characteristics of the measurement display.

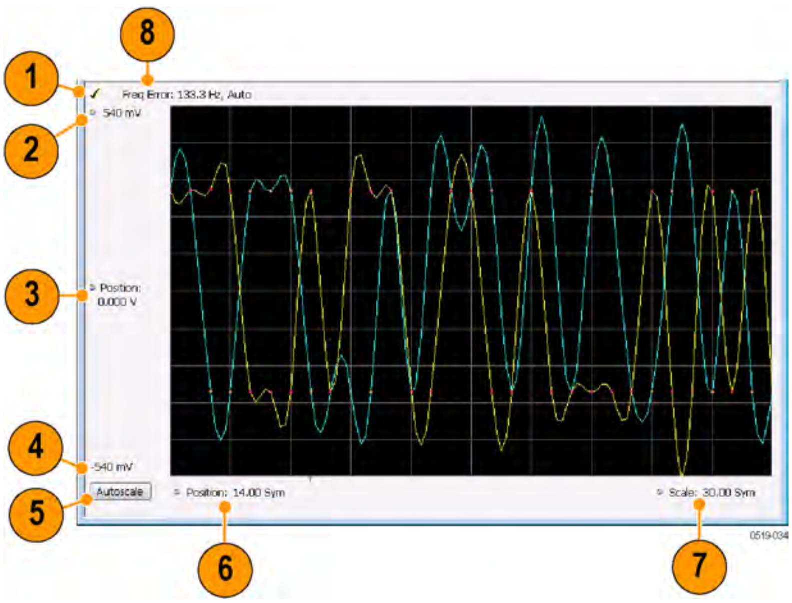
Demod I & Q vs Time Display

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.



Item	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.

Table continued…

Item	Element	Description
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 Settings & *Freq & BW* 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 Demod I&Q Settings.

Demod I & Q vs Time Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	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 on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	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

Item	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

EVM vs Time Settings

Main menu bar: Setup > Settings

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* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used in the input signal and other parameters that controls the demodulation of the input signal.
Freq & BW	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 on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies Freq Offset, Magnitude normalization parameters, and enables swapping I and Q.
Find Tab on page 614	The Find tab is used to set parameters for finding bursts within the data record.
Analysis Time Tab on page 615	The Analysis Time tab contains parameters that define how the signal is analyzed in the general purpose digital modulation displays.
Trace Tab on page 616	Specifies the display characteristics of the displayed trace.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	Specifies whether certain display elements are visible.

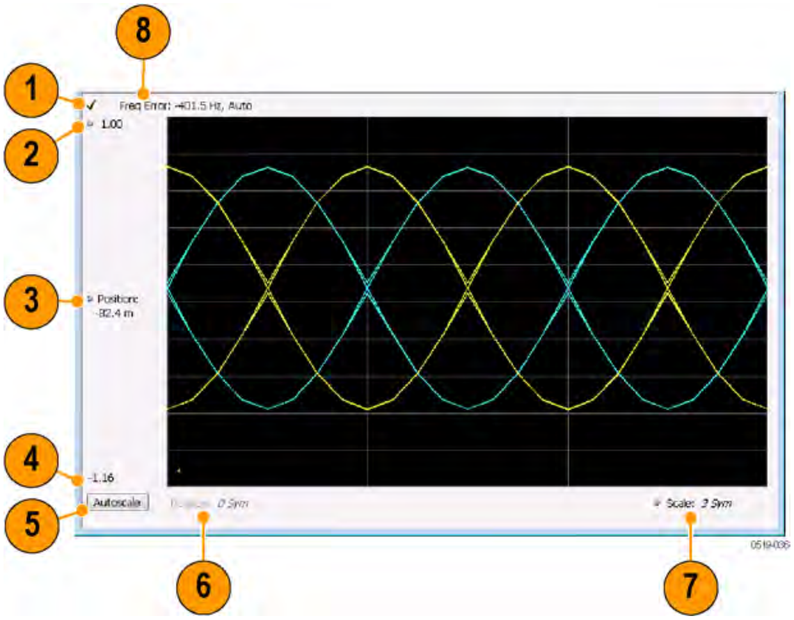
Eye Diagram Display

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



Item	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

Eye Diagram Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

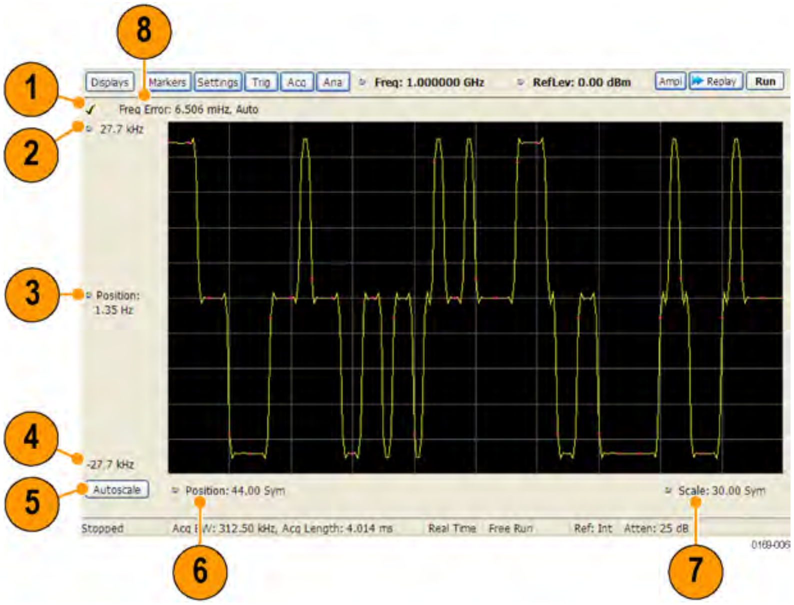
Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	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



Item	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

Frequency Deviation vs Time Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	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 on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	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.

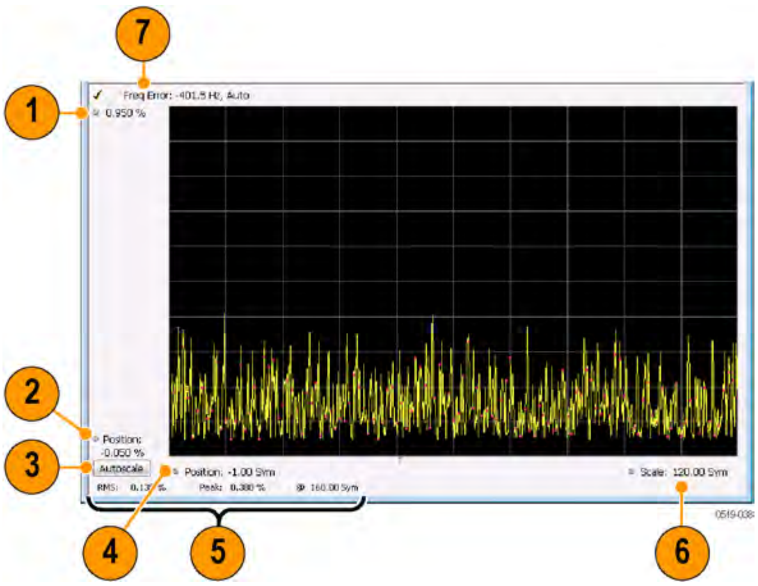
Note: A maximum of approximately 80,000 samples can be analyzed by the General Purpose Digital Modulation measurements (the actual value varies with modulation type).

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



Item	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 > *Advanced Params* tab is set to Manual.

Changing Magnitude Error vs Time Display Settings

Magnitude Error vs Time Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	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 on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	Enables you to set characteristics of the measurement display.

Phase Error vs Time Display

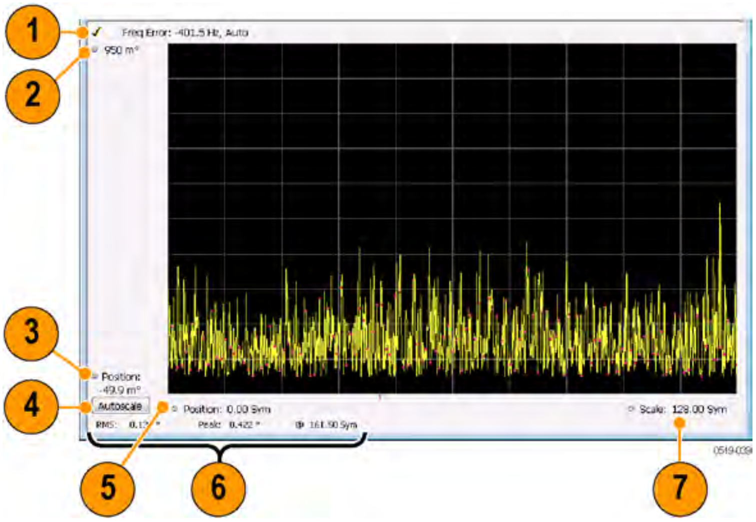
The Phase Error vs. Time display shows the phase angle of the symbol error over time. The phase is plotted along the vertical axis while time is plotted along the horizontal axis.

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



Item	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 > *Advanced Params Tab* on page 611 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

Phase Error vs. Time Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	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 on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	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.

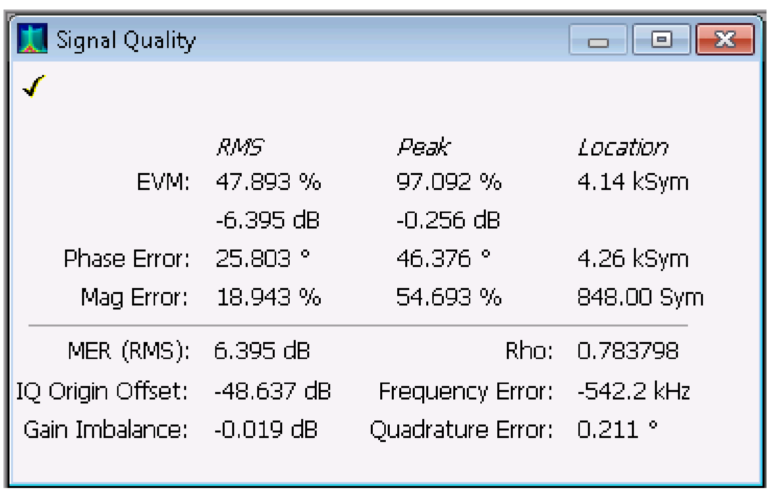


Figure 77: Signal Quality display for all modulation types except nFSK, C4FM, OQPSK, and SOQPSK

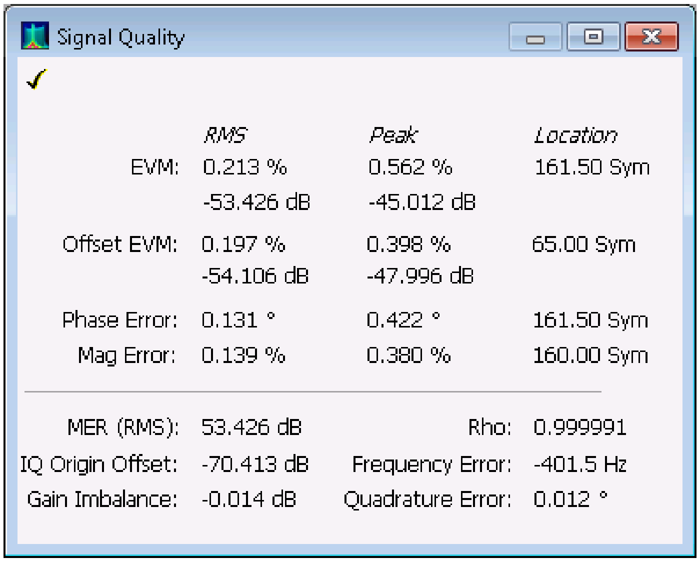


Figure 78: Signal Quality display for OQPSK and SOQPSK modulation types

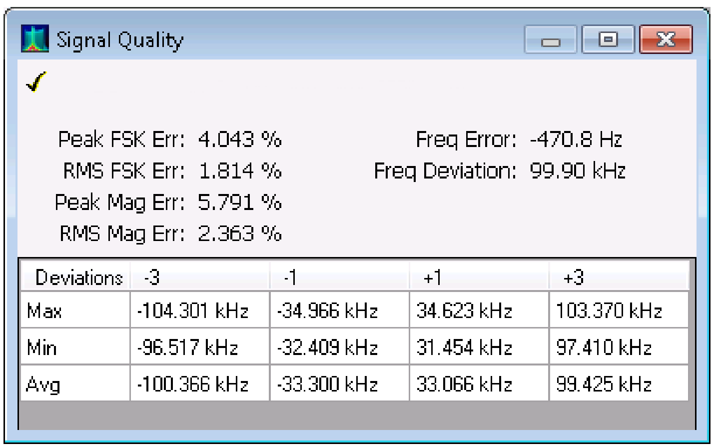


Figure 79: Signal Quality display for nFSK modulation type

Figure 80: Signal Quality display for C4FM modulation type

Elements of the Display

Table 36: 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.

Table 37: 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.

Table continued…

Measurement	Description
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.

Table 38: Measurements for nFSK modulation types

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.

Table 39: 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

Signal Quality Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

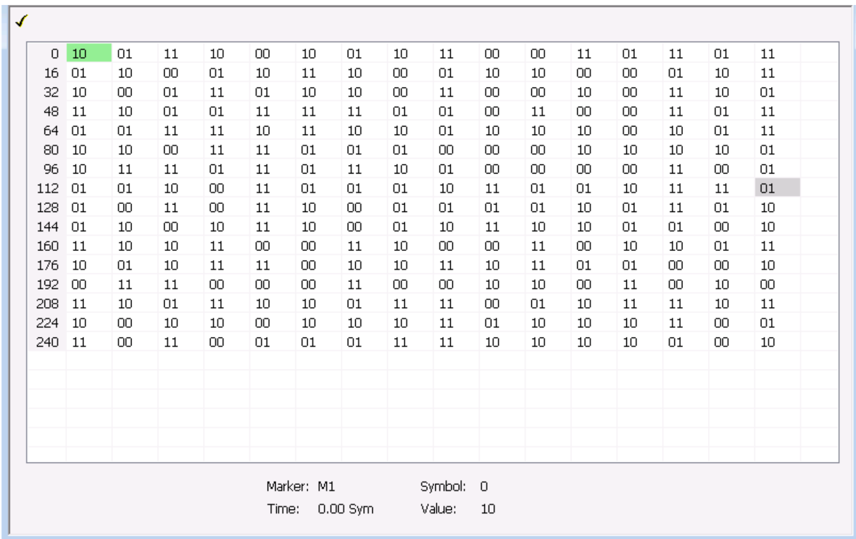
Settings tab	Description
Modulation Params Tab on page 604	The Modulation tab specifies the type of modulation used for the input signal and other parameters.
Freq & BW	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	The Advanced Params tab specifies frequency offset, magnitude normalization method and allows you to swap the I and Q signals.
Find Tab on page 614	Find tab is used to set parameters for finding bursts within the data record.
Analysis Time Tab on page 615	The Analysis Time tab contains parameters that define the portion of the acquisition record that is used for analysis.
Prefs Tab on page 619	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. Recall an appropriate acquisition data file.
2. Select the **Displays** button or select **Setup** > **Displays**. This displays the **Select Displays** dialog box.
3. From the **Measurements** box, select **GP Digital Modulation**.
4. Double-click the **Symbol Table** icon in the **Available Displays** box. This adds the Symbol Table icon to the **Selected displays** box.
5. Click the **OK** button. This displays the Symbol Table view.
6. Press the **Replay** button to take measurements on the recalled acquisition data file.



0	10	01	11	10	00	10	01	10	11	00	00	11	01	11	01	11
16	01	10	00	01	10	11	10	00	01	10	10	00	00	01	10	11
32	10	00	01	11	01	10	10	00	11	00	00	10	00	11	10	01
48	11	10	01	01	11	11	11	01	01	00	11	00	00	11	01	11
64	01	01	11	11	10	11	10	10	01	10	10	10	00	10	01	11
80	10	10	00	11	11	01	01	01	00	00	00	10	10	10	10	01
96	10	11	11	01	11	01	11	10	01	00	00	00	00	11	00	01
112	01	01	10	00	11	01	01	01	10	11	01	01	10	11	11	01
128	01	00	11	00	11	10	00	01	01	01	01	10	01	11	01	10
144	01	10	00	10	11	10	00	01	10	11	10	10	01	01	00	10
160	11	10	10	11	00	00	11	10	00	00	11	00	10	10	01	11
176	10	01	10	11	11	00	10	10	11	10	11	01	01	00	00	10
192	00	11	11	00	00	00	11	00	00	10	10	00	11	00	10	00
208	11	10	01	11	10	10	01	11	11	00	01	10	11	11	10	11
224	10	00	10	10	00	10	10	10	11	01	10	10	10	11	00	01
240	11	00	11	00	01	01	01	11	11	10	10	10	10	01	00	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

Symbol Table Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

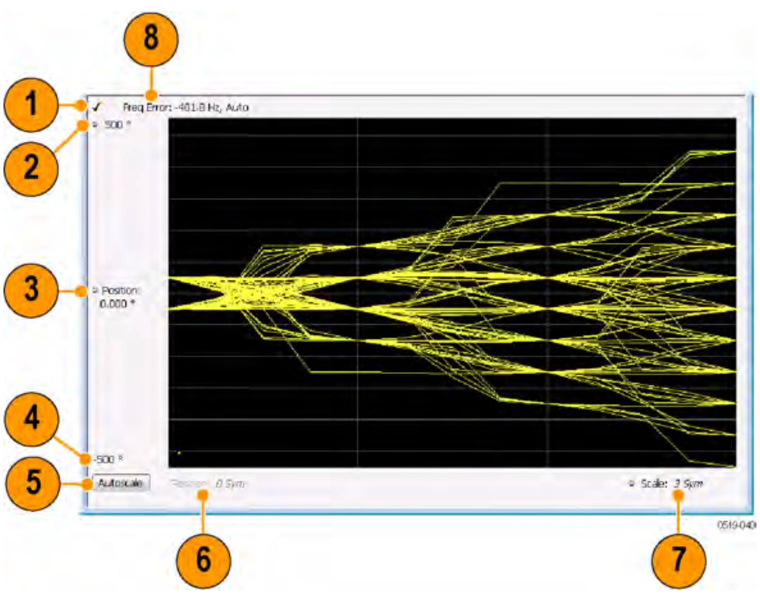
Settings tab	Description
Modulation Params Tab on page 604	The Modulation tab specifies the type of modulation used for the input signal and other parameters.
Freq & BW	Specifies settings for frequency error, measurement BW and Frequency Deviation. Each of these settings is set internally when set to Auto. Alternatively, you can specify values appropriate for specific measurement needs.
Equalizer Tab on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	The Advanced Params tab specifies additional parameters.
Find Tab on page 614	Find tab is used to set parameters for finding bursts within the data record.
Analysis Time Tab on page 615	The Analysis Time tab contains parameters that define the portion of the acquisition record that is used for analysis.
Prefs Tab on page 619	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



Item	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

Trellis Diagram Settings

Main menu bar: Setup > Settings

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 *Standard Settings Button* on page 604

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation used for the input signal and other parameters.
Freq & BW	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.

Table continued…

Settings tab	Description
Equalizer Tab on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Scale Tab on page 618	Specifies the horizontal and vertical scale settings.
Prefs Tab on page 619	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.

Table 40: Common controls for GP digital modulation displays

Settings tab	Description
Modulation Params Tab on page 604	Specifies the type of modulation, symbol rate, and filters to be used in demodulating the input signal.
Freq & BW	Sets values for frequency error/offset, measurement bandwidth, and frequency deviation (not every control is present for every modulation type).
Equalizer Tab on page 610	Enable the Equalizer and adjust its parameters.
Advanced Params Tab on page 611	Specifies additional parameters that are less frequently used.
Find Tab on page 614	Used to set parameters for finding a burst within the data record and for entering a Synch word.
Analysis Time Tab on page 615	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 Tab on page 616	Allows you to set the trace display characteristics.
Prefs Tab on page 619	Enables you to set characteristics of the measurement display.

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

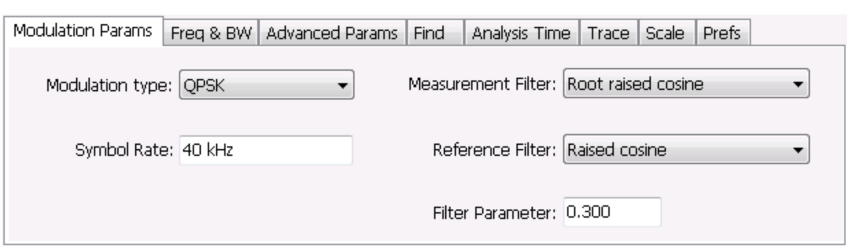
Table 41: Parameter values set by presets in the standard settings dialog

Standard	Modulation	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	[5]
CPM-MIL	CPM	19.2e3	None	None	NA	
SOQPSK-ARTM Tier 1	SOQPSK	2.5e6	None	SOQPSK-ARTM	NA	[5]
Project25 Phase 1	C4FM	4.8e3	C4FM-P25	RC	0.2	
CDMA2000–Base	QPSK	1.2288e6	IS-95 TXEQ_MEA	IS-95 REF	NA	
W-CDMA	QPSK	3.84e6	RRC	RC	0.22	

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.



5 Center Symbol Position, Half Shift Removed

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:

Modulation type	Description
QPSK	Quadrature Phase Shift Keying
8PSK	8-Phase Shift Keying
D8PSK	Differential Eight Phase Shift Keying
D16PSK	Differential Sixteen Phase Shift Keying
PI/2DBPSK	Pi/2 Differential Binary Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
PI/4DQPSK	Pi/4 Differential Quadrature Phase Shift Keying
BPSK	Binary Phase Shift Keying
OQPSK	Offset Quadrature Phase Shift Keying
16QAM	16-state Quadrature Amplitude Modulation
32QAM	32-state Quadrature Amplitude Modulation
64QAM	64-state Quadrature Amplitude Modulation
128QAM	128-state Quadrature Amplitude Modulation
256QAM	256-state Quadrature Amplitude Modulation
MSK	Minimum Shift Keying
2FSK	2-Frequency Shift Keying
4FSK	4-Frequency Shift Keying
8FSK	8-Frequency Shift Keying
16FSK	16-Frequency Shift Keying
CPM	Continuous Phase Modulation
SOQPSK	Shaped Offset Quadrature Phase Shift Keying
SBPSK	Shaped Binary Phase Shift Keying
C4FM	Constant Envelope 4-Level Frequency Modulation
16APSK	16-symbol Amplitude Phase Shift Keying
32APSK	32-symbol Amplitude Phase Shift Keying

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 PI/2DBPSK 8PSK D8PSK DQPSK PI/4DQPSK 16QAM 32QAM 64QAM 128QAM 256QAM QPSK 16APSK 32APSK	None RootRaisedCosine RaisedCosine Gaussian User Rectangular (freq) IS-95TX_MEA IS-95TXEQ_MEA	None RaisedCosine Gaussian User Rectangular (freq) IS-95REF
MSK	None Root Raised Cosine RaisedCosine Gaussian User Rectangular (freq)	None Gaussian User
OQPSK	None RootRaisedCosine User IS-95TX_MEA IS-95TXEQ_MEA	None Half sine RaisedCosine User IS-95REF

Table continued…

Modulation type	Measurement filters	Reference filters
HDQPSK	HDQPSK-P25	None RaisedCosine Gaussian User Rectangular (freq)
SOQPSK	None User	SOQPSK-MIL SOQPSK-ARTM User
CPM	None User	None User
2FSK 4FSK 8FSK 16FSK	None Gaussian RootRaisedCosine RaisedCosine Rectangular (freq) User	None Gaussian RaisedCosine User
C4FM	C4FM-P25	RaisedCosine User
SBPSK	None User	SBPSK-MIL 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.

Measurement BW

The measurement BW (reported on the Settings > Freq & BW tab) is computed based on the Modulation Type, the Symbol Rate (SR), the Reference Filter type, and the Filter Parameter (alpha). The following table shows the formulas used, where SR= symbol rate, and α = filter parameter.

Modulation type	Measurement filter	Measurement bandwidth
QPSK, 8PSK, D8PSK, DQPSK, PI/4DQPSK, BPSK, PI/2DBPSK, QAM16-256, APSK	Raised Cosine None / Rectangular All others	SR * (1 + α) SR * 16 SR * 2

Table continued…

Modulation type	Measurement filter	Measurement bandwidth
D16PSK	Raised Cosine	SR * (1.5 + α)
	None / Rectangular	SR * 16
	All others	SR * 2.5
OQPSK	Raised Cosine	SR * 2
	Half Sine	SR * 12
	None / Rectangular	SR * 16
	All others	SR * 2
GMSK	Gaussian	SR * 12 * α
	None / Rectangular	SR * 4
	All others	SR * 4
GFSK, FSKn, C4FM	All	SR * 8

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.

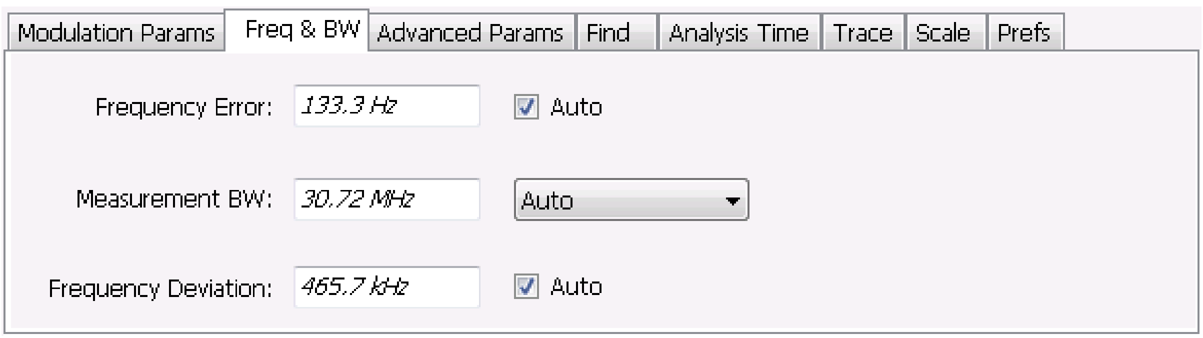


Figure 81: Freq & BW tab with nFSK or C4FM modulation type selected and Frequency Error readout enabled (Auto selected)

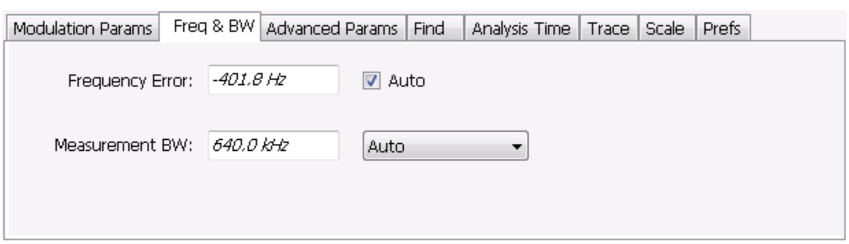
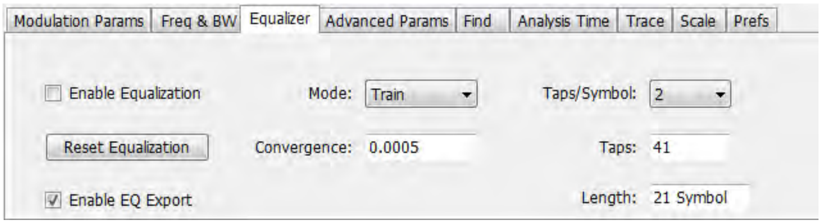


Figure 82: Freq & BW tab with SOQPSK modulation type selected and Frequency Offset enabled (Auto deselected)

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.



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/Symbol	The number of filter coefficients per symbol used by the filter. Available choices are 1, 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, *Training the Equalizer* on page 610 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 0

<line2>EQ_Sample_Rate_Hz 0

<line3>Demod_Symbol_Rate_Sps 0

<line4>EQ_Samples_per_Symbol 0

<line5>Number_of_EQ_Taps_Following 0

Exporting EQ Files

Advanced Params Tab

The Advanced Params tab specifies additional parameters that control the demodulation of the signal.

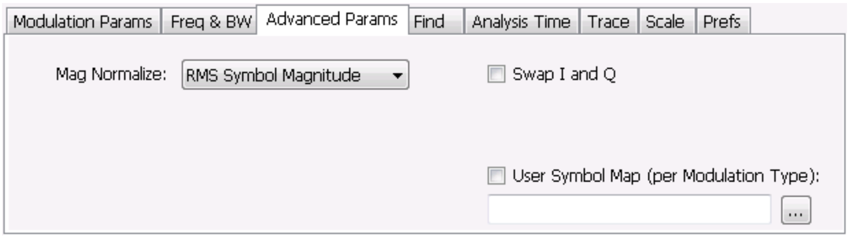


Figure 83: Advanced Params tab for all modulation types except nFSK and C4FM

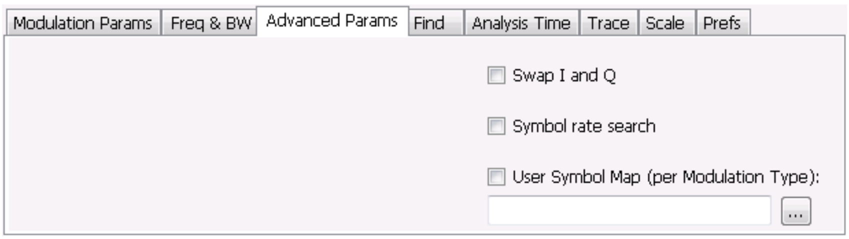


Figure 84: Advanced Params tab for modulation type nFSK

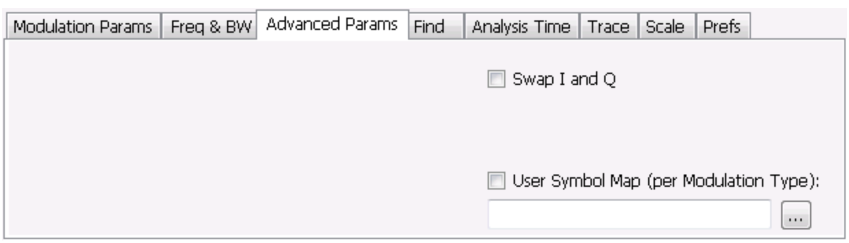


Figure 85: Advanced Params tab for modulation type C4FM

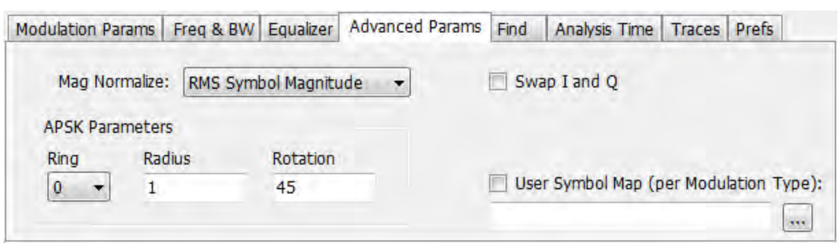


Figure 86: Advanced Params tab for modulation type APSK

Parameter	Description
Mag Normalize (not present for nFSK or C4FM modulation types)	Select RMS Symbol Magnitude or Max Symbol Magnitude. This setting applies to Mag Error and EVM.
Swap I and Q	When enabled, the I and Q data are exchanged before demodulating.
APSK Parameters (Present only for APSK modulation types)	Sets Constellation display parameters for APSK modulation types.

Table continued…

Parameter	Description
Symbol rate search (Present only for nFSK modulation types)	Determines whether to automatically detect or manually set the symbol rate. When 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.

APSK Parameters

Three parameters can be set for Constellation display of APSK modulation types.

Parameter	Description
Ring	Use to select which ring the radius and rotation values are being specified for. Values are 0 and 1 for 16APSK. 0, 1, and 2 for 32APSK.
Radius	Sets the Ring ratio relative to Ring 0 (inner most ring). Set after selecting the appropriate Ring setting.
Rotation	Sets the rotation value from the I axis. Set after selecting the appropriate Ring setting.

User Symbol Map

A User Symbol Map is a text file that specifies the location of symbols in the display. The symbol map is unique for each modulation type. The easiest way to create a custom symbol map is to start with the default symbol map and modify it. The default symbol map file is located at C:\RSA5100B\ExampleFiles. The default symbol map file is named **DefaultSymbolMaps.txt**. See *Symbol Maps* on page 620 for illustrations of the default symbol mapping.

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.

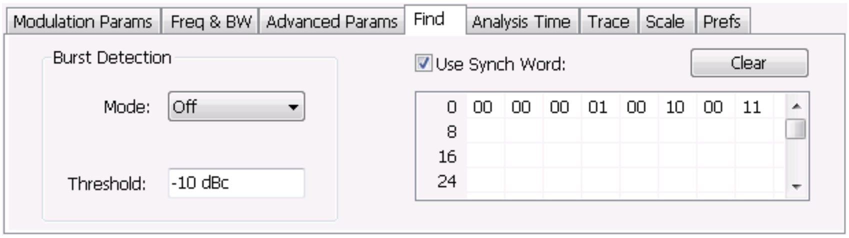
```
## Symbol Mapping Definitions
## Version 1.2
## This file defines the mapping of modulation states to symbol values.
##
## File Format :
## -------------
## 1. Comments begin with '##' and may appear after the last field in a line
## 2. A symbol map begins and ends with a line containing the name 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)
                32QAM
        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

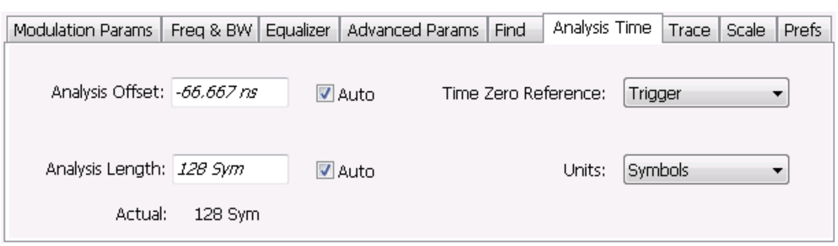
The Find tab is used to set parameters for finding bursts within the data record. This is a post-acquisition operation. Synch Word search controls are also on this tab.



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.



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.

Table continued…

Setting	Description
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.

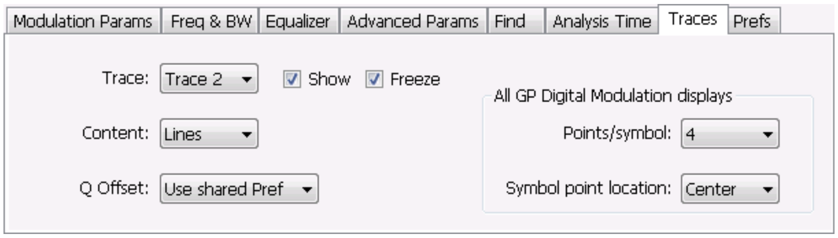


Figure 87: Example traces tab for constellation display set to SOQPSK modulation type

Note that some settings are not present for all modulation types and some settings are not present for all displays.

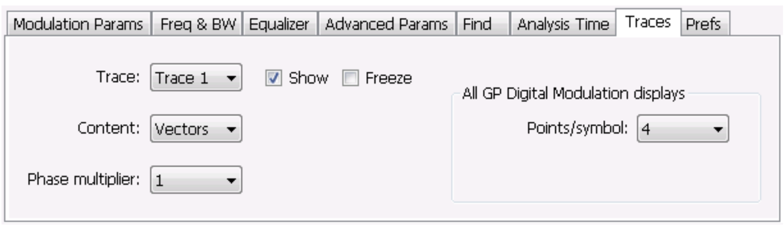


Figure 88: Example trace tab for constellation display set to CPM modulation type

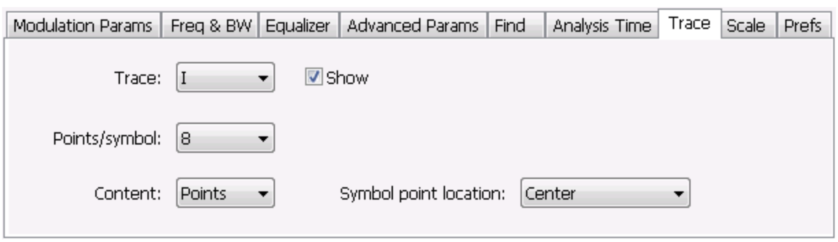


Figure 89: Example trace tab for Demod I&Q display

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.

Table continued…

Setting	Description
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

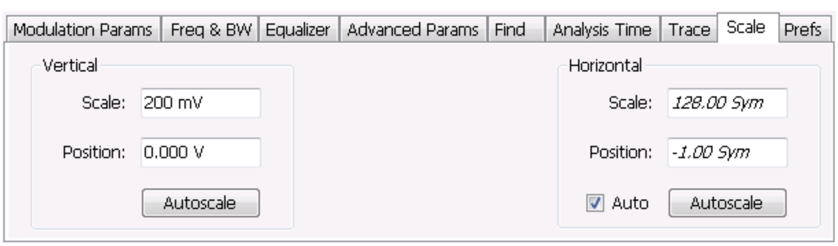
When the Constellation display is the selected display, you can use the Traces tab to enable the display of a second trace. The second trace is a version of the current acquisition. You can choose to freeze a trace in order to display the current live trace to an earlier version of itself, you can display 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.



Setting	Description
Vertical	Controls the vertical position and scale of the trace display.
Scale	Changes the vertical scale units.

Table continued…

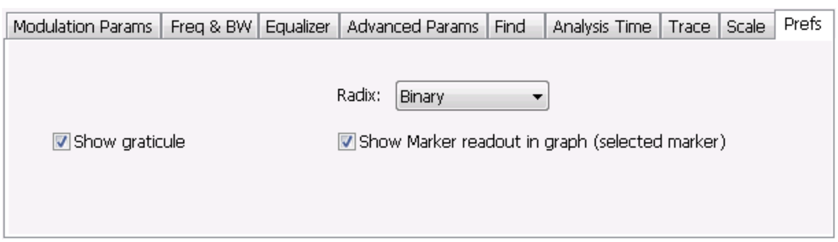
Setting	Description
Position	Position adjusts the reference level away from top of the graph.
Autoscale	Resets the scale of the vertical axis to contain the complete trace.
Horizontal	Controls the span of the trace display and position of the trace.
Scale	Allows you to, in effect, change the span.
Position	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

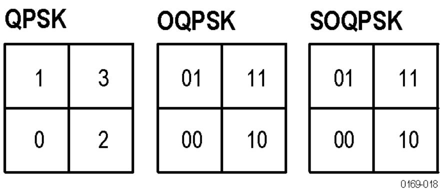
The Prefs tab enables you to change appearance characteristics of the GP Digital Modulation displays.

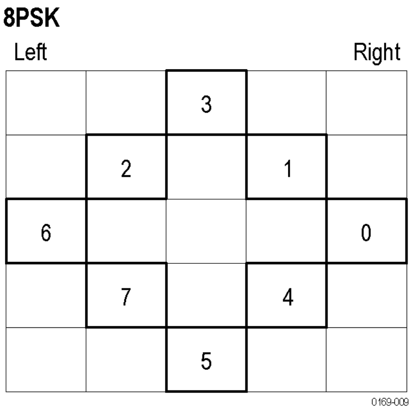


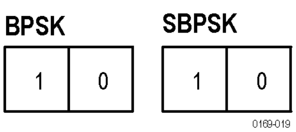
Setting	Description
Show graticule	Shows or hides the graticule.
Show Marker readout in graph (selected marker)	Shows or hides the readout for the selected marker in the graph area.
Radix	Specifies how symbols are displayed in the Symbol Table display and in the Marker readout in the Constellation display.
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.







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
B	A	9	8
F	E	D	C

0169-010

32QAM

Left					Right
	3	2	1	0	
9	8	7	6	5	4
F	E	D	C	B	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	E	D	C	B	A	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	3A	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

256QAM

Left ... Right

EF	FD	EB	F9	E7	F5	E3	F1	0F	3F	4F	7F	8F	BF	CF	FF
CE	DC	CA	D8	C6	D4	C2	D0	0C	3C	4C	7C	8C	BC	CC	FC
AF	BD	AB	B9	A7	B5	A3	B1	0B	3B	4B	7B	8B	BB	CB	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

0169-013

2FSK

Left ... Right

0	1

4FSK

Left ... Right

0	1	3	2

0169-014

8FSK

Left ... Right

0	1	2	3	7	6	5	4

0169-015

16FSK

Left ... Right

0	1	2	3	4	5	6	7	15	14	13	12	11	10	9	8

0169-016

C4FM

Left ... Right

11	10	00	01

0169-020

CPM	
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 *User Filter File Format* on page 625.

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.

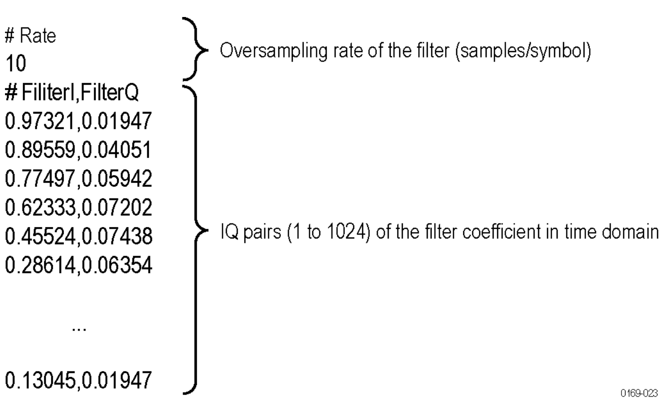


Figure 90: User filter file structure

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.

FilterI,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.

Raised Cosine (α = 0.3)			
(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
# FilterI,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	0.286147,0	-0.174718,0	-0.0136498,0
0.0194761,0	0.455249,0	-0.143898,0	-0.0062255,0
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	

Table continued…

Raised Cosine (α = 0.3)			
(Row 1 to 18)	(Row 19 to 36)	(Row 37 to 54)	(Row 55 to 68)
0.0743803,0	0.973215,0	0.0383599,0	
0.063548,0	1,0	0.063548,0	

Gaussian (BT = 0.5)			
(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	7.10E--05,0
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
4.21E-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
4.37E-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	
0.000172633,0	0.917004,0	0.00390625,0	
0.000401796,0	0.978572,0	0.00191127,0	
0.000895512,0	1,0	0.000895512,0	

Marker measurements

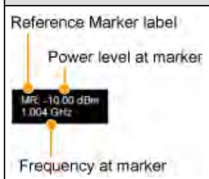
Using markers

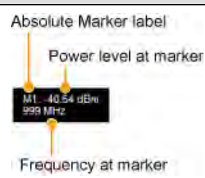
Overview

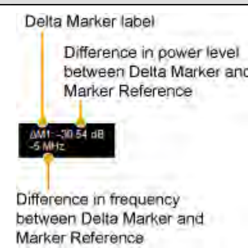
Markers are indicators in the display that you can position on a trace to measure values for the X and Y axes, such as frequency, power, and time. A Marker always displays its position and, if enabled, will display the difference between its position and that of the Marker Reference (MR).

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.

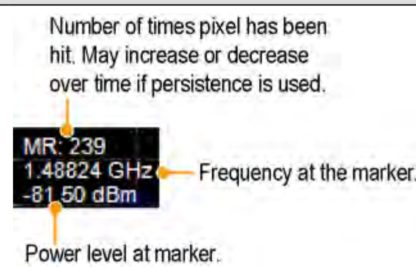
<table>
<tr><th>Marker Reference Readout</th><th>Absolute Marker Readout</th><th>Delta Marker Readout</th></tr>
<tr><td>


</td><td>


</td><td>


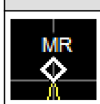
</td></tr>
</table>

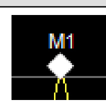
<table>
<tr><th>Power Marker Readout</th><th>DPX Bitmap Marker Readout</th></tr>
<tr><td>


</td><td>


</td></tr>
</table>

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.

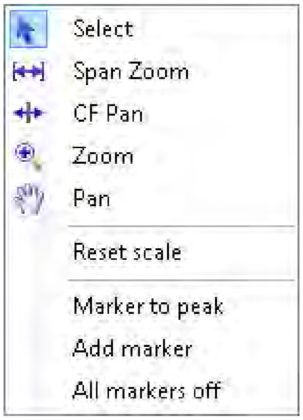
<table>
<tr><th>Marker Reference</th><th>Absolute, Delta, and Power Marker</th></tr>
<tr><td>


</td><td>


</td></tr>
</table>

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.

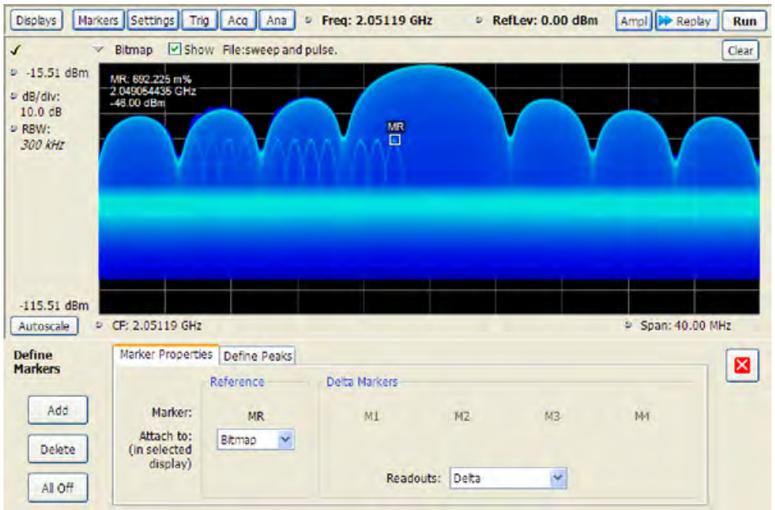
Measuring signal density frequency and power on a DPX bitmap trace

To measure the signal density, frequency and power at a point on a DPX Bitmap 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 **Bitmap**.
5. Click  to remove the Define Markers control panel.
6. Touch or click on the MR marker on the trace to activate the marker.
7. Drag the marker to the desired location on the bitmap.

Note: Delta markers on the DPX Bitmap trace can be placed on any point in the display, unlike markers in other displays that can be placed only on a trace. This enables you to measure the signal density, frequency, and power level at any point on the graph.

Note: Power markers can only be placed on a trace. To use Power markers in the DPX display, click the down arrow in the top left portion of the display labeled Bitmap and select a Trace from the drop down menu.



Searching for peaks on the DPX bitmap trace. To locate peaks on the DPX Bitmap trace, use the arrow buttons on the Marker toolbar. The left / right arrows move the selected marker to the next peak lower or higher in frequency. The up and down arrows search for peaks at the same frequency. The peaks on the DPX Bitmap trace are defined by the settings for the DPX Signal Density on the Markers > Define Markers > *Define Peaks* tab.

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.

Common marker actions

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.

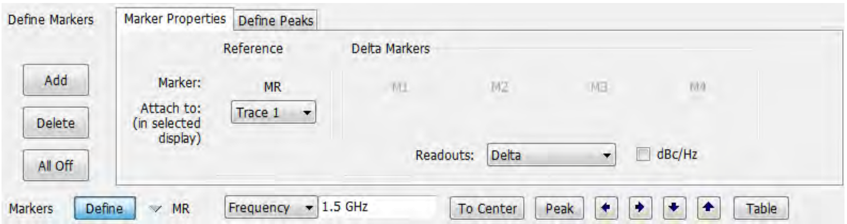
Define markers control panel

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



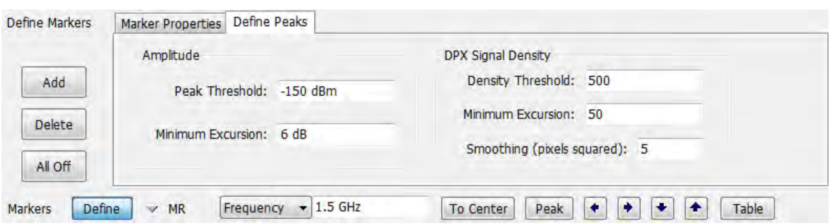
1. Select **Markers** > **Define Markers** to display the Define Markers control panel.
2. Select **Add** to turn on the next marker. A drop-down list under the marker label allows you to assign the marker to a trace.

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*.
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.



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.

Table continued…

DPX Signal Density	
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.

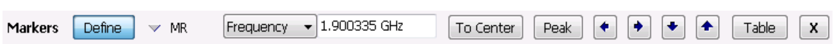
Markers toolbar

Using the markers toolbar

Front Panel: Markers

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.



Enabling a marker or adjusting the position of a marker automatically opens the Markers toolbar.

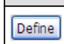
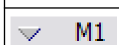
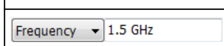
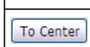
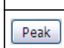
Icon / Readout	Description
	Opens the Define Markers control panel.
	Selected marker readout. This readout shows which marker is selected. The pop-up menu allows you to choose the selected marker, add markers, and turn all markers off.
	Marker position controls. For frequency displays, this readout shows 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.

Table continued…

Icon / Readout	Description
	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.
Table	Displays/hides the marker table from the display.
X	Removes the Marker Toolbar from the display.

Noise markers in the spectrum 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.

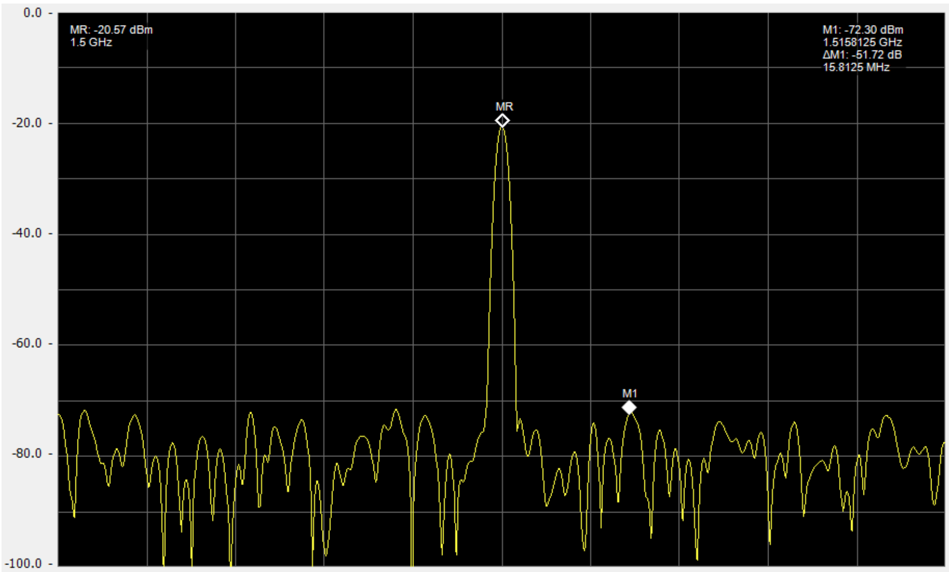
Measuring Noise

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.

Mask Testing

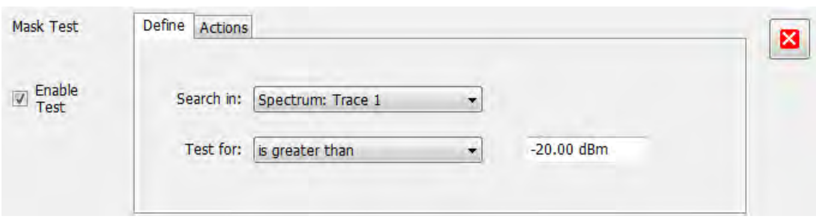
The Mask Test Tool

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.

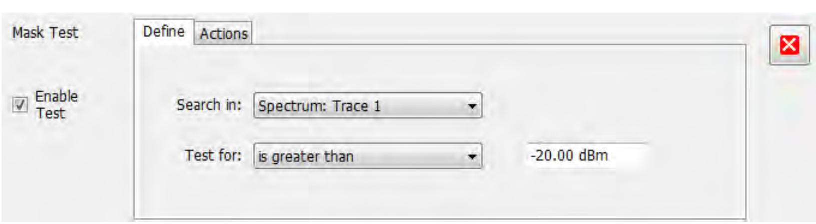


Setting	Description
Enable Test	Select to perform a test, then set the test conditions.
Define	Specifies which result to test and what to test for.
Actions	Specifies the action to take when the test condition is met.

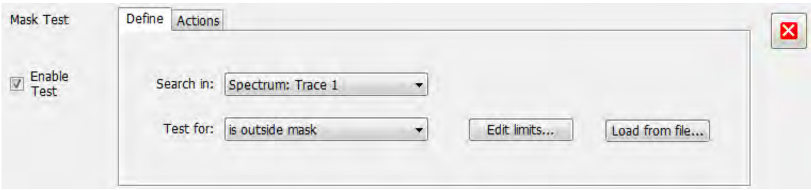
Define Tab (Mask Test)

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*.



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*.



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:

Test For

The **Test for** setting has selections that vary based on which display's results you are testing.

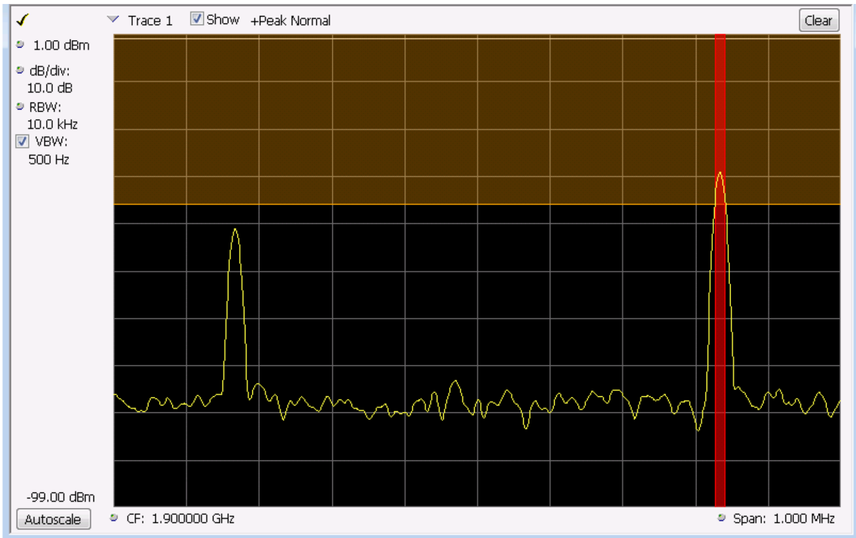
Pass/Fail Tests for Spurious and Settling Time

The Frequency Settling Time, Phase Settling Time measurements, and Spurious measurements test functions provide pass/fail results.

Greater Than/Less Than Tests for Spectrum

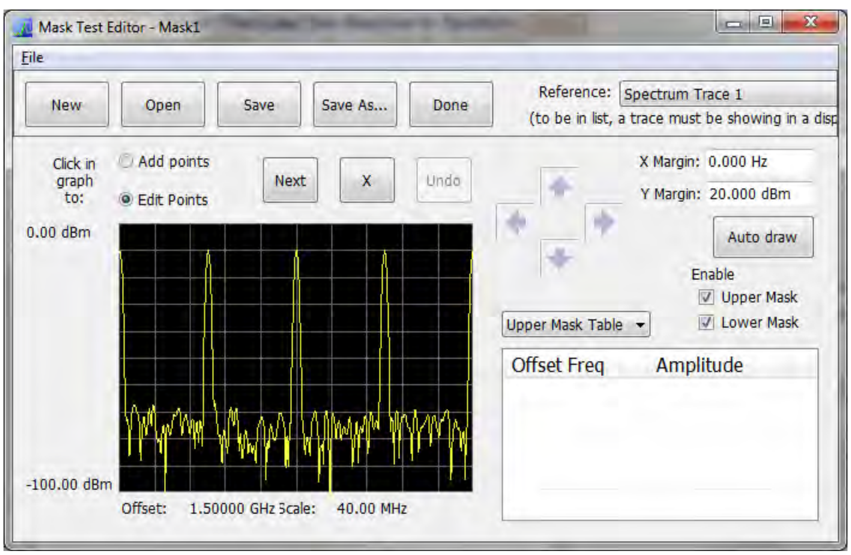
If you select a greater than/less than test, you also specify the level that defines a violation. When you select either **is greater than** or **is less than**, a text entry box appears to the right of the drop-down list. Use the text entry box to specify the signal level you wish to test for. While 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.



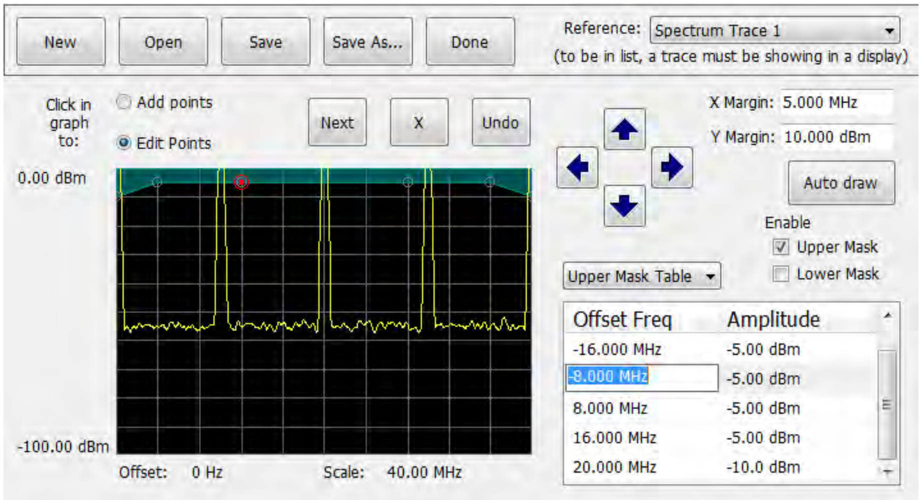
Outside/Inside Mask Tests

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.

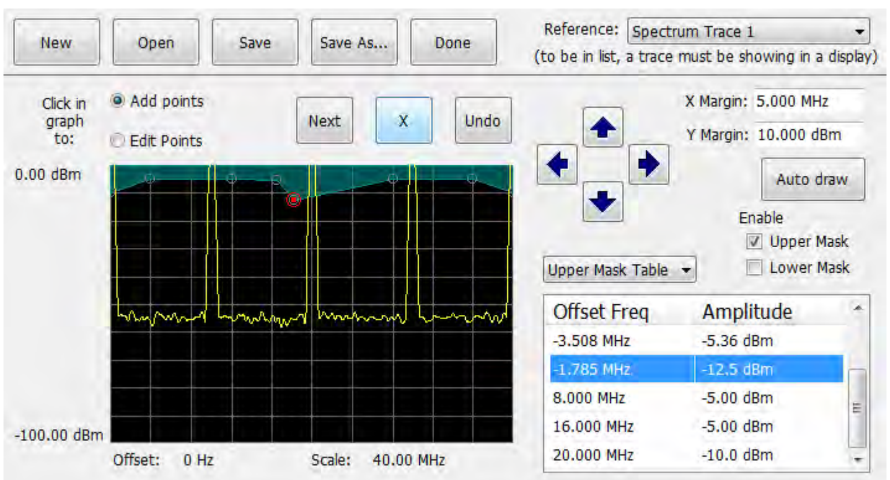


b. To add a new point, check the box next to the target mask (located below the **Auto draw** button).

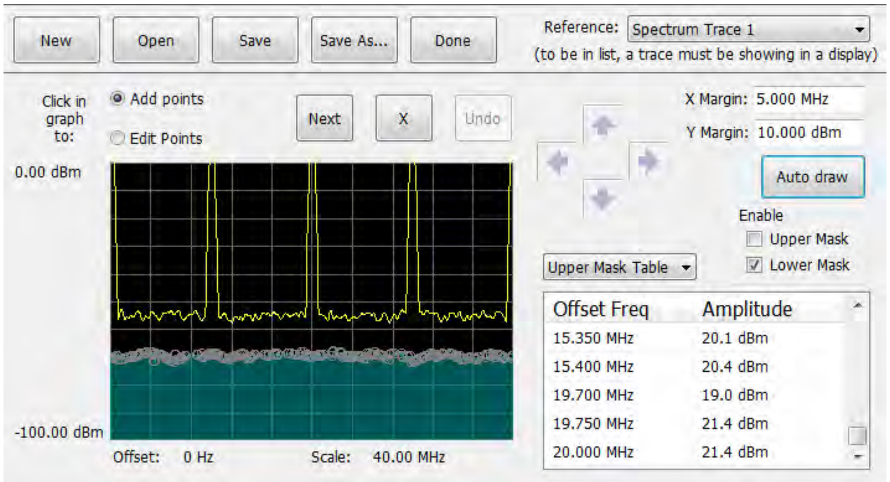
c. Select **Add points** located below the **Open** button.

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.

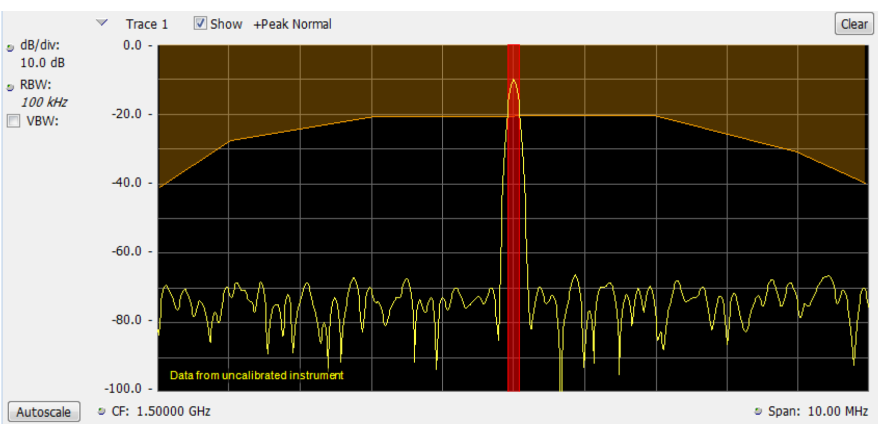
4. To delete a point from the table, select the point to be removed, and click the **X** button.
5. To save the mask to a file for later recall, click **Save As**.
6. From the Save As dialog, name the file and save it in the desired location.

Note: Masks are saved in XML format with a .msk extension.

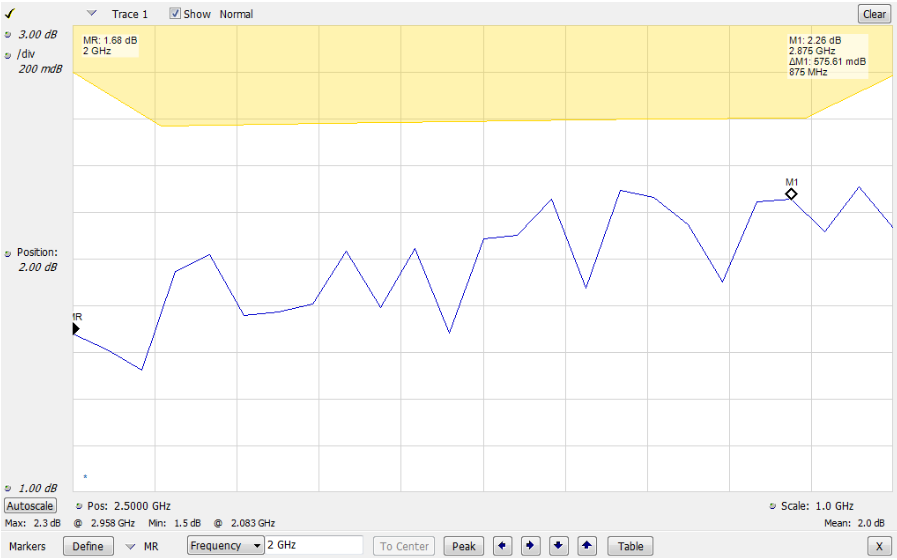
7. To dismiss the Mask Test Editor window, click **Done**.

Mask Test Result Example

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.



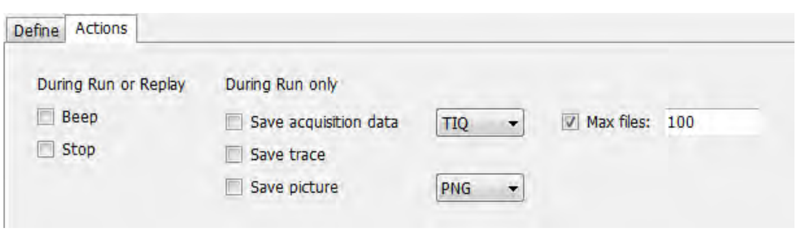
The following figure shows the results of a passing Noise Figure **is outside mask** test with Upper Mask enabled. Markers are also in use.



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.



Setting	Description
During Run or Replay	Actions specified here will occur in either Run mode or Replay mode.
Beep	The analyzer beeps when the test condition is met.
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*.
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: *PNG, JPG, and BMP*. 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*.

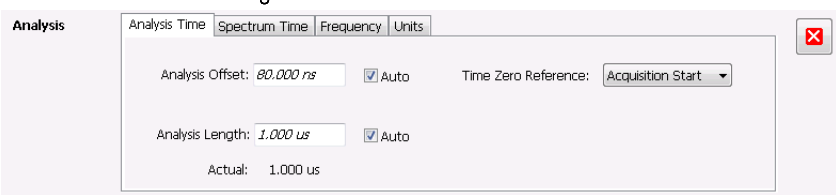
Analyzing Data

Analysis Settings

Menu Bar: Setup > Analysis

Favorites toolbar: 

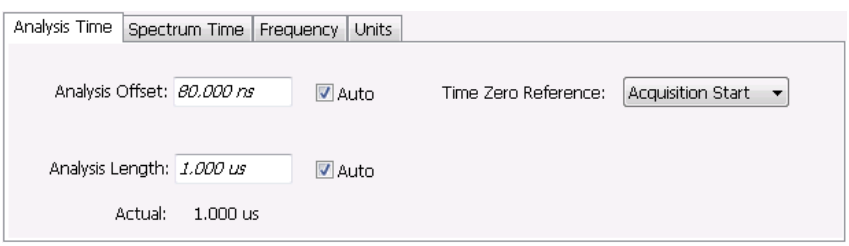
The Analysis control panel provides access to settings that are used by all displays. These settings affect only post processing and they do not control hardware settings.



Setting	Description
Analysis Time Tab on page 643	Specifies the length of time to use in measurements.
Spectrum Time Tab on page 644	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 Tab on page 645	Specifies the measurement frequency (center frequency).
Units Tab on page 647	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.



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.

Table continued…

Setting	Description
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).

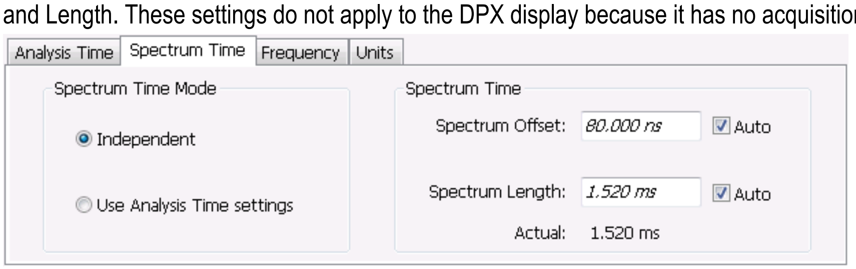
Time Zero Reference

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

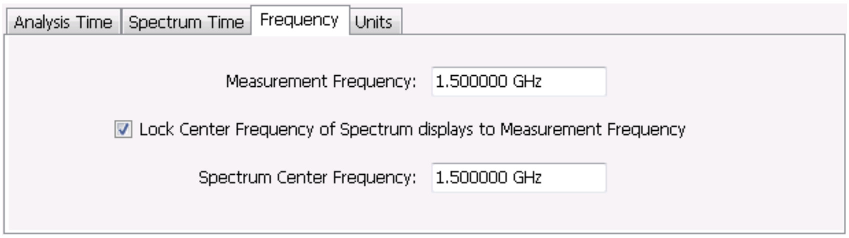
This tab controls whether the Spectrum display uses the same Analysis Time parameters as all the other views or uses a different Offset and Length. These settings do not apply to the DPX display because it has no acquisition record or analysis time.



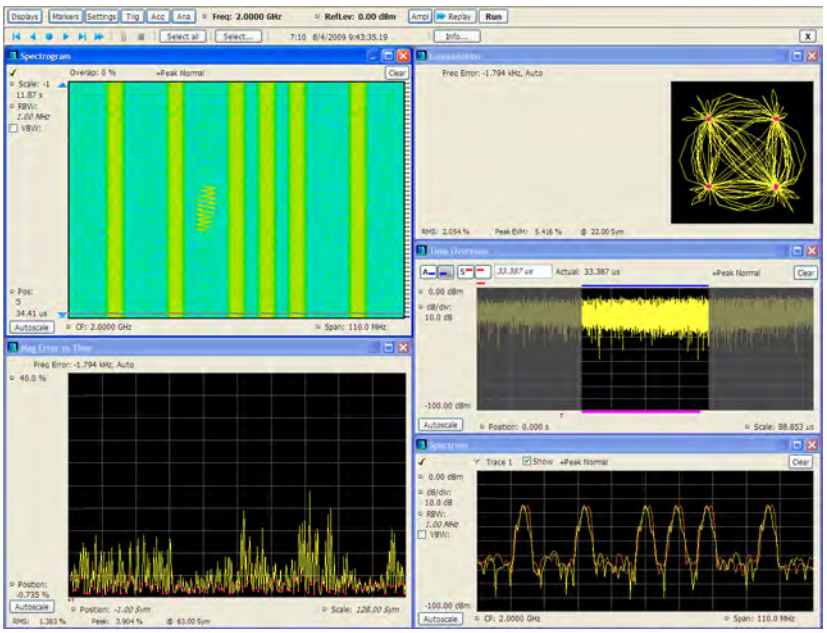
Settings	**Description**
Spectrum Time Mode	
Independent	Causes the spectrum analysis views to use the settings unique to those displays.
Use Analysis Time settings	Causes the spectrum analysis views to use the settings on the Analysis Time tab.
Spectrum Time (only available when *Independent* is selected)	
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

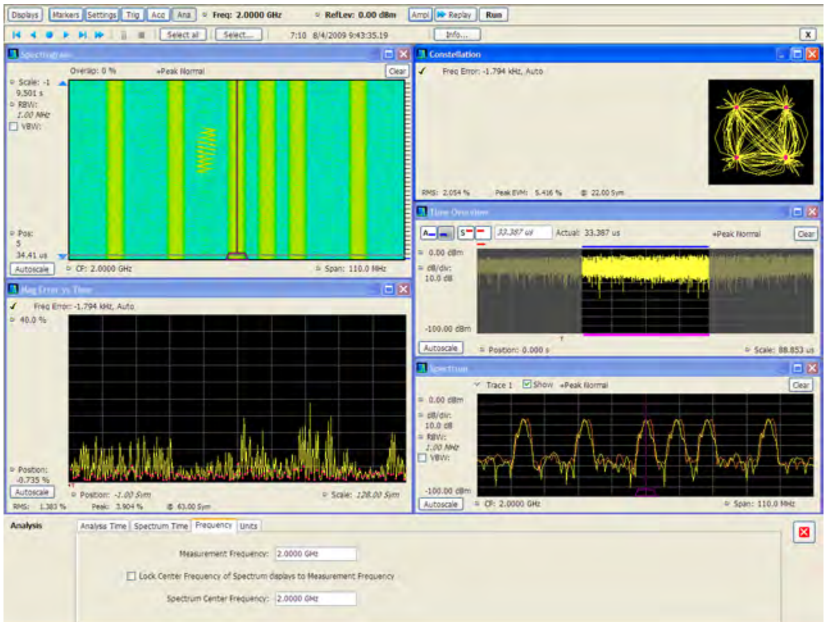
The Frequency tab specifies two frequency values: the Measurement Frequency and the Spectrum Center Frequency. The Measurement Frequency is the frequency at which most displays take measurements. The Spectrum Center Frequency is the center frequency used by the Spectrum, DPX Spectrum, Spectrogram and Time Overview displays.



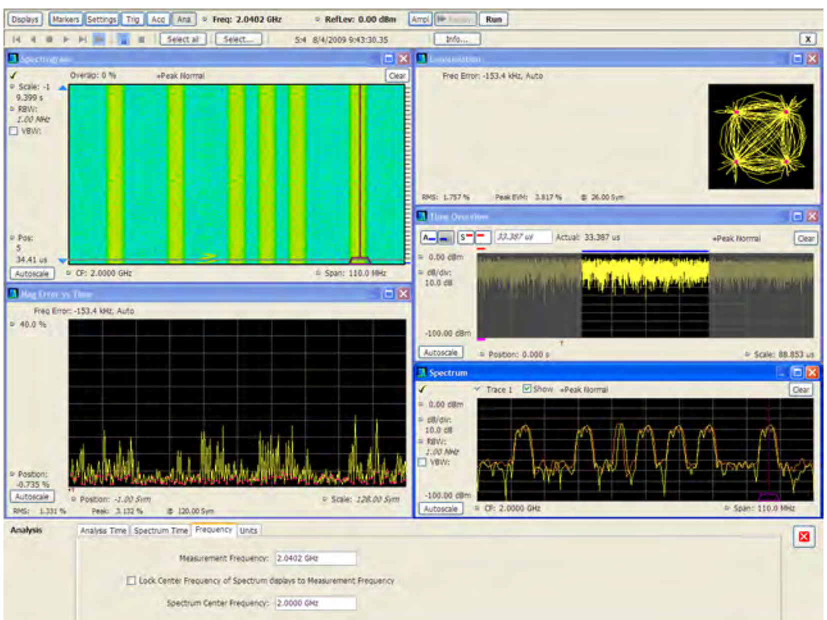
The following screen capture shows a display with both the Measurement Frequency and the Spectrum Center Frequency locked together.



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.



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.

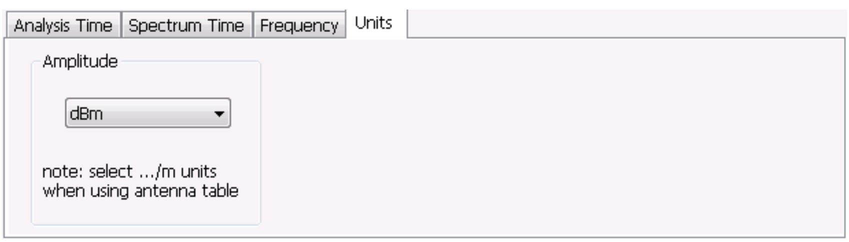
There are interactions between frequency unlocking and RF & IF Optimization (see the *Amplitude Settings* on page 653). When **Best for multiple displays** is the selected optimization, the instrument is allowed to use its full bandwidth to meet the needs of all open displays. This is the most user-friendly 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.



Note: If you are using an External Loss Table for antenna corrections (Ampl > External Gain/Loss Correction), set the Amplitude units to dBuA/m or dBuV/m.

Replay Overview

The Replay function enables you to reanalyze data with different settings and even different measurements. You can replay all the acquisitions in memory, a single acquisition, a single frame within an acquisition (if Fast Frame is enabled), or any contiguous set of data records from acquisition history. You can replay the DPX Spectra that make up a DPXogram display.

Displaying the Replay Control Panel

To display the Replay control panel:

1. Select **View** from the main menu bar.
2. Select **Replay Toolbar** in the menu. The toolbar will appear near the bottom of the display.

3. Click the **Define** button to open the Replay control panel.

Tip: You can read more about the other toolbar buttons *here*.

Selecting the Data Type to Replay

You can choose to replay either acquisition data or DPX spectra. Choose **Acq Data** to replay any acquisitions except DPXogram acquisitions. Choose **DPX Spectra** to replay a DPXogram acquisition.

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.

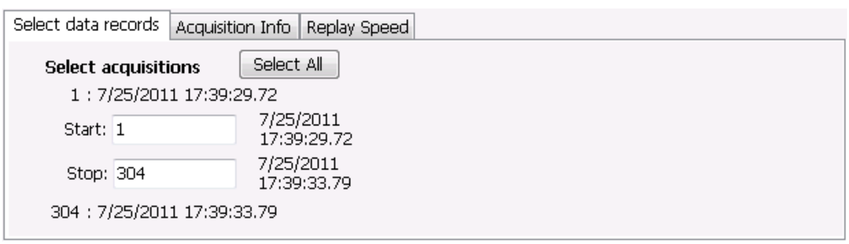


Figure 91: Without FastFrame enabled

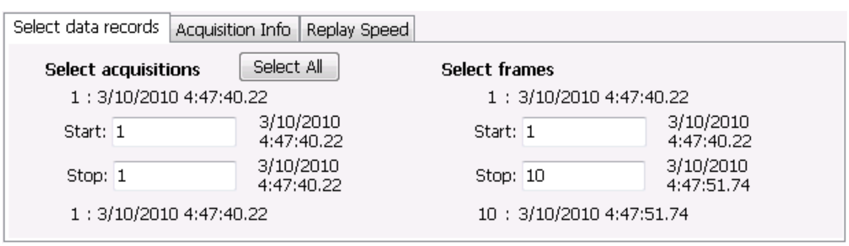


Figure 92: With FastFrame enabled

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.

Select DPX Spectra Tab

The Select DPX Spectra tab is used to select which DPXogram spectra to replay. A spectra is the smallest DPXogram unit that can be replayed. It is equivalent to one line in the DPXogram display.

Date and Time Stamps. The line that appears to the right of each Start box displays the date and time the selected DPX Spectra was acquired. The line that appears to the right of each Stop box displays the date and time the selected DPX Spectra in the current acquisition was acquired.

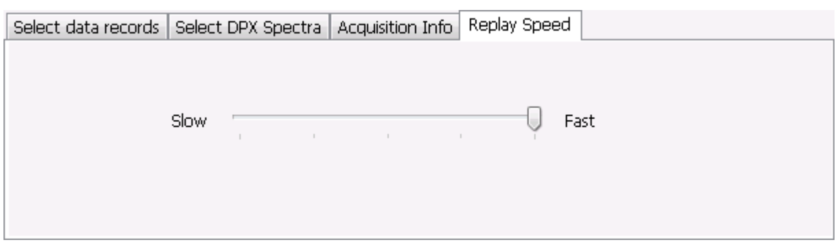
Select All button. Selecting Select All resets the Start and Stop values. The Start value is reset to the first DPX Spectra of the current acquisition. The Stop value is reset to the last DPX Spectra in the current acquisition.

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.



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.
DPX Spectra	Select DPX Spectra to replay a DPXogram display.
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.
First record	Replays the first record within the selected set.

Table continued…

Menu item	Description
Previous	Replays the previous record within the selected set.
Next	Replays the next record within the selected set.
Last record	Replays the last record within the selected set.
Pause	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.
Stop	Halts the replay of acquisitions. If replay is started after Stop has been selected, replay starts from the first acquisition.
Select all	Selects all acquisitions for replay.
Select records from history	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.
Replay toolbar	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.

DPX Spectra

Selecting **DPX Spectra** selects DPX spectra as the source for replay. Selecting DPX Spectra 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.

Figure 93: Replay toolbar

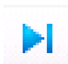
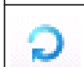
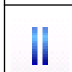
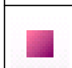
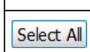
Item	Description
Replay	Selects data type to be replayed. Select DPX Spectra to replay a DPXogram. Select Acq Data for all other types of replay.
	Replays the first record in the selected set.
	Replays the previous record in the selected set.
	Replays the current record in the selected set.
	Replays the next record in the selected set.
	Replays the last record in the selected set.
	Replays all records in the selected set.
	Replays all records in the selected set continuously until stopped.
	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.
	Clicking **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.

Table continued…

Item	Description
Define	Clicking the **Define** button displays the Define 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. You can also view and use the Select data records tab, Select DPX Spectra tab, and Replay Speed tab.
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.

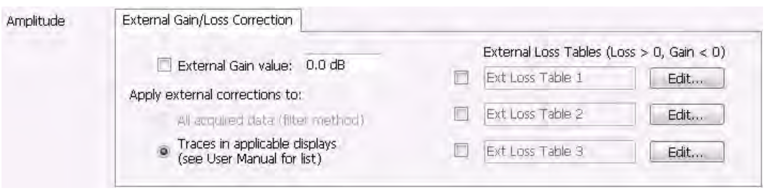
Amplitude Corrections

Amplitude Settings

Main menu Bar: Setup > Amplitude

Favorites toolbar: 

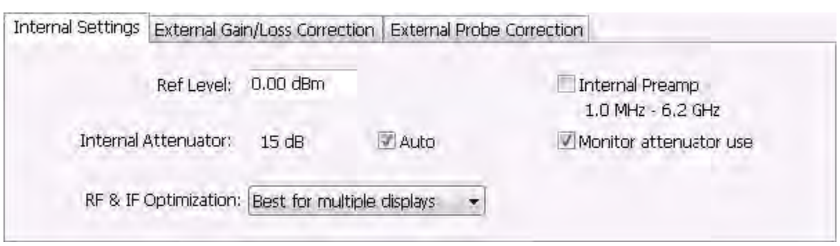
The Analysis control panel provides access to settings that are used by all displays. These settings affect only post processing and they do not control hardware settings.



Setting	Description
Internal Settings	Sets the parameters that control the acquisition of the signal.
External Gain/Loss Correction	Specifies whether a correction is applied to the signal to compensate for the use of external equipment.
External Gain/Loss Correction	Specifies whether a correction is applied to the signal if the analyzer detects a probe is connected to the instrument. (Probes are connected to the analyzer through the RTPA2A Real-Time Spectrum Analyzer TekConnect Probe Adapter.)

Internal Settings Tab

On the Internal Settings tab, you can specify the Reference Level 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.



Ref Level

The reference level can be set for the RF Input of the connected instrument.

Internal Attenuator

The Internal Attenuator setting can be 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 varies depending on the instrument in use.

Internal Preamp

If your instrument has the optional internal preamp installed, use this setting to switch the preamp on or off.

Note: To ensure the best accuracy, thermally stabilize before taking critical measurements.

Monitor Attenuator Use

The input attenuator relays are rated for several million cycles. Some measurement settings result in high rates of attenuator switching and could prematurely age the relays. Enabling this function causes the instrument to monitor the attenuator switching rate. When a high rate of switching is maintained for more than an hour, the instrument will halt acquisitions and display a message about the condition. To restart acquisitions, press Run. If the check box is not selected, the monitoring function is disabled.

Note: This feature is provided to prevent accidental long-term high-rate attenuator switching (thus extending attenuator life). If you need to run the instrument for extended period, such as overnight or over a weekend, disable the setting to prevent the halting of acquisitions.

RF & IF Optimization

Specifies how the gain and bandwidth should be optimized (in the RF and IF stages of the front end).

You can select RF & IF optimizations to achieve the best dynamic range, fastest sweep speed, or minimum displayed noise. These choices affect the RF and IF attenuation levels, the selection of the acquisition bandwidth, digitizer and the resolution of the mathematical operation performed on the acquisitions used in varying conditions of span, reference level and resolution bandwidth.

The following paragraphs describe the effects of choosing each of the available choices.

Best for multiple displays (Default). This setting is the instrument default and is set as part of the Preset function. When this is selected, the instrument considers all the open displays and chooses an Acquisition Bandwidth wide enough to satisfy as many measurements as possible. Instead of optimizing the measurement performance of the selected display, this setting decreases the incidence of non-selected displays being unable to run because the acquisition bandwidth is set too small by the selected display.

Auto. The Auto setting is an optimized trade-off of the competing performance choices.

Minimize sweep time. Selecting Minimize Sweep Time causes the instrument to use the widest available acquisition bandwidth when sweeping across spans greater than the maximum available real-time span. For instruments with Option B40/B85/B16x, swept update rate is significantly faster than Auto. This setting has no effect in instruments without Option B40/B85/B16x.

Maximize dynamic range. Selecting Maximize Dynamic Range has several effects:

- Sets RF attenuation to allow higher drive levels at the RF mixer.
- Sets IF gain levels to optimize the IF for the higher signal levels that result from allowing higher drive levels at the mixer.
- Selects the acquisition path used in the instrument taking into account the user-specified Resolution Bandwidth (RBW). When an RBW of less than 20 kHz is selected, the instrument uses a narrow-band (312.5 kHz) acquisition path, regardless of the selected span or measurement bandwidth. This results in the best rejection of out-of-band signals in the IF stage of the analyzer, but comes at the cost of slower update rates for all signal analyzer spans and measurement bandwidths greater than 312.5 kHz.
- Increases the resolution of the mathematics used in calculations of all signal results from 16 bits to 28 bits whenever span or measurement bandwidth is set to ≤312.5 kHz. This is made possible by the high levels of decimation applied to signals processed in these narrow bandwidths.

Minimize noise. This mode increases the system gain at points past the RF mixer. This has the effect of reducing the displayed average noise level.

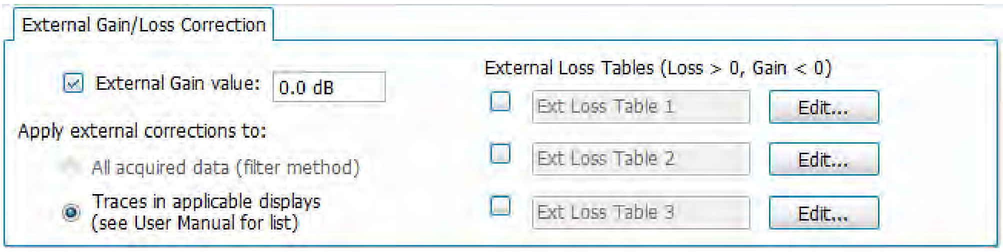
The table below summarizes the conditions.

Settings	RF auto attenuation (min 10 dB, max 55 dB)	Selected Acquisition Bandwidth	IF Gain/Loss settings	Notes and Trade-offs
Best for Multiple Displays	Ref Level +15 dB	Acquisition Bandwidth is set to the value required to service as many of the open displays as possible.	Neutral	Swept Speed, Dynamic Range, Noise Floor
Auto	Ref Level +15 dB	Driven by the measurement bandwidth of the selected display. If span is greater than the available acquisition BW, unit sweeps using 25 MHz acquisitions	Neutral	Swept Speed, Dynamic Range, Noise Floor may not be optimal
MinimizeSweep Time	Ref Level +15 dB	Unit uses widest available acquisition BW for spans greater than maximum acquisition BW.	Neutral	Instruments equipped with Option B40/B85/B16x, swept update rate is significantly faster than Auto. No effect in units without Option B40/B85/B16x.
MaximizeDynamic Range	Ref Level +20 dB	Driven by span and user-selected RBW when a spectrum-type display is selected, or by measurement bandwidth and filter bandwidth when other display types are selected. For RBW < 20 kHz, the high dynamic range 312.5 kHz path is used regardless of selected span or measurement bandwidth. Sweeps are made in 25 MHz acquisitions.	IF attenuation increased to improve dynamic range. This causes higher noise level.	Might result in very slow sweep speeds in wide spans when RBW < 20 kHz.
Minimize Noise	Ref Level +15 dB	Same as Auto	Set to minimize noise level.	Might result in earlier IF overload under some signal conditions.

Tip: See the *Advanced* topic for more information about preselector settings.

External Gain/Loss Correction Tab

The External Gain/Loss Correction tab allows you to apply a correction to a signal to compensate for the use of external equipment, such as an amplifier or attenuator. You can specify whether the corrections on this tab apply to all acquired data or only to a set group of displays. You can also apply external corrections to traces in the Spectrum, Spectrogram, Spurious, and Amplitude vs Time displays.



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 –80 to +50 dB. Resolution is 0.1 dB.

Note: Selecting Preset clears the check box, but it does not change the value.

Apply External Corrections To

Use the two selections to specify whether the enabled external loss tables are applied to all acquired *data* or only to *traces* in the Spectrum, Spectrogram, Spurious, and Amplitude vs Time displays.

When choosing whether to correct sample data or traces, keep the following in mind:

- If sample data is acquired while data correction is enabled, that data record is permanently corrected. If the acquisition is saved and recalled, the recalled acquisition includes corrections. Corrections are not saved separately from the raw data; they are used during the acquisition process to adjust the data values.
- Trace corrections can be applied at any time, as they are part of the measurement's computations. Using Replay will apply trace corrections to a trace if this control is enabled (and an external loss table is specified and enabled).
- Be aware that if you recall acquisition data that was saved with data corrections and you use Replay with trace corrections selected and an external loss table enabled, the trace will be calculated using corrected data and also corrected with trace corrections. This probably creates incorrect traces.
- When only Traces are being corrected, triggering operates on uncorrected acquisition data. Frequency masks and trigger level lines in the displays are also not corrected, so there is a visual discrepancy between data traces and trigger indicators in the graphs under this condition.
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Trace Corrections Versus Data Corrections. Because of the real-time nature of the instrument and desire to frequently reanalyze stored acquisitions, it is possible to apply amplitude corrections in real time. Applying real-time corrections to the incoming data means that, the correction factors present during the acquisition are already part of the data when the data is stored and then reanalyzed. This also allows the DPX display to maintain its update rate while presenting an amplitude-corrected display.

Real-time gain/loss factors are applied by creating a correction filter that is applied by the same digital signal processing hardware used to correct for calibration and alignment factors in the instrument. This process does have limitations. In creating a digital filter to represent the gain/loss table, a limited number of filter taps are be used in order for the filter to be practically realizable. If your amplitude corrections contain discontinuities or extremely sharp transitions, the filter used will contains errors and ringing.

If the above is the case, we recommended that you use trace corrections. These are very similar to a conventional spectrum analyzer, and may be applied to the spectrum, spectrogram, spurious search and amplitude vs. time displays. These traces may contain transitions of any type within the maximum and minimum correction values allowed in the tables.

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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.

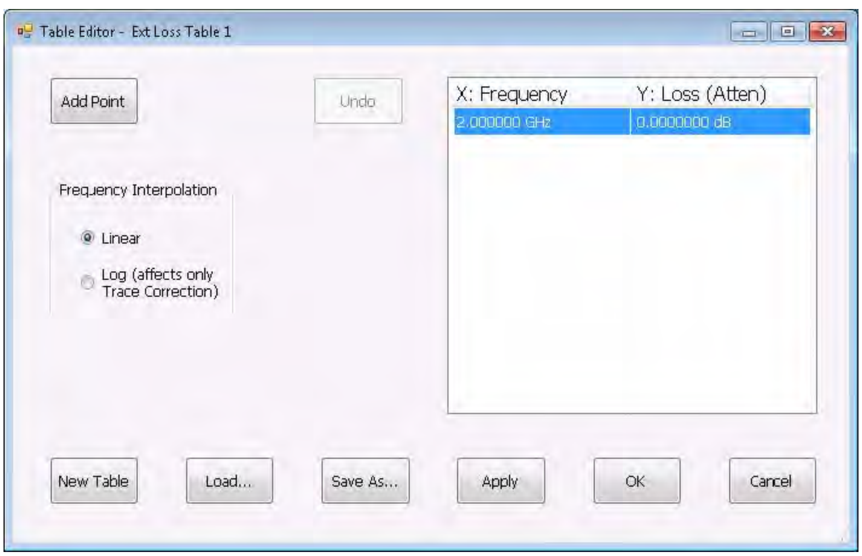
Note: If you are using an External Loss Table for antenna corrections, be sure to set the Amplitude units (Setup > Analysis > Units) to dBuA/m or dBuV/m.

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.



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.

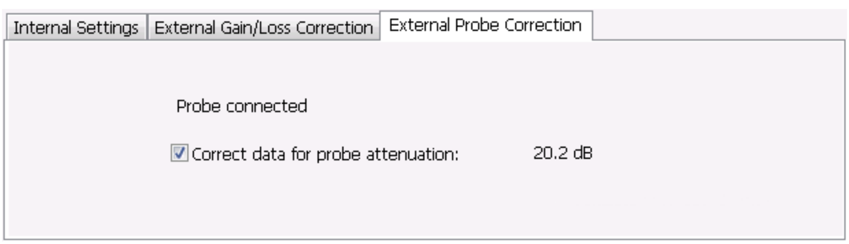
Loading an External Loss Table

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**.

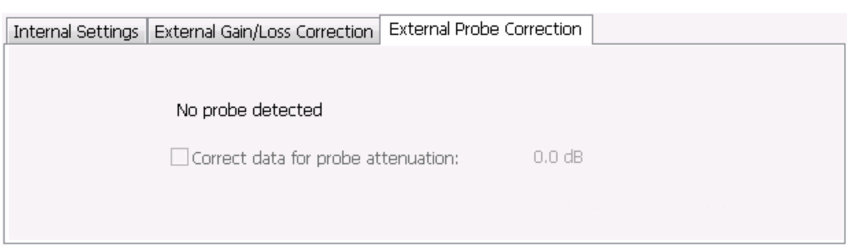
External probe correction tab

The External Probe Correction tab is used to specify whether a correction factor is applied to the signal when a Tektronix P7000 Series probe is connected to the analyzer through the Tektronix RTPA2A Real-Time Spectrum Analyzer TekConnect Probe Adapter.



The analyzer can detect when an RTPA2A TekConnect probe adapter is connected to the instrument. The only setting available on the tab specifies whether a correction is applied to the signal or not. The amount of correction is specific to the probe and is communicated to the signal analyzer through the RTPA2A TekConnect probe adapter.

If the signal analyzer does not detect a probe adapter, the setting to correct for a probe is dimmed and **No probe detected** is displayed on the tab.



Controlling the acquisition of data

Acquisition controls in the run menu

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

Application Bar / Front Panel: 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

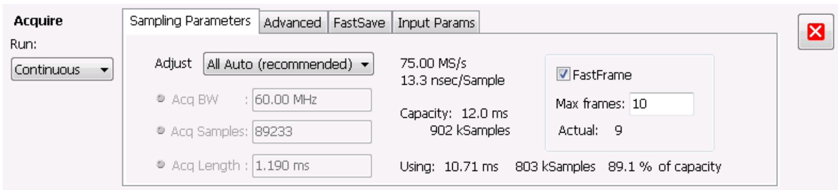
Selecting **Abort** immediately halts the current acquisition/measurement cycle. In-process measurements and acquisitions are not allowed to complete. Visibility and accuracy of results is unspecified after an abort.

Acquisition controls in the acquire control panel

The acquire control panel

Menu Bar: Setup > Acquire

Selecting **Acquire** displays the Acquire control panel. These settings control the hardware acquisition parameters for the signal analyzer. Normally, these parameters are automatically adjusted for selected measurements. You can use Acquire to change these parameters manually if necessary.



Tab	Description
Sampling Parameters	Sets the parameters that control the acquisition of the signal.
Advanced	Sets the Dither parameters.
FastSave	Sets the FastSave parameters. Initiates FastSave acquisitions.

Run

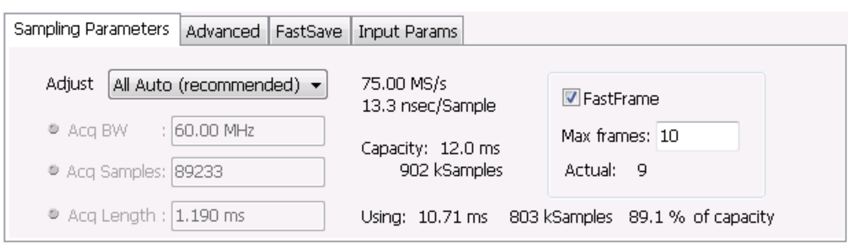
Run mode specifies whether the analyzer will stop acquiring data after it completes a measurement sequence.

- **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.

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 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

Table continued…

Adjust	User sets		Analyzer calculates
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

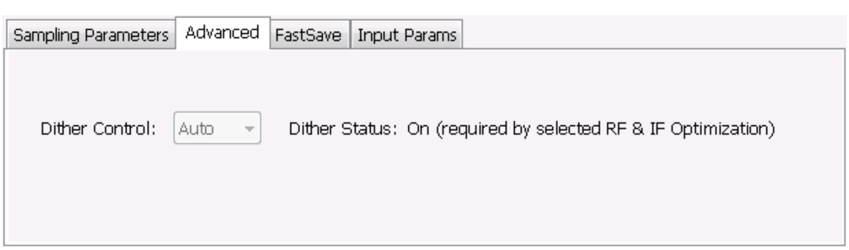
FastFrame is a feature that allows you to segment the acquisition record into a series of frames, or data records. A typical use of FastFrame is to record data samples around signal events of interest, while not wasting memory on irrelevant data between these events. FastFrame is only valid for real-time 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.



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.

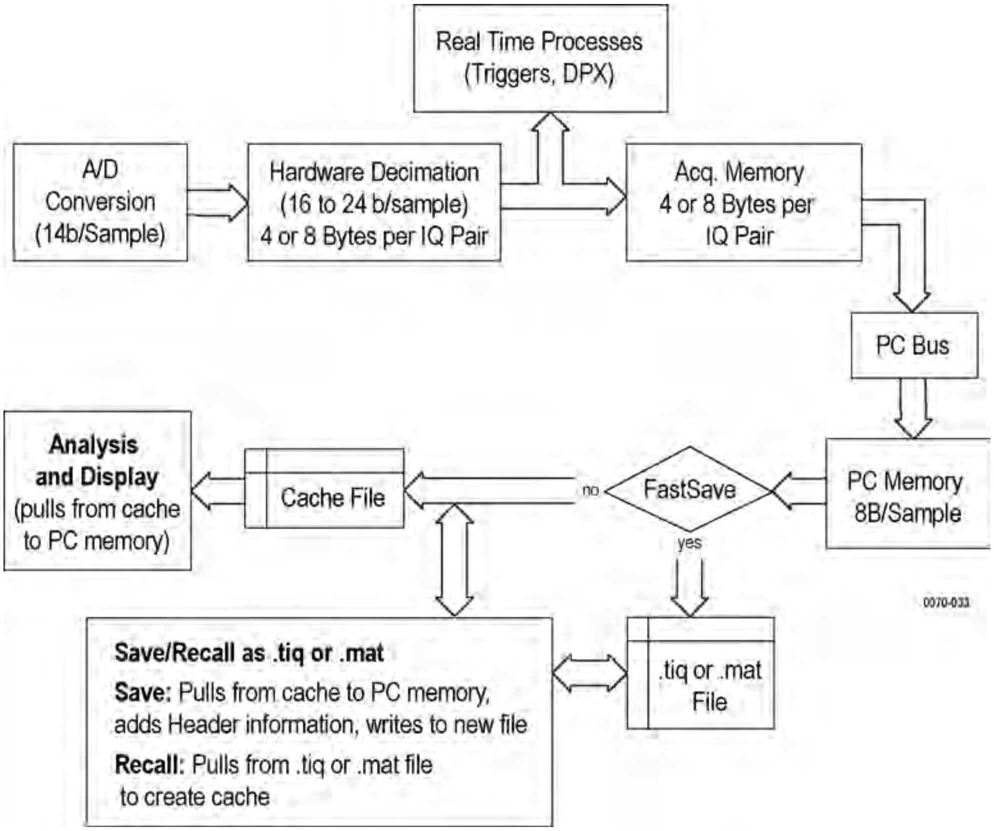
Note: If the *RF & IF Optimization* is set to Best for multiple displays, you cannot change the Dither setting.

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 on. It is doing its job to improve dynamic range. If it makes it worse, dither 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).

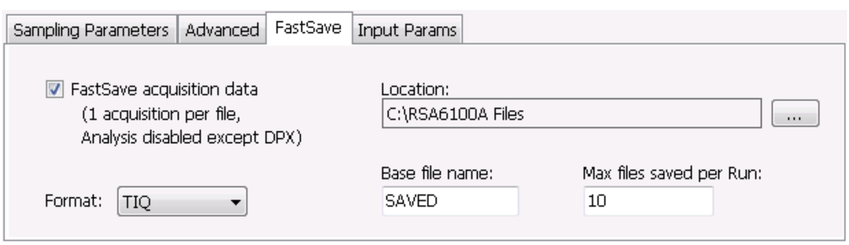
FastSave Status Messages

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* acquisitions.



Setting	Description
FastSave acquisition data	Enables/disables FastSave acquisitions. If acquisitions are running, selecting the FastSave acquisition data checkbox immediately begins saving acquisition data to files. If the instrument is paused, FastSave acquisitions will not begin until you select **Run**.
Format	Specifies the file format of the FastSave acquisition data files. Files can be saved in *TIQ* or *MAT* 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.

Table continued…

Setting	Description
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.

Using triggers to capture just what you want

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)* for details on configuring Save on trigger.

Trigger Front Panel Status Lights

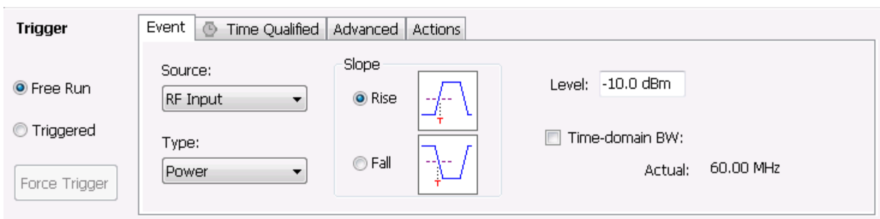
The analyzer has three lights on the front panel that indicate the Trigger status:

- 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).*

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*.

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 *Event Tab (Triggering)* and *Mask Editor*. 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)*.

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)*.

Frequency mask trigger

The frequency mask trigger monitors all changes in frequency occupancy within the capture bandwidth (40 MHz or 165 MHz).

The following topics describe the frequency mask trigger controls:

Event tab: explains how to configure frequency mask triggering parameters.

Mask Editor: explains how to create and edit frequency masks.

Triggering: 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**.

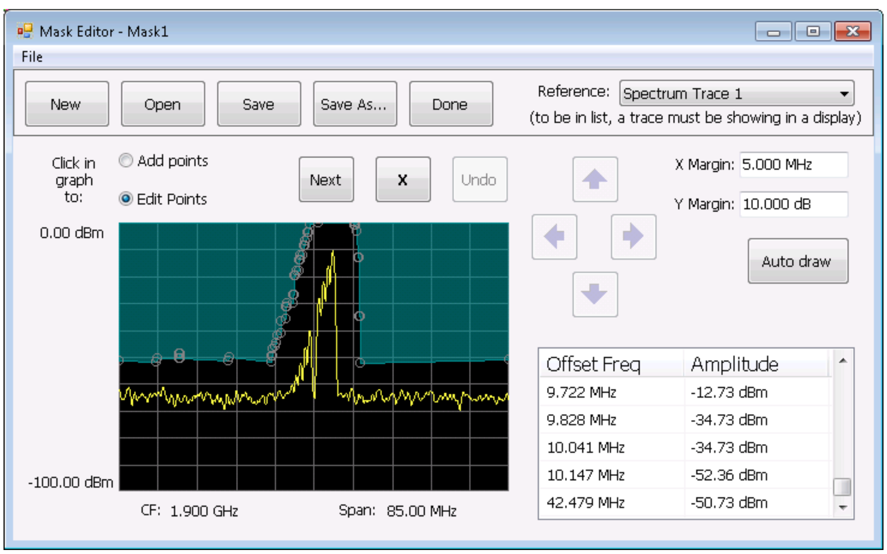
Creating a Mask

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.



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.

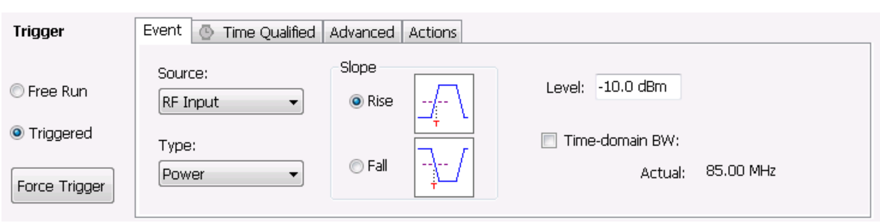
Trigger Tabs

Use the Trigger tabs to access controls for setting the different trigger parameters.

Tab	Description
Event	Sets parameters that control triggering on the selected trigger source.
Time Qualified	Sets values used to adjust time of acquisition with respect to time of trigger event.
Advanced	Sets controls for triggering in swept acquisitions.
Actions	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.



Source

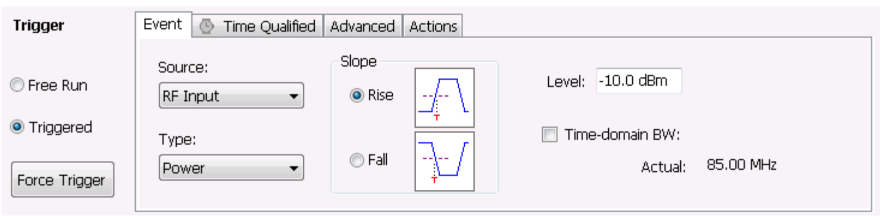
Source specifies the source of the signal to be monitored for a trigger event. The choices available are: RF Input, Trig In (front), Trig 2 In (rear), Gated, and Line. The Source drop-down list is always visible on the Event tab.

Type

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.



The following table describes the settings for each triggering type available when Source is set to RF Input. Type specifies whether a Power level, Frequency Edge violation, Frequency Mask violation, DPX Density threshold violation, or Runt signal will define a trigger event.

Table 42: Trigger types

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.

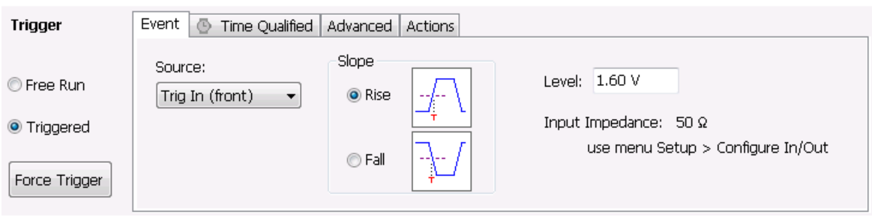
Table continued…

Event Type	Setting	Description
	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.
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.

Table continued…

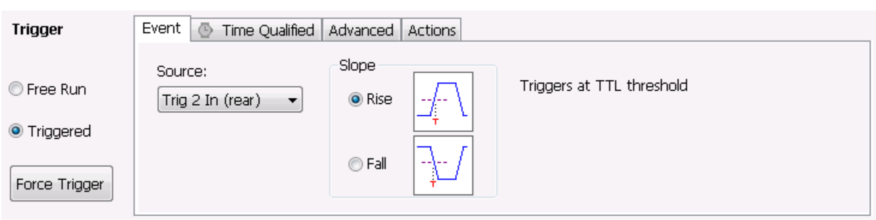
Event Type	Setting	Description
	Pulse	Specifies whether the runt trigger is defined by a positive-going pulse or a negative-going pulse.
	High level	The High level defines the upper voltage limit (first threshold) of a runt pulse.
	Low level	The Low level defines the lower voltage limit (second threshold) 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).



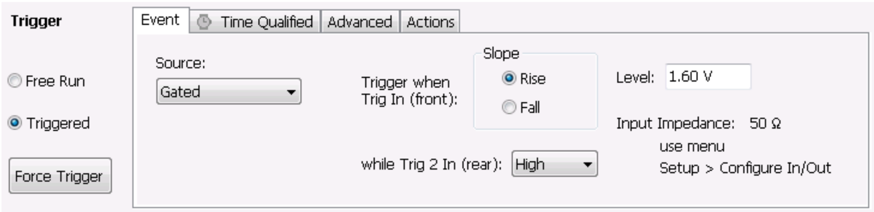
Setting	Description
Slope	The slope control determines whether the analyzer finds the trigger point on the rising or the falling edge of the trigger input signal.
Level	The Level setting determines the signal amplitude that will be recognized as a trigger event.

Source = Trig 2 In (rear).



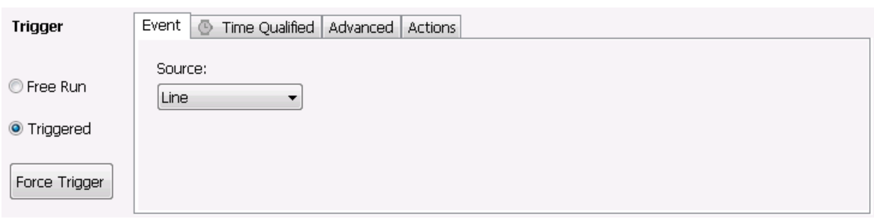
Setting	Description
Slope	The slope control determines whether the analyzer finds the trigger point on the rising or the falling edge of the trigger input signal. The trigger level is automatically set at a TTL level.

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.



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.



The analyzer triggers off of the AC line supply.

Source = RF Input and Type = Frequency Edge.

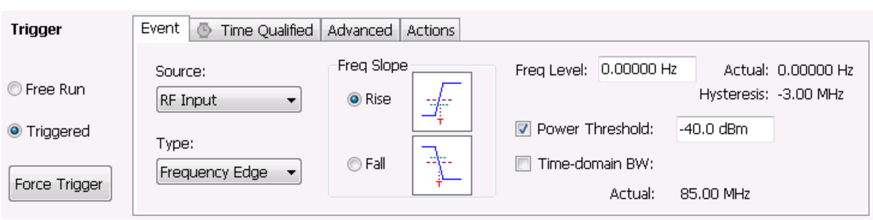


Table 43:

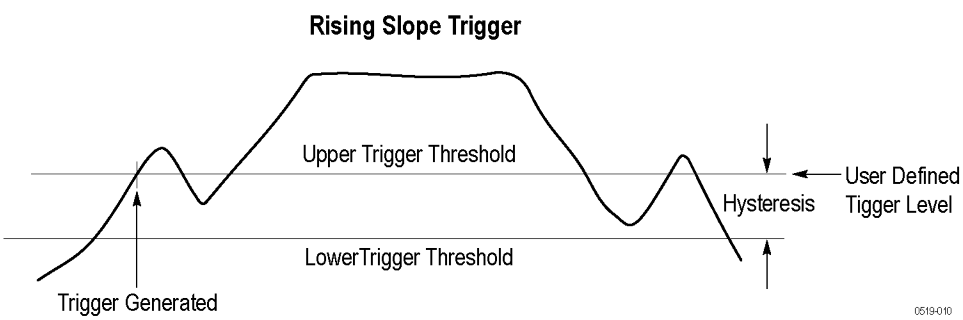
Setting	Description
Freq Slope	The slope control sets whether the analyzer triggers on the rising (increasing) or the falling (decreasing) edge. This setting is analogous to the Slope control on the Power trigger type.
Freq Level	The Freq Level setting specifies the difference in frequency between the 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. For example, if your analyzer has an 85 MHz real-time bandwidth, the Freq Level is limited to ±42.5 MHz. If your analyzer has a 25 MHz real-time bandwidth, the Freq Level is limited to ±12.5 MHz.

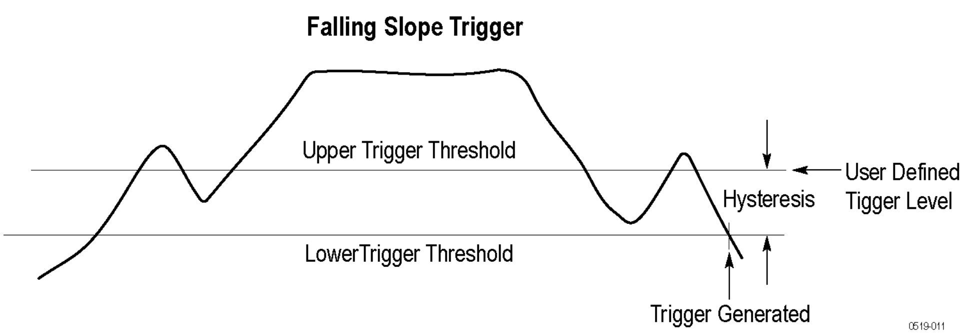
Table continued…

Setting	Description
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

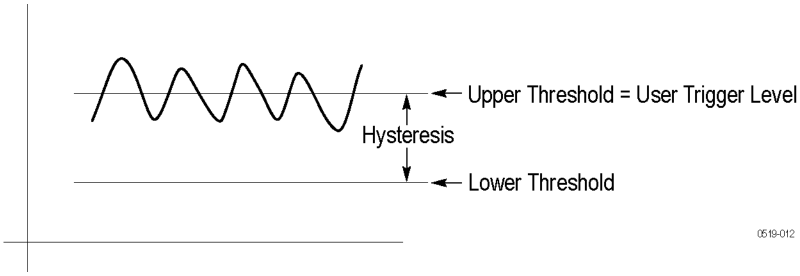
The following figures show how the Freq Slope setting affects the trigger.



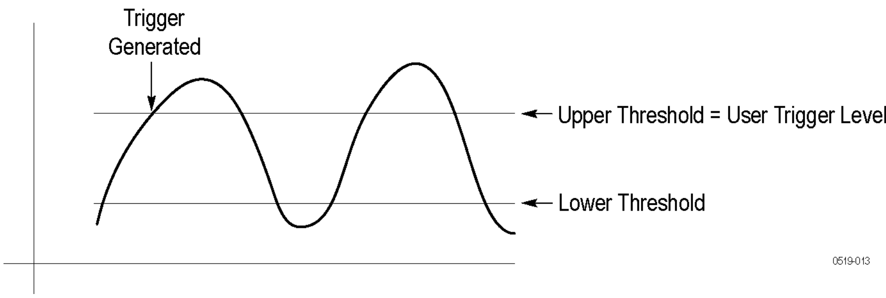


Hysteresis

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

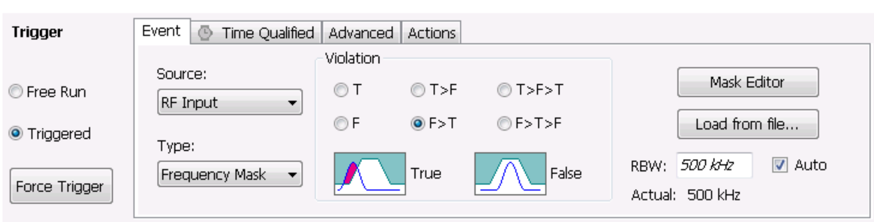
This amounts to 0.2 divisions if the full range is set to 10 divisions.

- If Time-domain BW is not enabled and the ACQ BW is 165 MHz, the full range is 165 MHz, so the hysteresis is 2.2 MHz
- 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.



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.

Table continued…

Setting	Description
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
T	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 (In)	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.

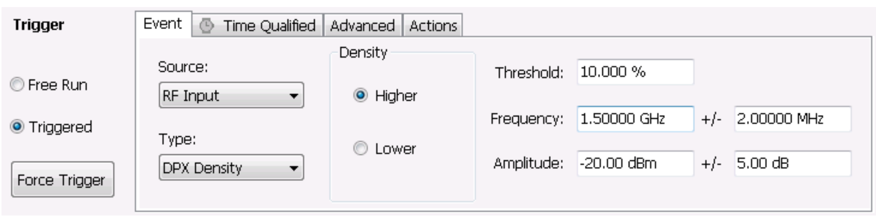
Table continued…

Violation	Description
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 *Mask Editor* that enables you to create and edit Frequency Masks.

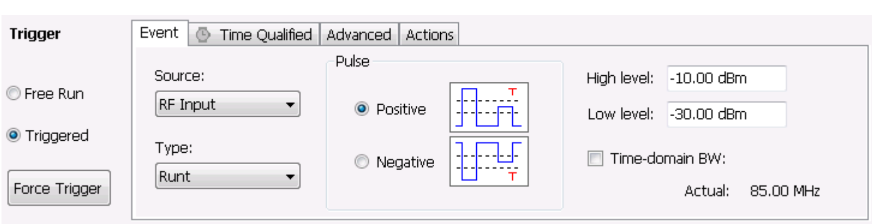
Load from File. Enables you to load an existing frequency mask for use with Frequency Mask Trigger.

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.



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.

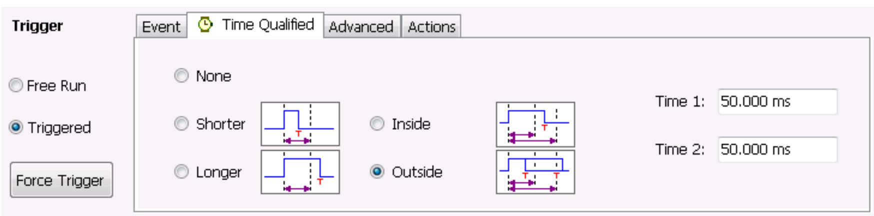
Source = RF Input and Type = Runt. Runt triggering defines a trigger event based on whether or not a signal transition fails to cross a user-defined level. Two levels are defined for Runt triggering. A Runt signal is one that passes through both levels in one cycle but only passes through one level on the next cycle.



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.

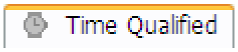
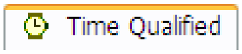
Time qualified tab

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.



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
	When None is selected on the Time Qualified tab, the watch icon is dimmed.
	When any selection other than None is selected on the Time Qualified tab, the watch icon appears in color.

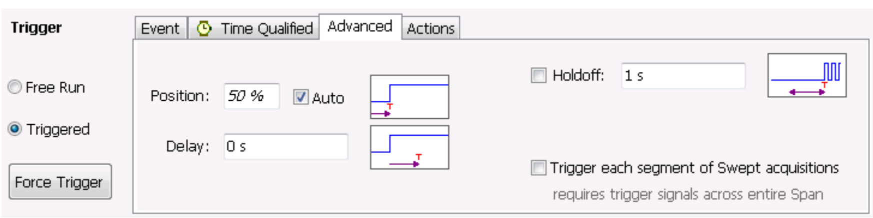
Minimum off time between trigger events. This readout shows how long the trigger conditions must be absent between the end of one trigger event and the start of the next trigger event to be ensure that the end of the first event is recognized. For example, if Freq Mask is selected and its RBW causes a minimum off time of 500 µs, and your signal violates the mask for 600 µs of every 1 ms, (so that the OFF time is 400 µs), 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.



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* and *Time Qualified* tabs.

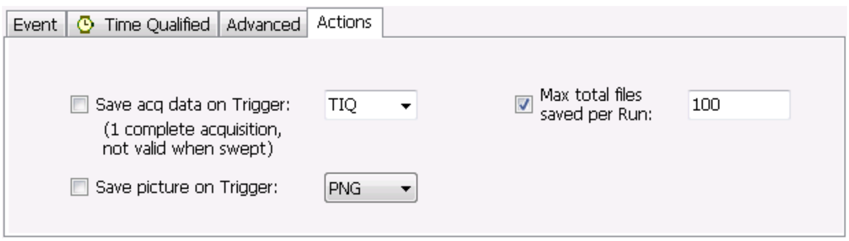


Table 44: Action tab settings

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 *Data, Settings and Picture File Formats*. 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 *Save and Export*), 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*.
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.

Signal Database and Channel Navigation

How to use the Signal Database

Select **Tools** > **Signal Database** to open the Signal Database window. Here you can select which signal standards and types are listed (and selectable) in the Channel Navigation toolbar and/or the Define Survey control panel.

Signal standards and signal types defined

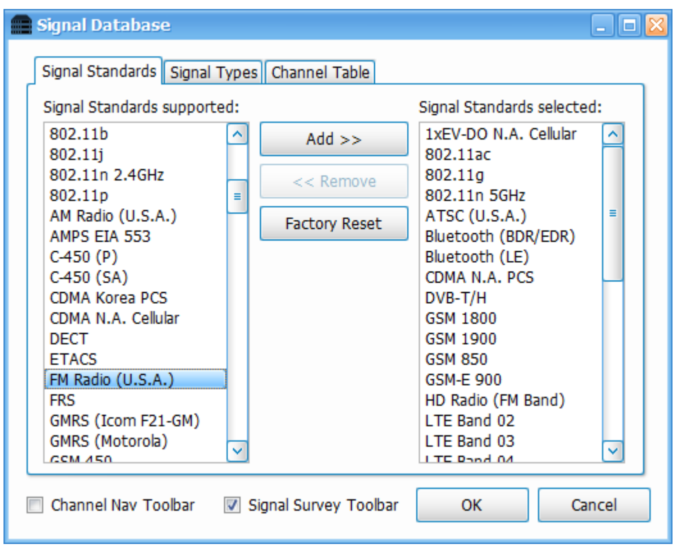
The analyzer uses the following definitions of signal standards and signal types to populate the Signal Database.

- **Signal standard**: A group of channels that adheres to the parameters and characteristics of a given signal type. These channels could include both uplink and downlink frequencies.

- **Signal type**: Parameters and characteristics (bandwidth, spectral shape) common to a given signal. A signal type can be shared by multiple signal standards.

How to select signal standards in the database window

The following image is of the Signal Database window with the Signal Standards tab selected. The table describes the fields and buttons of the tab. The standards selected here show in the Define Survey control panel and the *Channel Navigation* toolbar.



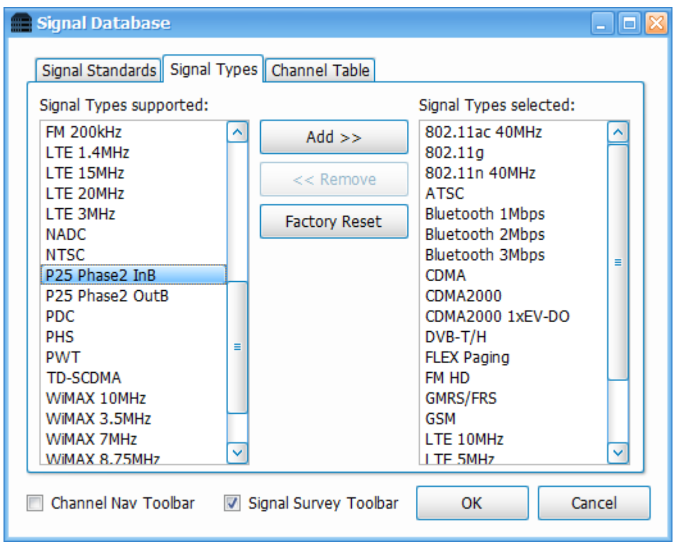
Setting	Description
Signal Standards Supported	List of all available signal standards. Click a standard to select it or click and drag to select a contiguous range of standards.
Add > >	Adds (moves) selected items from the **Signal Standards Supported** list to the **Signal Standards selected** list.
< < Delete	Deletes (moves) selected items from the **Signal Standards selected** list to the **Signal Standards Supported** list.

Table continued…

Setting	Description
Signal Standards selected	List of selected signal standards that will be made available in the Channel Navigation toolbar and the Region tab of Define Survey control panel. To delete items, select one or more signal standards and click the **Delete** button.
Factory Reset	Sets the supported and selected fields to the factory-specified signal standards.
Channel Nav Toolbar check box	Check box to open the Channel Navigation toolbar. The Signal Database window stays open. You can read more about the Channel Navigation toolbar *here*.
Signal Survey Toolbar check box	Check box to open the Signal Survey toolbar. The Signal Database window stays open. You can read more about the Signal Survey toolbar *here*.

How to select signal types in the database window

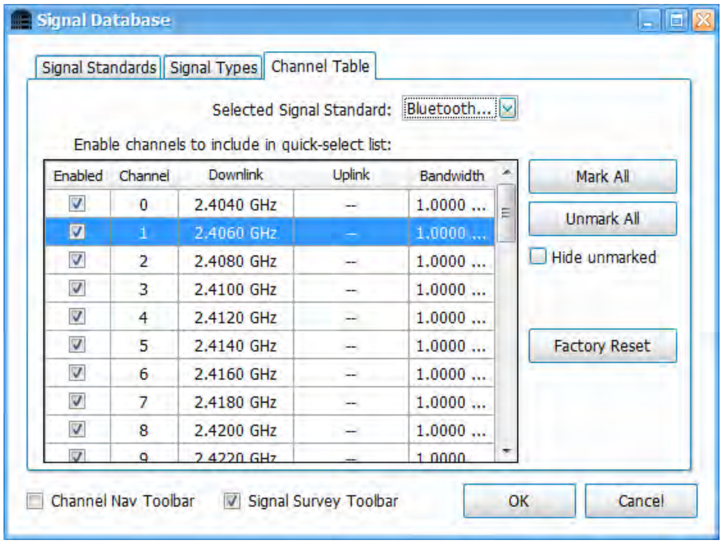
The following image is of the Signal Database window with the Signal Types tab selected. The table describes the fields and buttons of the tab. The types selected here show in the Define Survey control panel.



Item	Description
Signal Types supported	List of all available signal types. Click a type to select it or click and drag to select a contiguous range of types.
Add > >	Adds (moves) selected items from the **Signal Types Supported** list to the **Signal Types selected** list.
< < Delete	Deletes (moves) selected items from the **Signal Types selected** list to the **Signal Types Supported** list.
Signal Types selected	List of selected signal types made available in the Region tab of the Define Survey control panel. To delete items, select one or more signal types and tap the Delete button.
Factory Reset	Sets the supported and selected fields to the factory-specified signal types.
Channel Nav Toolbar check box	Check box to open the Channel Navigation toolbar. The Signal Database window stays open. You can read more about the Channel Navigation toolbar *here*..
Signal Survey Toolbar check box	Check box to open the Signal Survey toolbar. The Signal Database window stays open. You can read more about the Signal Survey toolbar *here*..

How to select channels in the database window

The following image is of the Signal Database window with the Channel Table tab selected. The table describes the fields and buttons of the tab. The channels selected here are included in the Signal Channel Selection window. (See the *Channel Navigation toolbar* on page 684 section for information about channel selection.)



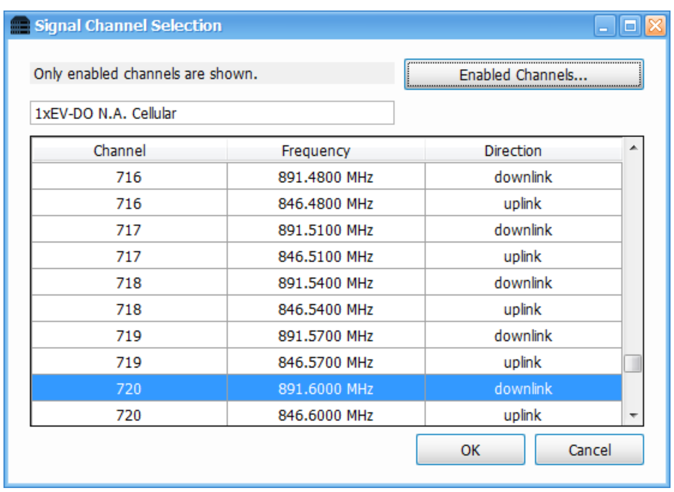
Item	Description
Selected Signal Standard	Drop down list allows you to select the signal standard, the channels of which will populate the channel table. This list is taken from the enabled standards in the Signal Standards tab.
Enabled column checkboxes	Enables/disables the channel in the row.
Mark All	Selects all channels in the table to enable them.
Unmark All	Deselects all channels in the table to disable them.
Hide unmarked checkbox	Hides any deselected channels so that you can view only the enabled channels in the table.
Factory Reset	Sets each channel to the factory-specified enabled/disabled state.
Channel Nav Toolbar checkbox	Check box to open the Channel Navigation toolbar. The Signal Database window stays open. You can read more about the Channel Navigation toolbar *here.*.
Signal Survey Toolbar checkbox	Check box to open the Signal Survey toolbar. The Signal Database window stays open. You can read more about the Signal Survey toolbar *here.*.

Channel Navigation toolbar

Select **View** > **Chan Nav Toolbar** to view the Channel Navigation toolbar. This toolbar allows you to navigate easily from channel to channel in any measurement display. It provides the following capabilities:

- Select a channel for enabled standards (only standards selected in the Signal Database).
- Select the channel direction, if applicable (uplink or downlink).
- Access the Signal Channel Selection window, which allows you to select from a list of enabled channels.

The following image shows the toolbar and the following table describes how it functions.

Item	Description
Signal Standard	Drop down list allows you to select the signal standard, the channels of which will populate the Channel field to the right . This list is taken from the enabled standards in the Signal Standards tab of the Signal Database.
Channel	This field shows the channel number of the currently selected signal standard that the instrument is currently tuned to. An entry of "--" indicates that the current instrument frequency does not match that of any of the currently enabled channels. Clicking in this field allows for direct channel number entry. To select the next or previous channel, you can use the up and down arrow keys on your keyboard or the arrows in the Numeric Keypad (in the View menu, check the Numeric Keypad box). Note that this applies to enabled channels only. If you see a ≈ in front of the channel number, it means that the current instrument frequency is close to, but not exactly equal to, the currently selected channel. It means that the current instrument frequency does not exactly match the currently selected channel frequency, but that it is within the current channel bandwidth. You cannot directly enter or use the arrow keys to select non-numeric channel names for signal standards You must use the **Select Channel** button.
Select Channel	Opens the Signal Channel Selection window. This window shows a table of enabled channels for the selected standard. Click on the channel you want to view in the plot and then click the OK button. This window also allows you to access the Signal Database window (using the Enabled Channels button) so that you can enable different channels or change standards or types, if desired. 
Uplink	Click to select the uplink channels for the currently selected signal standard.
Downlink	Click to select the downlink channels for the currently selected signal standard.

See also:

How to use the Signal Database on page 682

Signal Classification

Overview

With the SV54 optional application license for SignalVu-PC installed, you can use the signal classification toolset to help you classify signals. You will first define areas of interest as regions anywhere on a Spectrum or DPX waveform. You can then use our Signal Database tool to compare the spectral shape of the selected signal area to known signal types, and the center frequency of the selected signal area to known signal standard channels. Finally, you can assign classification labels to regions, record related notes, and save all defined regions to a region survey file. This toolset also allows you to import and export survey files. The following information and procedures are available to help you find, navigate through, and use the signal classification tools to classify a signal.

- *Step by step procedures for classifying a signal.* These procedures walk you through the classification process from start to finish using the analyzer's signal classification tools. Examples are included.
- *How to use the Signal Survey toolbar.* Once launched, this toolbar allows you to access the Create/Edit, Define, and Classify tools. These tools allow you to create a new survey/region, import and export surveys, define region signal standards and types, navigate quickly through regions in a survey, and classify a signal in a region.
- *Signal Survey toolbar* on page 694*How to use the Signal Survey Editor window.* This window is accessed through a Signal Survey toolbar button. It allows you to create and edit regions or import or export a survey.
- *How to use the Define Survey control panel.* This panel is accessed through a Signal Survey toolbar button. It allows you to select signal standards and types from the Standards Database; see bandwidth, frequency, and channel information; view all regions and related information in a survey in a table; and select and view a spectral profile (most signal types have an available profile).

How to classify a signal

The following procedure shows you how to use the signal classification tools to classify a signal. It is divided into four main tasks.

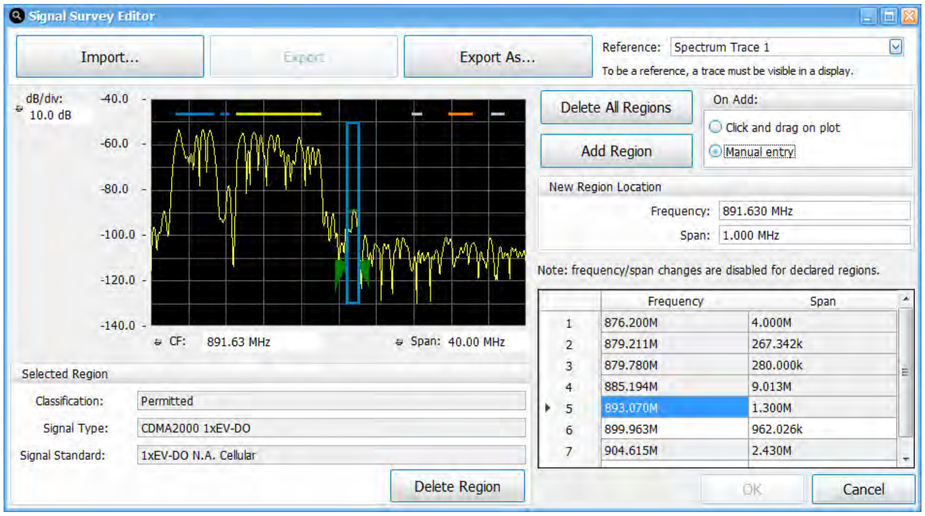
⚠ **Note:** Before you proceed, you will need to select a list of enabled signal standards, signal types, and channels in the *Signal Database*. You do not need to perform this setup each time you classify a signal. Once set up, this list does not change unless you reset to default or change the selections.

1. *Create* areas of interest as regions (center frequency and frequency span) anywhere on the signal.
2. *Define* a survey (a region or collection of regions) by comparing the bandwidth of the unknown signal to that of known signal types, and the center frequency of the unknown signal to that of known signal standard channel frequencies.
3. *Classify* the signal by assigning classification labels and notes to a defined region.
4. *Export or import* a region survey file.

Create a region

The first step in classifying a signal is to create a region that defines the portion of the signal you want to use.

1. Open a Spectrum or DPX display to view the signal you want to classify.
2. Select **View** from the analyzer menu bar and select (check) **Signal Survey Toolbar**. The toolbar will appear near the bottom of the screen.
3. Click the **Create/Edit...** button in the Signal Survey tool bar to open the Signal Survey Editor window.



4. Check that the selected reference trace is correct in the Reference dropdown list which is located to the right of the **Export As...** button. Note that for a trace to be in the list, it must be enabled in the Spectrum or DPX display.
5. Click the **Add Region** button.
6. By default, **Click and drag on plot** is selected for the add region method. Click and drag on the plot around the signal area of interest to define the width (span) of the region. The analyzer will draw a box on the plot that is outlined in gray, indicating that the region is as yet undefined. Click on the

   icon at the bottom of the region to change the CF. You can also click and drag on the left or right edge of the region rectangle to change its span. The amplitude of the signal does not need to be totally enclosed in the region box.
7. If you want to manually enter the center frequency and span parameters to create a region, select **Manual entry**, enter the values in the New Region Location fields, and then click the **Add Region** button.
8. Create more than one region, if needed.

   Note: A maximum of two regions can overlap at any given frequency. If you try to create a new region that contains any frequency point that is already shared by two other regions, an error message is displayed stating that too many regions overlap.
9. If you want to edit a region, then you can use the same tools as when you first created the region (click, drag,

). If you want to delete a region, select the desired region and then click the **Delete Region** button. You can also click **Delete All Regions** to delete all regions in the display.

   When Manual entry is selected in the On Add area, you can manually edit the Frequency and Span.
10. Click the **OK** button when you are finished creating and editing regions. Clicking the **Cancel** button will result in all additions/changes made during the current edit session (as long as the Signal Survey Editor dialog has been open) being discarded.

See also:

How to use the Signal Survey Editor window.

How to use the Signal Survey toolbar.

How to use the Define Survey control panel.

What region color codes mean.

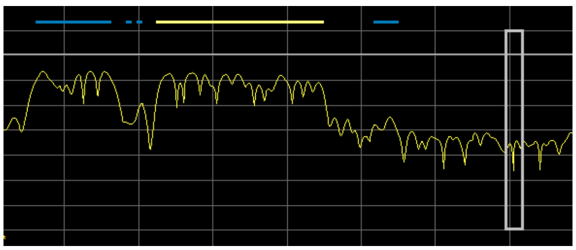
How to use the Signal Database on page 682

Define a region using known standards

The next step after creating a region is to define it by comparing the unknown signal's bandwidth and frequency to the known signal standards and signal types. Doing this allows you to potentially find a match and classify the unknown signal. You can also use known signal standard channel frequencies to match against a region's center frequency.

Note: You can also define a region using a known signal standard channel frequency and match it against the center frequency of a region.

1. Click the **Define** button to open the Define Survey panel.
2. Do one of the following to select a region:
   - Click on a region (shown as a horizontal bar along the top edge of the plot) in the Spectrum or DPX display. When selected, the region will expand to a rectangular box around the signal.



   - Click on a row in the Survey Summary tab table of the Define Survey panel. This table is scrollable and contains summary information about all of the regions in the current display (called a survey). Clicking on a row in the table selects the region in the display. Information in the rows is not editable.

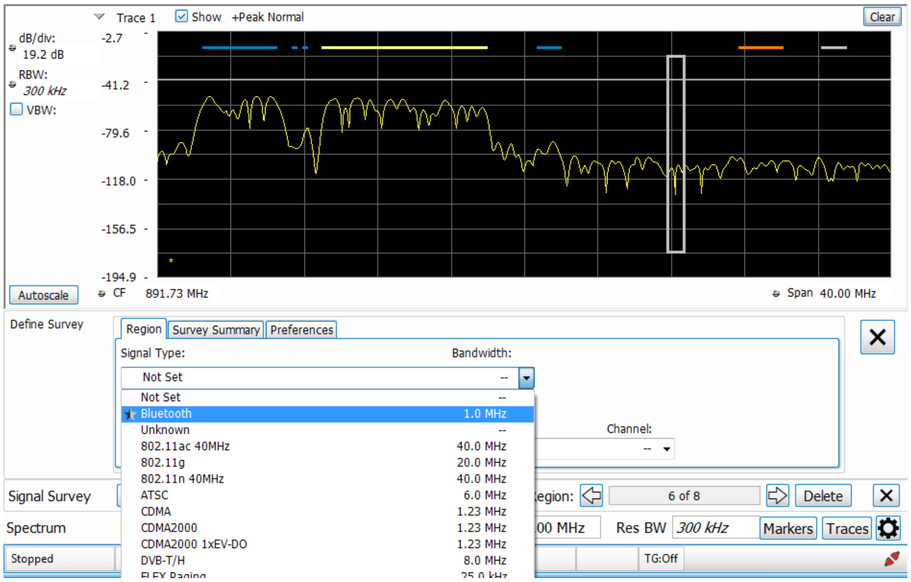
Region | Survey Summary | Preferences

	Frequency	Span	Classification	Type	Standard
5	893.07038 MHz	1.3 MHz	None	CDMA2000 1xEV-DO	1xEV-DO N.A. Cellular
6	899.963038 MHz	962.026 kHz	None	Bluetooth 1Mbps	Bluetooth (LE)
7	904.614684 MHz	2.43038 MHz	Unauthorized	Not Set	Not Set
8	908.583544 MHz	1.392404 MHz	None	Not Set	Not Set

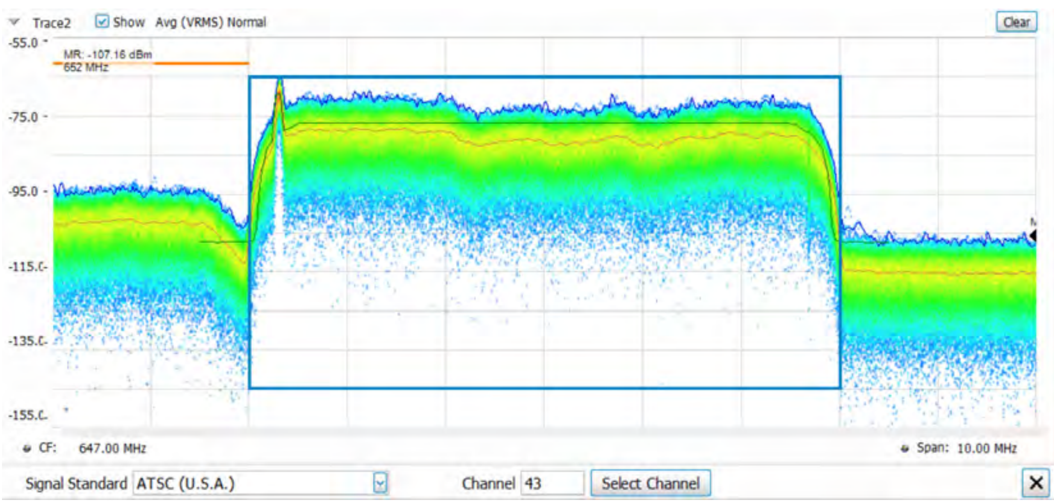
   - Use the left or right arrows on the Signal Survey toolbar to navigate to the desired region. Notice that this will highlight the row number in the Survey Summary tab table of the associated region, and thus select the region in the display.

Note: Only one region can be active at a time. Inactive regions are shown as horizontal bars along the top edge of the signal. An active region is shown as a box drawn around the signal.

3. In the Define Signal panel, select the Region tab and click to view the drop-down list under the Signal Type Bandwidth. In the below image, you can see that in the list, the Bluetooth signal type has a star next to it. The degree and darkness of the shading of a star indicates how close of a bandwidth match the given signal type is to the unknown signal. (You can read about how the star indicator works in *The Define Survey control panel* topic.)



4. You now want to select from this list of known signal types and associated bandwidths. Once selected, a spectral profile (shown as a green waveform in the example image) will be overlaid on the portion of the signal in the region. The spectral profile is used to compare against the signal in the region. If the profile and the signal match, then there is a good chance the signal is that given signal type.



Note: Most, but not all, signal database signal types have spectral profiles.

5. Click on the Prefs tab in the Define Survey panel to set the spectral profile to do one of the following:
   - **Snap to Channel Frequency**: Use this option if you want to verify the frequency of the signal is aligned with the selected signal standard channel frequency. If the selected signal standard channel frequency is within the selected region, then the spectral profile will center on that channel frequency. If the channel frequency is outside of the selected region, then the spectral profile will revert to being centered within the region.
   - **Snap to Center of Region**: Use this option if you know that the frequency you are viewing has no defined signal standard channels in the database.
   - **Off**: Use this option if you want to view the signal in the region without the spectral profile overlayed on the signal.

See also:

The Signal Survey Editor on page 694

How to use the Signal Survey toolbar

How to use the Define Survey control panel.

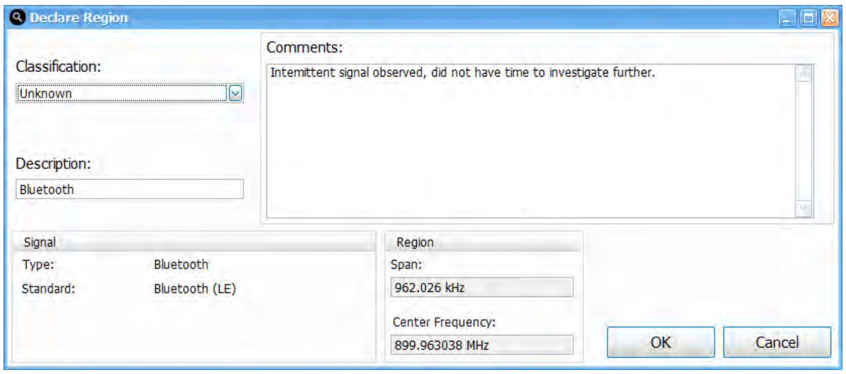
What region color codes mean

Signal Database

Classify a region

After you have created a region, you can classify it by assigning classification labels and notes to it.

1. Select a region.
2. Click the **Classify** button in the Signal Survey toolbar to view the Declare Region window.



3. Select a Classification state from the drop-down list and enter a Description and Comments for the region.

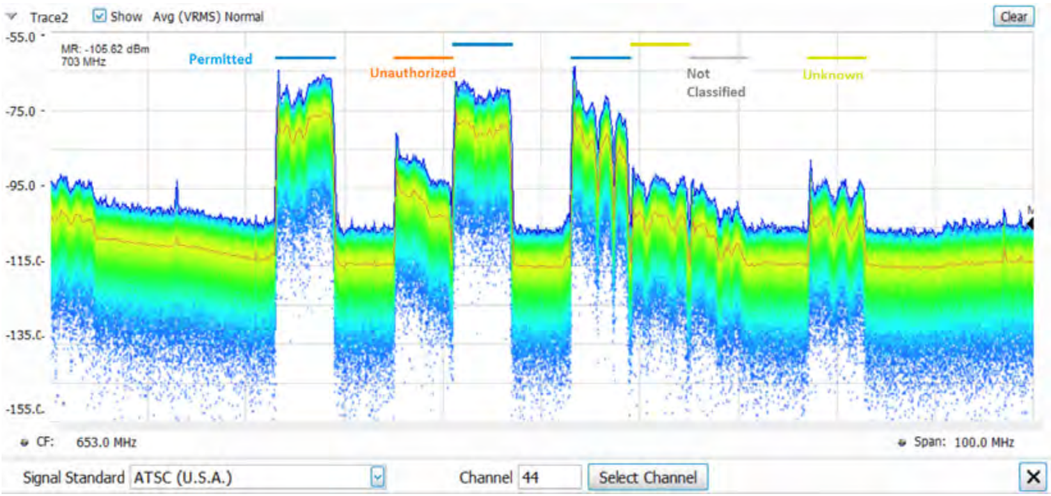
   Classification state and region color coding.

   Each region's outline is colored according to it's classification state:

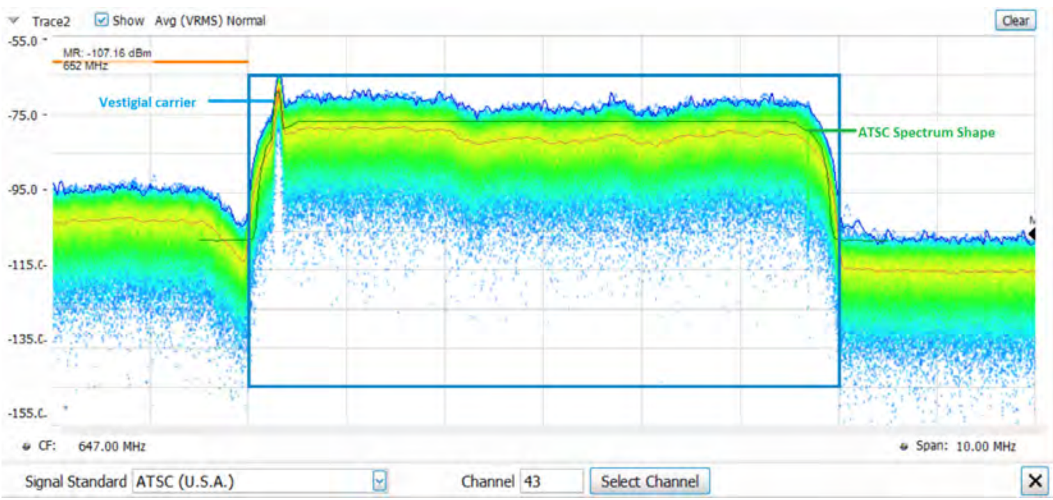
   - Gray = None
   - Yellow = Unknown
   - Orange = Unauthorized
   - Blue = Permitted

4. Click **OK** to save the classification information as a survey and close the window. Once a region has been classified, the signal type and signal standard used for classification are locked. To apply different signal types and standards to the region, set the classification to **None**.

The following example survey is of a portion of the TV broadcast band. Seven regions have been declared as either Permitted, Unknown, or Unauthorized, as indicated by the color bars for each region.



The illustration below shows a detailed portion of one of the declared regions. Since we have declared this to be an ATSC video signal, the spectral profile for the ATSC signal is shown overlaid in the region. The signal is a close match to the spectral profile, including the vestigial carrier at the lower side of the signal, characteristic of ATSC broadcasts.



See also:

How to use the Signal Survey Editor window

Signal Survey toolbar on page 694

The Define Survey control panel on page 695

How to use the Declare Region window

Signal Database

Export or import a survey file

The application does not enforce a hard limit on the total number of regions you can create. However, as the number or regions increase, system performance decreases. A good rule of thumb is to keep the total number of regions under 500. If more than that are required, create and save separate surveys, each with no more than 500 regions.

Export a file. To export a region or set of regions in a file, do the following:

1. Click the **Create/Edit...** button in the Signal Survey toolbar to open the Signal Survey Editor window.
2. Click the **Export As...** button in the Signal Survey Editor window.

3. Navigate to the location you want to save the file.
4. From the Save as type drop down list in the Save As window, select one of the following:
   - *.Survey – survey in an internal format
   - *.txt – survey in a tab separated format
   - *.csv – survey in a comma separated format
5. Enter the file name and click **Save** to save the file.

Survey Import/Export file format notes.

- All lines starting with a "#" character are treated as a comment line.
- All blank lines are ignored.
- Lines starting with "Signal Classification: Number of Regions" are ignored (in order to be compatible with H500/SA2500 survey import/export files).
- The only required fields are the region center frequency and region bandwidth all other fields can be left blank.

Survey file field definitions. You can create your own .txt and .csv Survey files using software applications such as Excel or Notepad, and then import them. The following information will help you do this. You can also refer to the *SurveyImportFileExample.txt* sample import/export file installed with SignalVu-PC in the *C:\SignalVu-PC SignalVuRSA5100BFiles\Example Files\SignalClassification* directory.

- **#** - Region number. Note that the value specified is not used during import (regions are renumbered as necessary)
- **Freq (Hz)** - Center frequency of the region
- **Span (Hz)** - Bandwidth of the region
- **Description** - Short description of the region
- **Classification** - Declared region classification (None, Unknown, Permitted, or Unauthorized)
- **Type** - Declared region signal type ("Not Set", "Unknown" or any currently defined signal type name)
- **Standard** - Declared region signal standard ("Not Set", "Unknown" or any currently defined signal standard name)
- **Channel** - Declared region channel number (channel number from the specified signal standard; "----" can be used to denote no channel number specified)
- **Ch Freq (Hz)** - Declared region channel frequency (for the specified channel number; "----" can be used to denote no channel frequency specified)
- **Comments** - Declared region comments

Import a file. To import a region or survey file, do the following:

Note: If a problem is found with the format of the file being imported, a dialog will be displayed indicating the file line number where the problem was found and a short description of the problem. For example, “Survey Import failed: Syntax Error near line 10: Invalid span value”.

1. Click the **Create/Edit...** button in the Signal Survey toolbar to open the Signal Survey Editor window.
2. Click the **Import...** button in the Signal Survey Editor window.
3. Navigate to the location of the saved file and select to import one of the following file types:
   - *.Survey – survey in an internal format
   - *.txt – survey in a tab separated format
   - *.csv – survey in a comma separated format
4. Click **Open** to open the selected file.

Importing guidelines. If you try to import a survey when regions are already defined, an Import Regions dialog will appear and prompt you to select one of the following import options:

1. Delete all existing regions prior to import.
2. Attempt to merge the imported regions with the existing regions.

3. Cancel the import.

If an import and merge action does not successfully merge all regions, the "Warning: not all regions were successfully merged" message will be displayed in the informational area of the Signal Survey Editor dialog.

Signal Survey toolbar

Select **View** > **Signal Survey Toolbar** to view the Signal Survey toolbar. It allows you to create, edit, define, and classify a signal. It also allows you to navigate from one region to another in the DPX or Spectrum display and to delete the selected region. This topic describes the toolbar and all of its related windows and functions.

Item	Description
Create/Edit...	Opens the *Signal Survey Editor window* that allows you to create and edit regions and import and export region survey files.
Define	Opens the *Define Survey* control panel. This panel allows you to view a survey summary, select how to view spectral profiles, and to specify a signal type and signal standard channel for each region.
Classify	Opens the *The Declare Region window (classify)* that allows you to classify a region.
Selected Region	Click the arrows to navigate from region to region.
Delete	Click to delete a selected region.

The Signal Survey Editor

Click the **Create/Edit...** button on the Signal Survey toolbar to access the Signal Survey Editor window. Following is an image of the window and a table describing it.

⚠ **Note:** If you change which waveforms are enabled in the DPX or Spectrum display after the Signal Survey Editor window is open, the Reference list in the Editor will no longer be accurate. You must close and then reopen the Editor to refresh the list.

Item	Description
Import	Click this button to import a survey from a file.
Export	Click this button to save changes made to a previously saved survey file. This button is only available for previously saved surveys. This function is like the common Save function.
Export As...	Click this button to export all of the region information to a survey file. This function is like the common Save As function.
Reference	This drop down list shows all active traces from the currently displayed Spectrum and/or DPX measurement displays. When you first open the Editor, the displayed reference trace will be the trace in the currently selected Spectrum or DPX measurement display.
Delete All Regions	Click this button to delete all regions on the plot.
Add Region	Click the Add Region button to enable the plot to allow you to add a region by clicking and dragging or entering the values manually, depending on the selected On Add setting.
On Add:	Select to add a region manually or by clicking and dragging on the plot.
New Region Location	When Manual entry is selected in the On Add area, the New Region Location area appears. Here you can manually enter the Frequency and Span.
Status message area	Shows informational and error messages.

Table continued…

Item	Description
Region table	Shows regions and the related frequency and span. These are editable in the table for regions that have not yet been classified.
Measurement display	Interactive view of the active measurement plot (DPX or Spectrum). You can click and drag on the plot to create a region and left-click in the display area to select the current click/drag mode. Allowable modes are Select, Span Zoom, and CF Pan. You can also adjust the area of the signal within the region using the following:
dB/div	Shows the dB per division on the y-axis of the plot.
CF	Shows the current region center frequency. Click on the field to enter a new value.
Span	Shows the current region span. Click on the field to enter a new value.
Classification	Shows the classification label of the selected region: Unknown, Unauthorized, or Permitted. If it has not been classified, this field reads None.
Signal Type	Shows the signal type of the selected region, if the signal in the region has been classified. If it has not been classified, this field reads Not Set.
Signal Standard	Shows the signal standard of the selected region, if the signal in the region has been classified. If it has not been classified, this field reads Not Set.
Delete Region	Click this button to delete the selected region.

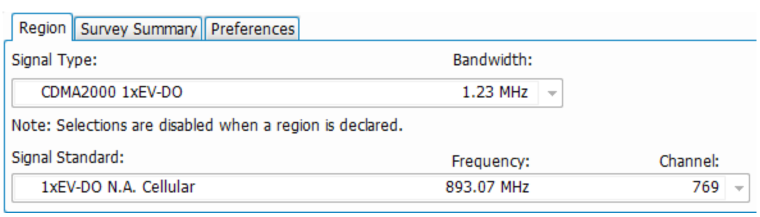
See also:

The *Create a region* on page 687 topic to see how the Signal Survey Editor works when creating/editing a region.

The Define Survey control panel

Click the **Define** button on the Signal Survey toolbar to access the Define Survey control panel. The following images and tables describe the Define Survey control panel and its tabs.

Region tab

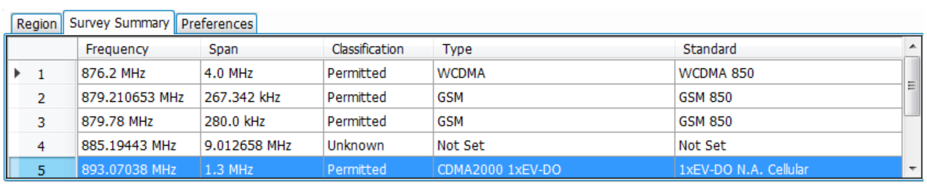


Item	Description
Signal Type	For classified regions, this field is not editable. For unclassified regions, this field is a drop-down list of all enabled signal types (set in the Signal Database). The types that best match the signal are starred in this list. See *here* for star rating definitions.
Bandwidth	Shows the bandwidth of the selected signal type.
Notification area	Notes may appear between the Signal Type and Signal Standard fields.
Signal Standard	For classified regions, this field is not editable. For unclassified regions, this field is a drop-down list of all enabled signal standards (set in the Signal Database) and standards for which channels are enabled. The standards and their channels that best match the center frequency of the region are starred in this list. See *here* for star rating definitions.
Frequency	Shows the channel frequency of the selected signal standard.
Channel	Shows the channel number for the selected signal standard. .

Criteria for signal standard and type star ratings.

	Criteria	
Star	**Signal standards**	**Signal types**
★	The region center frequency matches the selected signal standard channel frequency and the selected signal standards database signal type matches that of the selected signal type.	The region bandwidth exactly matches the selected signal type bandwidth.
⯪	The region center frequency matches the selected signal standard channel frequency.	The region bandwidth is within ±5% of the selected signal type bandwidth and does not exceed the defined min/max matching bandwidth range of the selected signal type.
★	A large portion of the region start/stop frequency overlaps the selected signal standard channel frequency.	The region bandwidth is within the defined min/max matching bandwidth range of the selected signal type.
☆	A small portion of the region start/stop frequency overlaps the selected signal standard channel frequency.	Not applicable.
No star	No portion of the region start/stop frequency overlaps the selected signal standard channel frequency.	The region bandwidth is outside the defined min/max matching bandwidth range of the selected signal type.

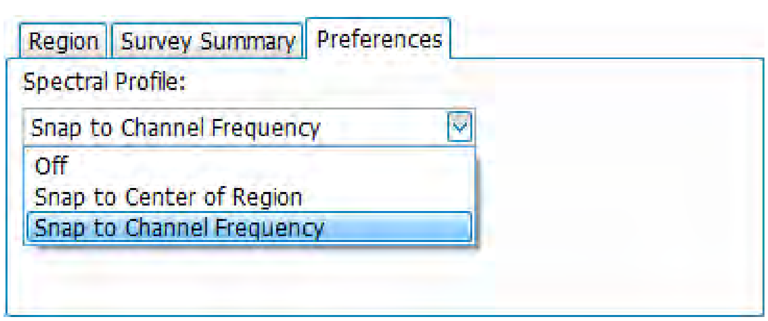
Survey Summary tab



	Frequency	Span	Classification	Type	Standard
1	876.2 MHz	4.0 MHz	Permitted	WCDMA	WCDMA 850
2	879.210653 MHz	267.342 kHz	Permitted	GSM	GSM 850
3	879.78 MHz	280.0 kHz	Permitted	GSM	GSM 850
4	885.19443 MHz	9.012658 MHz	Unknown	Not Set	Not Set
5	893.07038 MHz	1.3 MHz	Permitted	CDMA2000 1xEV-DO	1xEV-DO N.A. Cellular

Item	Description
Summary table of all of the regions in the active plot	Each region is identified by a number.
	The center frequency of the region.
	The span of the region.
	The classification of the signal in the region.
	The signal type of the signal in the region, if it has been set. Otherwise, this field reads Not Set.
	The signal standard and channel of the signal in the signal in the region, if it has been set. Otherwise, this field reads Not Set.

Preferences tab



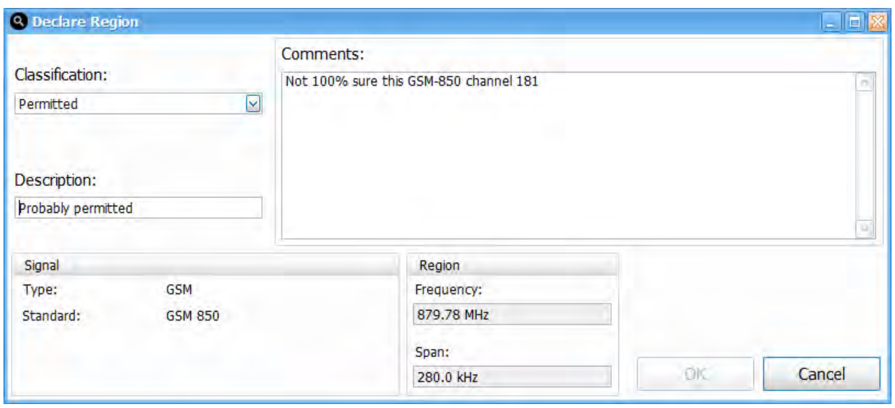
Item	Description
Spectral Profile	**Off** turns the spectral profile off so that it does not appear on the plot. Use this option if you want to view the signal in the region without the spectral profile overlayed on the signal.
	Snap to Center of Region aligns the spectral profile to the center of the region. Use this option if you know that the frequency you are viewing has no defined signal standard channels in the database.
	Snap to Channel Frequency aligns the spectral profile with the specified signal standard channel frequency of the signal. Use this option if you want to check that the channel frequency of the spectral profile matches the signal frequency you are looking at. If the selected signal standard channel frequency is within the selected region, then the spectral profile will center on that channel frequency. If the channel frequency is outside of the selected region, then the spectral profile will snap to the center of the region.

See also:

Define a region using known standards.

The Declare Region window (classify)

Click the **Classify...** button on the Signal Survey toolbar to access the Declare Region window. Once a region is classified, you can no longer change the signal type or signal standard in the Region tab of the *Define Survey control panel*. The following image and table describe the Declare Region window.



Item	Description
Classification	Lists classification types to assign to the current region. Each classification has a unique color that is assigned to the region box: None: Gray Unknown: Yellow Unauthorized: Orange Permitted: Blue
Description	Enter a brief description to identify the region.
Comment/Notes	Enter additional comments to provide needed information regarding the region.
Signal	Lists the selected signal type and signal standard of the selected region.
Region	Lists the span and center frequency of the selected region.

Note: If a region is classified, you need to change the classification to "None" before you can make any changes to that region.

Managing Data, Settings, and Pictures

Managing data settings and pictures

Saving and recalling data settings and pictures

You can save different types of data for later recall and analysis.

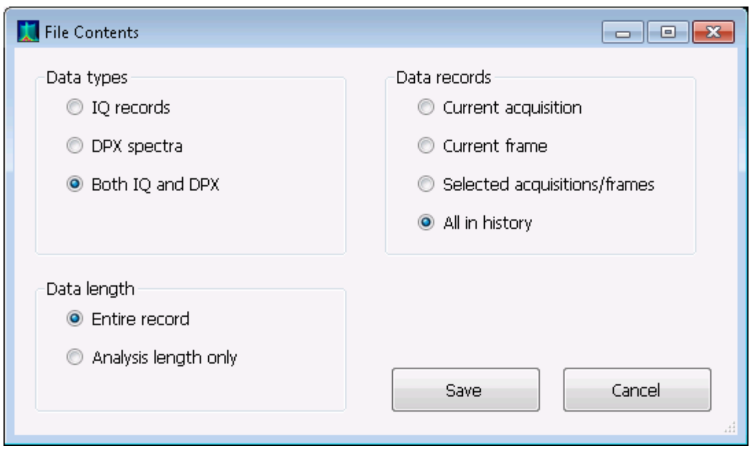
Data type	Description	Save as type
Setup files	Saves all of the setup information for all displays, except those settings that are not part of Preset.	Setup (.Setup)
Picture of Selected Display (PNG/JPG/BMP)	Saves a capture of the screen in the specified format. This option is useful for including the 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	Saves data for reanalysis by RSA6100B Series Real-Time Spectrum Analyzers, RSA5100B Series Real-Time Signal Analyzers, SPECMONB Series Real-Time Spectrum Analyzers, or as data to use with external software (either CSV (comma-separated value) or MAT (MATLAB format). For fastest capture of data files in TIQ or MAT format, use FastSave. This function disables caching and analysis of incoming data, greatly decreasing the time required to save files to local or network storage.	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. If you are going to save DPX Spectra (DPXogram) acquisition data, stop acquisitions.

   Saving while running is allowed by the analyzer, but data files saved while running will not contain any DPX spectral data.
2. Select **Save As** from the **File** menu to open the **Save As** dialog box.
3. Navigate to the folder where you want to save the setups, or use the default location.
   - To save setups so that they appear in the User Presets list, save your setup in the folder **C:\RSA5100B Files\User Presets**. The saved setup will appear in the User Presets window with the name you give the file.
4. Enter a file name.
5. Select the type of file to save from the **Save as type** drop-down list.
6. Click **Save**.
7. If you save acquisition data (Acq data with setup (TIQ), Acq data export (CSV), and Acq data export (MAT)), the File Contents window appears. In the File Contents window, you need to specify the data type, data records, and data length to save the acquisition data.



   a. Select the data type: Choose IQ data, DPX Spectra, or both. DPX spectral data only exists while either the DPXogram or Split DPX display is open, and acquisitions are stopped. IQ data is not available when FastSave is turned on. In cases where the selected data type is not available, the file will be saved without that data.
   b. Select the data records you want saved. Frames can be saved only when FastFrame was enabled during acquisition.
   c. Select the desired data length. The data length controls are enabled only when IQ data is being saved.
   d. Click Save to save the acquisition data file.

Saving Data with FastSave

To save data using FastSave, use the procedure *Preparing for a FastSave Acquisition*.

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.

Saved File Types

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	Screen capture of analyzer application window. They are useful for documenting results in test reports.
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.

Table continued…

File type	File extension	Description
Selected Trace	varies with display	Trace files contain the trace results data in binary format. These files are only readable by the analyzer application. Several of the instrument's measurements allow you to recall a Trace file for visually comparing a saved trace to a live trace.
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.

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 *Data, Settings, and Picture File Formats*. For details on saving a picture to a file, see *Saving and Recalling Data, Settings, and Pictures*.

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.

Reference

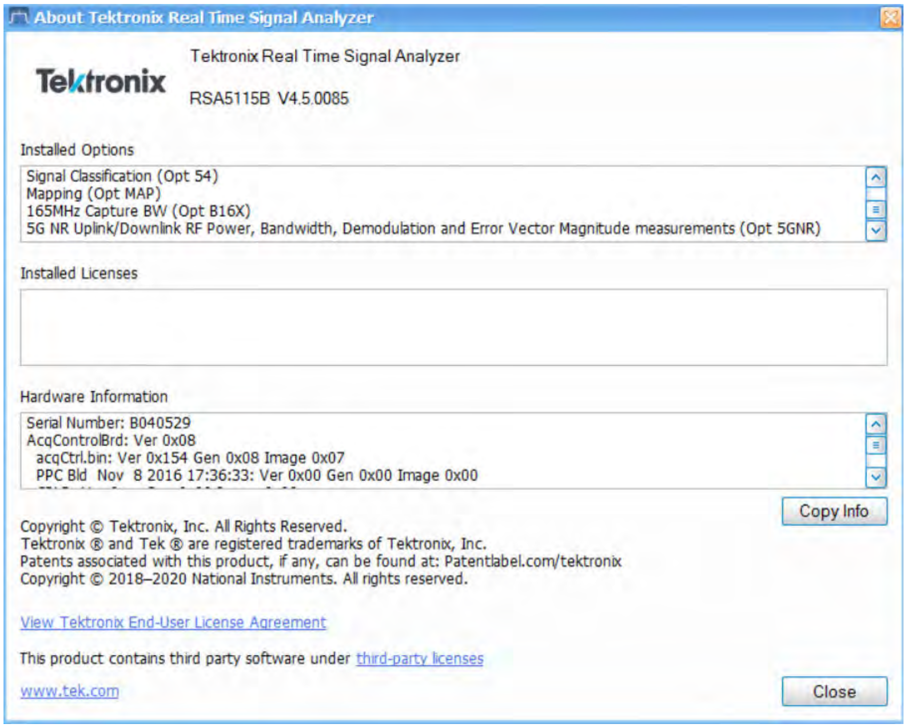
Online help

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.

About the Tektronix RTSA

This window displays information about the software and hardware versions for the analyzer.



Version

At the top of the window is a line that displays the version of the analyzer application software.

Installed Options

This text box lists the instrument options installed on the analyzer. This window does not list every option installed on the instrument, just those that can be detected by the software.

Hardware Information

This text box lists information about the instrument hardware versions.

Copy Info

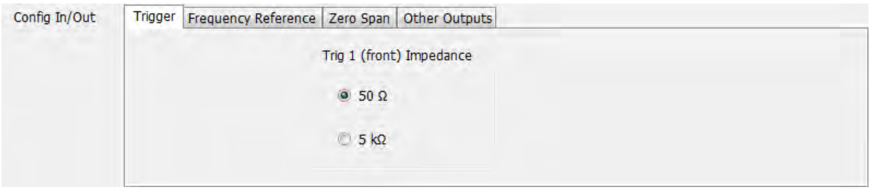
The Copy Info button copies information about the instrument to the Windows clipboard. This information may be useful if you need to have your instrument serviced.

Connecting signals

Configure In-Out settings

Menu bar: Setup > Configure In/Out.

The Configure In/Out control panel enables you to configure the analyzer inputs and outputs. The settings in this control panel are shared by all application windows.



Settings tab	Description
Trigger	Specifies the impedance for the Trig 1 (front panel) input. You can select between 50 Ω and 5 kΩ.
Frequency Reference	Specifies the source of the Frequency Reference. You can select between an Internal (10 MHz) source and an external source.
Zero Span	Specifies whether the Zero Span Output is on or off. Additional output settings (bandwidth and voltage) are available.
Other Outputs	Specifies whether the 28 VDC and Digital I and Q outputs are on or off. Additional settings are available for IQ outputs.

Connecting an RF signal

The analyzer has a single RF signal input located on the front panel. The input impedance is 50 Ω. The input frequency range for each analyzer model is listed in the following table. The maximum measurable continuous input power for all models is 1 W.

Table 45:

Model	Input frequency range
RSA5103B	1 Hz to 3 GHz
RSA5106B	1 Hz to 6.2 GHz
RSA5115B	1 Hz to 15 GHz
RSA5126B	1 Hz to 26.5 GHz

About RF Input Protection

The following paragraphs describe how the analyzer behaves to protect the RF input during power-off, power-on, power-on self test (POST), and attenuator switching:

- When switched off (or when power is removed), the RF input is electronically disconnected from the input connector. The analyzer always has a minimum 10 dB attenuation applied during power-up and power-on-self-test. This is accomplished by always switching the attenuation control to Auto during these states. The minimum Auto attenuation value is 10 dB and is applied prior to the pre-amplifier (Option 50/51) in the signal path.
- When switching attenuator values, the action is performed in a 'make before break' sequence, such that the attenuation never switches to zero during an attenuator switching sequence. For example, consider switching from 20 dB to 15 dB attenuation. This change requires the instrument to switch from using one 20 dB attenuator to using one 10 dB and one 5 dB attenuator. This attenuator switching is done such that the 10 dB and 5 dB attenuators are switched in prior to switching out the 20 dB attenuator.

To connect an RF signal:

1. If the source signal is greater than 1 Watt (+30 dBm), connect the source signal to an attenuator. Connect the attenuator output to the RF Input connector.

   CAUTION: To prevent damage to the analyzer, do not connect signals greater than +30 dBm (1 Watt).

   CAUTION: To prevent damage to the analyzer, do not turn the equipment under test on or off with a LISN (Line Impedance Stabilization Network) RF cable connected to the analyzer. The power cycling of the equipment under test causes surge currents that can damage the sensitive input of the analyzer.
2. Connect the appropriate Planar Crown connector if applicable for your instrument model.
3. Connect the signal to the RF INPUT connector.

The maximum limits for the input signal are as follows:

Table 46:

	RSA5100B Series
Characteristic	Description
Maximum DC Voltage	± 5 V (RF input)
Maximum Measurable Input Power	+ 30 dBm (RF input, RF ATT Auto)
	50 Watts peak (RF Band, RF ≧ 30 dB (<10 ms pulse width, 1% Duty Cycle repetitive pulses))

Connecting a signal using a TekConnect probe

You can connect a signal to the analyzer using a TekConnect Probe by using an RTPA2A Real-Time Spectrum Analyzer TekConnect Probe Adapter. The RTPA2A enables you to use Tektronix P7000 Series active and differential probes to connect to signals. See the RTPA2A Instruction Manual for instructions on how to connect the probe adapter and a probe to the analyzer.

Installing the RTPA2A Probe Adapter Device Driver

When the RTPA2A probe adapter is connected to the instrument's USB port for the first time, the Windows Add Hardware wizard may automatically start. If the wizard does start, use the procedure below to install the device driver for the new hardware. (If the wizard does not start, the probe adapter device driver is already installed.)

To properly install the probe adapter device driver:

1. Select the option for Windows to install from a specific location (then select **Next**).
2. Only search for the driver in the following location depending on your instrument:

- **C: \Program Files\Tektronix\RSA5100B\RSA\ProbeAdapter**

3. If Windows warns about Windows Logo testing, select **Continue Anyway**.
4. Select **Finish** after the Found New Hardware wizard completes.

Connecting external trigger signals

External trigger signals are connected to the analyzer using the **Trig In** connector on the front panel. There is also an additional trigger input on the rear panel, the Trig 2 In.

To connect a trigger signal to the analyzer, connect the signal to the **Trig In** connector on the front panel, or the **Trig 2 In** connector on the rear panel.

Table 47: External trigger signal input requirements

Input	Level	Impedance
Trig In	-2.5 V to +2.5 V	50 Ω or 5,000 Ω Set in Setup > Configure In/Out > Trigger tab.
Trig 2 In	+5 V (TTL)	10,000 Ω

Enabling External Trigger

To use an external trigger signal, select either **Trig In (front)** or **Trig 2 In (rear)** in the **Source** control on the Trigger control panel's *Event tab*.

Digital I and Q outputs

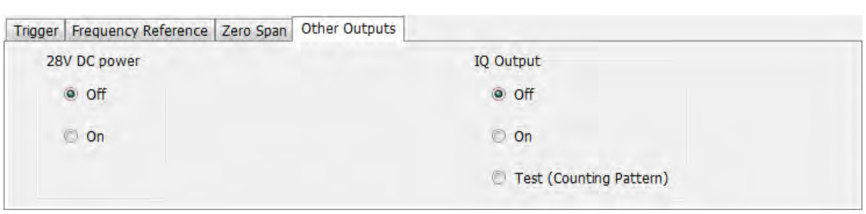
The Digital I and Q outputs are a means for you to obtain the analyzer digital baseband I/Q signals in a real-time data stream. This output enables you to use the analyzer as a down-converter and then pass the down-converted baseband I/Q signals to external equipment for either additional processing or storage.

The rear panel I and Q output connectors are LVDS connectors. For full details on the connectors, see the Specifications and Performance Verification manual. A PDF file on the manual is located on the Documentation CD that shipped with your instrument. The manual can be downloaded from the Tektronix Web site, *www.tektronix.com/manuals*.

Note: The Digital I and Q outputs are disabled when an alignment is running.

Other outputs

The Other Outputs tab is accessed from the Config In/Out control panel (Setup > Configure In/Out > Other Outputs tab). The IQ Output settings appear only when Option 65 is installed.



28V DC power

The 28V DC power provides a voltage source to power an external noise source. The output connector is located on the rear panel and provides 28 VDC at 140 mA.

IQ Output

The IQ Output transmits the digitized analyzer data for capture and storage by external equipment. The I/Q data is provided in 16-bit, two's complement format, along with clock and data-valid signals.

There are three selections available for the IQ Output: Off, On, and Test. When in the "Off" position, the IQ Output is disabled, and all lines are static. When in the "On" position, the data is output as described in the Specifications and Performance Verification manual.

Use the "Test" position to verify operation when setting up your equipment. When in the "Test (Counting Pattern)" position, the I channel data will be counting up and the Q channel data will be counting down. The EXT_IQ_CLK and EXT_IQ_DAV signals will operate at a rate consistent with the instrument SPAN setting.

Note: The IQ outputs are disabled when an alignment is running.

Zero span

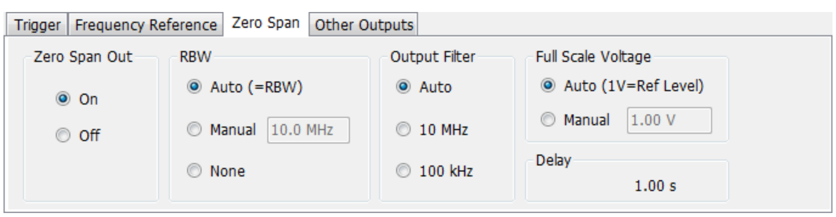
The Zero Span tab is accessed from the Config In/Out control panel (Setup > Configure In/Out > Zero Span tab). The tab only appears if Option 66 is installed.

With Zero Span installed, the instrument provides an analog zero span output at the rear of the instrument.

The output is a voltage that represents the signal at the center frequency. The resolution bandwidth is based on the selected display and the output is scaled by the vertical settings (offset and scale) of the selected display.

The zero span output is only active with the following displays:

- DPX spectrum
- DPX Zero-Span
- Spectrum



Note: The analog Zero Span output is disabled when an alignment is running.

Control	Description
Zero Span Out	Enables or disables the rear panel analog zero span output. Active or Disabled is displayed to indicate if a signal is being output. The output is disabled if DPX or Spectrum is not displayed or if the output is swept. When disabled, a message is also displayed in the status bar at the bottom of the screen.

Table continued…

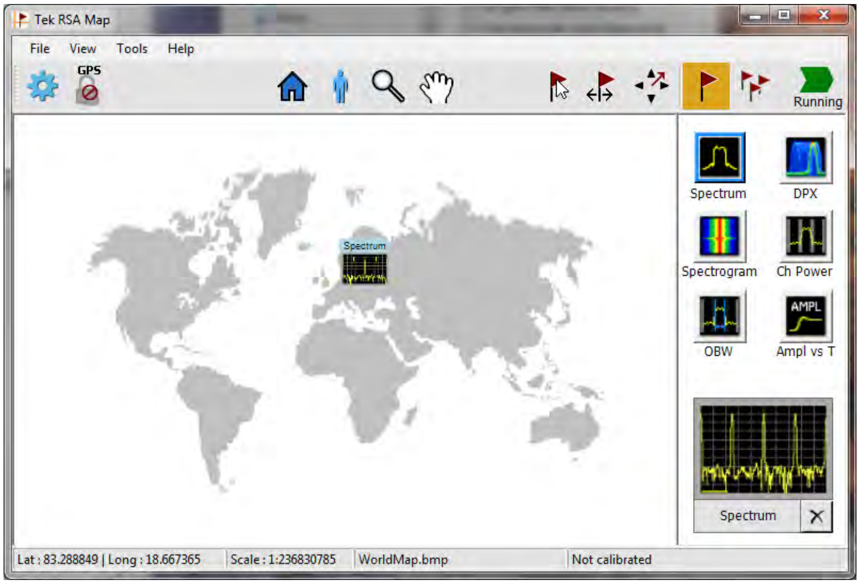
Control	Description
RBW	This control sets the RBW that is applied to the real-time baseband I/Q data. • Auto: The RBW specified in the active (selected) Spectrum display is applied to the Zero Span data. • Manual: The user may specify the RBW to be applied. The acceptable range of values are Span/4096 < RBW < Span/2. • None: The RBW filter is bypassed, allowing the full I/Q bandwidth to generate the ZSO output (including the full noise power within the IF). This mode provides the best detail for pulsed signals.
Output Filter	This control selects the analog output filter applied to the Zero Span output. These low-pass filters are designed as anti-alias filters to eliminate the images created by the DAC sampling. Refer to Figure 1 to understand where these filters are applied in the signal path. They are multiple-pole low-pass filters. • Auto: Chooses the appropriate output filter (10 MHz or 100 kHz) based on the sample rate. • 10 MHz: Uses the 10 MHz low pass output filter. • 100 kHz: Uses the 100 kHz low pass output filter. This filter reduces the noise content of the output, but also causes a slight distortion of the pulse edge.
Full Scale Voltage	• Auto (1V=Ref Level): Sets the voltage scale where 1 V equals the Reference Level input power. • Manual: The user may specify anywhere from 0.5 V to 1 V as the full-scale representation of a signal at reference level.
Delay	Indicates the processing delay for the Zero Span Output. The value represents the delay from a signal present at the RF input connector to the corresponding signal present at the Zero Span Output connector.

Mapping measurements

The RSA Map software lets you record measurements on a geo-referenced map or a bitmap map for documentation purposes. If an external GPS receiver is connected to the analyzer, measurements can be mapped at the GPS coordinates where the measurement was taken. Using an external GPS receiver, RSA Map can perform repeat measurements using either time or distance to initiate measurements. RSA Map software can also save results for future reference or analysis.

To map measurements:

- Select Tools > RSA Map. This launches the RSAMap software in a separate window.



Full documentation on how to use RSA Map is provided in the RSA Map Help. In RSA Map, select **Help** > **User Manual**.

Menus

Menu overview

The main menus are:

Menu	Description
File	Select measurements, open and save files, print documents, and preset.
View	Change display size, display the Marker toolbar and Status bar.
Run	Start, stop and abort acquisitions, select single or continuous acquisition mode.
Replay	Replay measurements; select which record(s) to play, Replay/Stop/Pause, or enable continuous loop.
Markers	Define markers and search for signal peaks.
Setup	Change settings for acquisition, trigger, analysis, measurements, amplitude, alignments, and configure in/out settings.
Presets	Load and configure presets.
Tools	Perform searches, access diagnostics, install upgrades and configure user preferences.
Window	Controls the size and layout of displays within the analyzer application.
Help	Access the help, display information about the instrument hardware and software.

File menu

Command	Description
Recall	The Recall dialog enables you to recall saved data, setups and traces.
Save	Saves a file without asking for a file parameters (based on most recent settings).
Save As	Displays the Save dialog enabling you to specify the parameters of the save operation.
Save on trigger	Displays the Actions tab of the Trigger control panel which allows you to configure the Save on Trigger function.
Acquisition save options	Displays the Save and Export tab of the Options control panel which allows you to specify how much data is saved in acquisition files.
FastSave Acquisitions	Displays the FastSave tab of the Acquire control panel which allows you to configure FastSave acquisitions.
Acquisition data info	Displays the *Acquisition Info tab* 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	Displays the characteristics of the most recently analyzed record in the display.
Print	Prints the selected display.
Print Preview	Displays a preview of the print output.
Exit	Closes the analyzer application. Selecting Exit does not shut down the instrument.

Recall

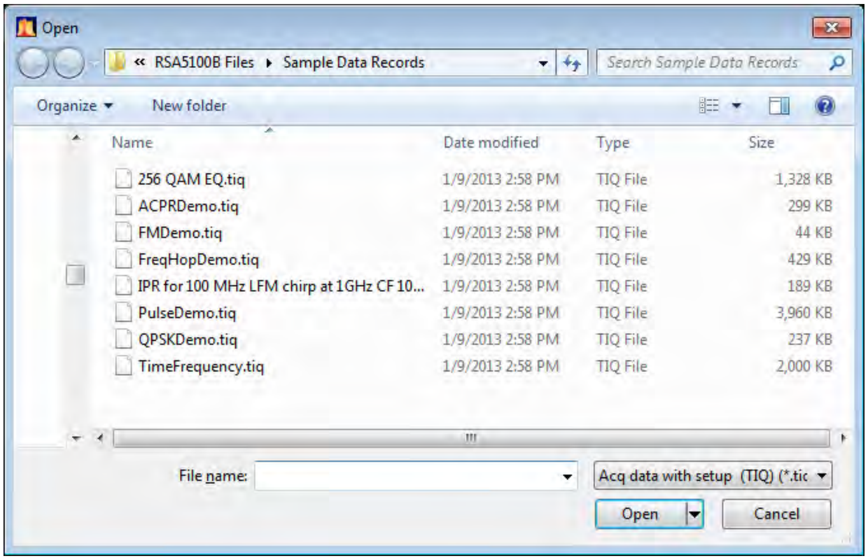
Menu Bar: File > Recall

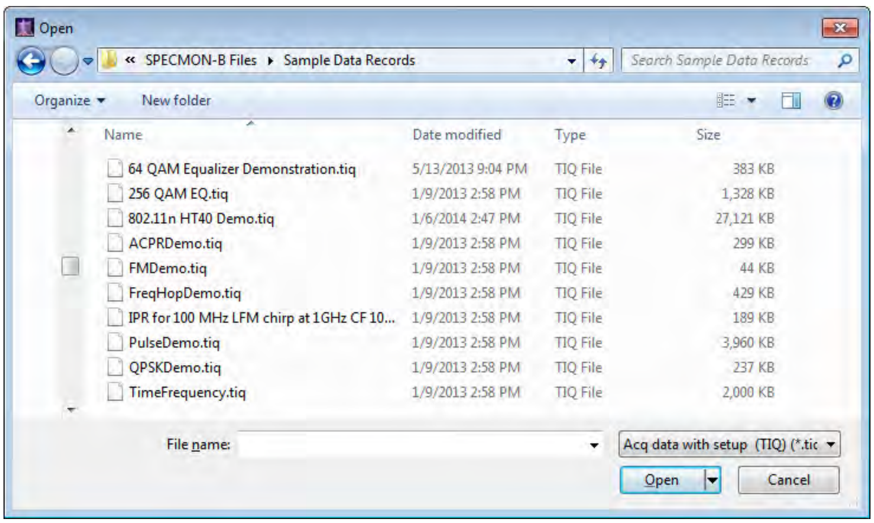
Front Panel: Recall

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 *Save and Export option* 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.

What Data Types Can Be Saved

Data type	Description
Acquisition Data	Data collected during acquisition that can be recalled for later analysis. Data is saved in a format readable only by RSA6100/RSA5100/SPECMON Series instruments or oscilloscopes running SignalVu software. You can save acquisition data as IQ records only, DPX spectra (DPXogram data) only, or both IQ records and DPX Spectra.
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.

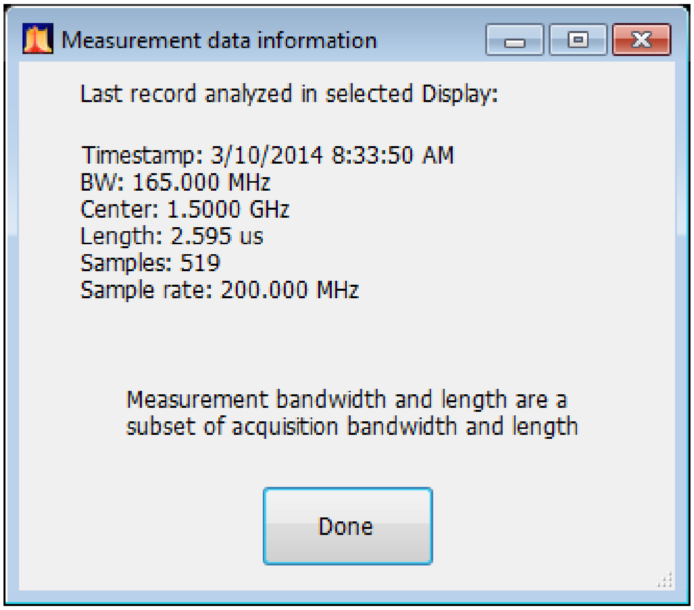
Data, Settings, and Picture File Formats.

Options for Saving Pictures of the Display

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.

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

Front Panel: 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*.

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	Toggles all views between full-screen size and user-selected size.
Replay Toolbar	Shows or hides the Replay toolbar.
Marker Toolbar	Shows or hides the Marker toolbar. Enables you to define Markers and perform Peak searches.
Status Bar	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

Area within Bar	Description
Run Status	Displays the running state. For example, some run states are Arm, Ready, Triggered, Analyzing, or Stopped.
Status message area	Displays status messages (for example, ADC Overrange). When there no status messages to report, displays current acquisition parameters (for example, Acq Length: 22.320 us).
Acquisition mode	Displays either Real Time or Swept. Indicates how the next acquisition will be acquired.
Trigger Settings	Displays Trigger settings. For example, you will see Free Run, Power, Trig In (front), Frequency Mask and others.
Frequency Reference Setting	Indicates whether the internal or external reference source is selected. Displays Ref: Int or Ref: Ext.
Internal Attenuator setting	Displays the setting of the internal attenuator.
Preamp Setting	If the optional preamp is installed, this indicates whether the preamp is on or off. If the preamp is on, displays Preamp: ON, 3 GHz max. as a reminder that the input frequency range is restricted when using the preamp.

Run Status Indicators

Indicator	Description
Acquiring	The analyzer is capturing the signal.
Analyzing	The analyzer has captured the signal and is processing the signal record.
Arm	The trigger circuitry is filling the pretrigger portion of the signal record.
File Data	The analyzer is analyzing recalled acquisition records.
Replaying	The analyzer is analyzing recalled waveform or acquisition records.
Stopped	If Stopped is displayed, Signal acquisition has been halted. This can occur because the Run button has been pressed or because a trigger event has occurred, signal acquisition has occurred and Run mode was set to Single.
Triggered	If Triggered is displayed, the analyzer has recognized a valid trigger and is filling the posttrigger portion of the signal record.

Showing or Hiding the Status Bar

- Select **View** > **Status Bar** to toggle the display of the Status bar.

Run menu

The Run menu provides access to commands that control the signal acquisition.

Command	Description
Run	If acquisition mode is Stopped, selecting Run begins a new measurement/acquisition cycle. If acquisition mode is Run, pressing Run halts the current measurement/acquisition cycle after it completes.
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. Resume is not available if instrument settings have been changed.
Abort	Immediately halts the current measurement/acquisition cycle.
Single Sequence	Selects the single-sequence acquisition mode. This is only a mode selector; it does not initiate an acquisition.
Continuous	Selects the continuous acquisition mode. Selecting Continuous does initiate acquisitions.

Single sequence acquisition mode

Menu Bar: Run > Single

Selecting **Single** sets the Run mode to Single. In Single mode, as soon as one acquisition sequence completes, acquisition stops.

Note that a single 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 to produce 100 intermediate traces that are averaged together to create the final trace that is displayed. Once the 100 acquisitions have been completed, acquisition stops.

This is only a mode selector, it does not initiate an acquisition.

Continuous acquisition mode

Menu bar: Run > Continuous

Selecting **Continuous** places the analyzer in the Continuous acquisition mode. In Continuous mode, the analyzer acquires and displays acquisitions repeatedly. The Continuous and Single Sequence acquisition modes are mutually exclusive.

Selecting Continuous restarts acquisitions.

Replay menu

The *Replay Menu* allows you to rerun measurements using the data in acquisition memory or a recalled TIQ file. You can use this to compute new results for old data after you change settings or measurements.

Markers menu

The Markers menu provides to settings that define and control the location of markers.

Setting	Description
Peak	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	Displays the Define Marker control panel.

Setup menu

The Setup menu provides access to control panels that specify parameters for numerous signal analyzer functions.

Command	Description
Displays	Displays the Displays control panel.
Settings	Displays the Settings control panel for the selected display.
Trigger	Displays the Trigger control panel.
Acquire	Displays the Acquire control panel.
Analysis	Displays the Analysis control panel.
Amplitude	Displays the Amplitude control panel.
Configure In/Out	Displays the Configure In/Out panel.

Presets menu

The Presets menu provides you access to instrument presets and preset options.

Command	Description
Main	Resets the instrument to factory defaults. Acquisition data and settings that have not been saved will be lost.
DPX	Recalls the DPX presets.
Standards	Recalls the Standards presets.
Application	Recalls the Application presets.
User	Recalls the User presets.

Table continued…

Command	Description
Preset Options	Displays a control panel where you can configure options for Presets.

Tools menu

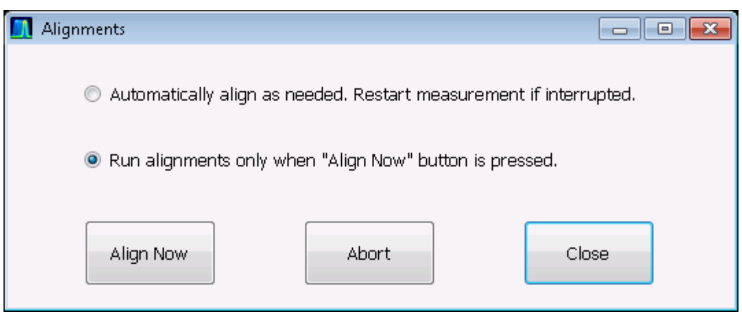
Provides access to several utilities for controlling instrument functions.

Command	Description
Mask Test	Enables you to locate and highlight specified signal levels in specified displays.
Alignments	Displays the Alignments dialog box.
Diagnostics	Displays the Diagnostics dialog box.
Install Upgrades	Used to activate upgrades you have purchased.
Options	Displays the Options control panel.

Alignments dialog

Menu Bar: Tools > Alignments

The analyzer can adjust itself, optimizing the internal signal path used to acquire the signal you measure. Alignment optimizes the analyzer to take more accurate measurements based on the ambient temperature. The Alignments dialog enables you to specify when alignments occur, either automatically or only when manually initiated.



Elements of the Alignments Dialog

Setting	Description
Automatically align as needed	Specifies that alignments run as ambient conditions require.
Run alignments only when "Align Now button is pressed.	Specifies that alignments will never run unless manually initiated.
Align Now	Use to manually initiate an alignment.
Abort	Stops the alignment process.

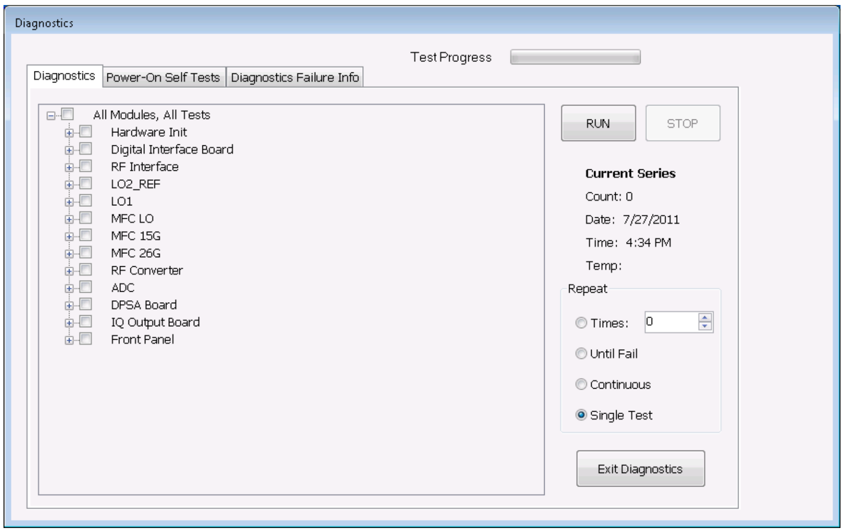
Table continued…

Setting	Description
Close	Closes the Alignments dialog box.

Diagnostics

Menu Bar: Tools > Diagnostics

The Diagnostics menu item displays the Diagnostics Tests window, which enables you to run variety of tests to verify the operation of the signal analyzer. For detailed information on running diagnostics, refer to the Service Manual. The manual can be downloaded from the Tektronix Web site, *www.tektronix.com/manuals*.



Install upgrades

You can install upgrades on your analyzer as your needs change. To install upgrades, you will need an Option Installation Key. For information about available options or to make a purchase in North America, call 1-800-833-9200. Worldwide, visit *www.tektronix.com* to find contacts in your area.

Full instructions on how to install your upgrade and activate the option with the Option Installation Key are provided with the upgrade kit.

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).

Table continued…

Command	Description
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

The Help menu provides access to the help and version information about the analyzer hardware and software.

Command	Description
User Manual On-line	Displays the help.
User Manual (PDF)	Displays a PDF version of the help.
Application Reference (PDF)	Displays a PDF version of the analyzer Applications Manual.
Quick Start Manual (PDF)	Displays a PDF version of the analyzer Quick Start User Manual.
About Tektronix Real-Time Analyzers	Displays information about the analyzer model and installed options.

Troubleshooting

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.

- The current Frequency setting is different than that of the data record, causing the measurement bandwidth to fall at least partly outside the bandwidth of the data.

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.

Cache file missing. Unable to create new cache file. Not enough free space (need XXX GB).Remove unnecessary files, defragment the hard drive using a standard disk management utility, then relaunch application.

The instrument is unable to create a required cache file. To resolve this issue, use a standard disk management utility to defragment the hard disk. If this error persists, backup your data (including any setup files you have saved), any applications and associated files you have installed and perform an OS restore on the hard disk. After restoring the OS, reinstall the analyzer product software.

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.

Data acquired during hardware failure

If this data is from a saved file, the error cannot be cleared.

Data acquired during RF ADC overrange

If this data is from a saved file, this error cannot be cleared.

Data acquired during RF digital gain overflow

This data was acquired when the input signal contained peaks greater than 6 dB above the Reference Level setting.

See the definition for "RF digital gain overflow".

If the data is from a file, this error cannot be cleared.

Data acquired during warm-up

This data was acquired while the instrument was warming up. The warm-up period is 20 minutes. Until this warm-up period is completed, the instrument is considered uncalibrated.

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.

Data from uncalibrated instrument

The acquisition data was captured when the instrument was not calibrated. This message refers to the acquisition data currently being analyzed, but not necessarily to the current status of the instrument. See the definition for "Not calibrated".

If this data is from a file, the error cannot be cleared.

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.

Disabled: Freq Mask Trigger in use

The DPX display cannot run while the instrument is set to use Frequency Mask Trigger.

- To run the DPX display, you must turn off Frequency Mask Trigger.

DPX disabled: RefLev too low for Volts/Watts units

The Reference Level value is set too low. It is possible to set a RefLev value so low that DPX can't run if volts or watts are the selected amplitude units. Reset the Reference Level to a higher value.

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.

Dither: manual control

This is a reminder that the *Dither control* has been set to manual, which might affect the quality of measurement results.

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.

External Frequency Reference signal not valid.

The instrument is no longer locked to the external reference signal because it can no longer detect a signal with proper amplitude and frequency.

- Verify that the external reference signal is still connected to the instrument.

Hardware failure detected by Diagnostics

A hardware failure was detected while running Diagnostics. To see a description of the event initiated by the failure, *display the Windows Event Viewer*. There is a shortcut to the Windows Event Viewer on the Windows desktop.

Hardware failure - see Windows Event Viewer

A hardware failure has occurred. To see a description of the event initiated by the failure, *display the Windows Event Viewer*. There is an shortcut to the Windows Event Viewer on the Windows desktop.

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.

Locking to ext freq ref signal

This a status message displayed while the instrument is attempting to lock to an external reference signal. The message disappears when the instrument locks to the reference signal.

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.

Not aligned

The instrument needs to be aligned. When the instrument is not aligned, measurements might not be accurate.

- Select Tools > Alignments > Align Now to alignment the instrument.

No burst detected

The *Burst Detection Mode* is On, but no burst was detected in the signal.

- Check that the Threshold setting is properly set.

Not calibrated

The instrument requires calibration. Calibration can be performed only at a Tektronix Service center. Contact Tektronix to schedule a calibration.

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 *parameters that define a pulse*), 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 *analysis length* 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 *Measurement Filter* 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 *Power threshold to detect pulses*.
- The pulse interval is too long for the current settings. Try decreasing the *filter bandwidth*, 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.

RF ADC overrange

This input signal power is outside the range of the analog-to-digital converter circuitry.

- Decrease the input signal power or increase the internal attenuation setting.
- Increase the Reference Level setting.

RF Attenuator: manual control

This message is just a reminder that the *internal attenuator* has been set to manual mode.

RF digital gain overflow

The input signal contains peaks greater than 6 dB above the Reference Level setting.

- Increase Reference Level
- Decrease input signal power

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 *Measurement time for Freq & Phase results* 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).

Swept: RF Trig invalid for most signals

This is an status message that appears when the instrument is in swept acquisition mode and Power Trigger mode at the same time. When the acquisition is swept, it captures the requested bandwidth using multiple acquisitions, each for a different portion of the bandwidth. The trigger system evaluates each of these separate acquisitions for trigger events, so unless a valid event exists in each of these smaller frequency ranges, the acquisition will not complete.

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.

- Switch the instrument off and restart it or relaunch the analyzer application.

Unable to lock to External Frequency Reference.

The instrument is no longer locked to the external reference signal.

- Verify that the external reference signal is still a valid signal.
- Select External on the Frequency Reference tab in the Config In/Out control panel.

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.

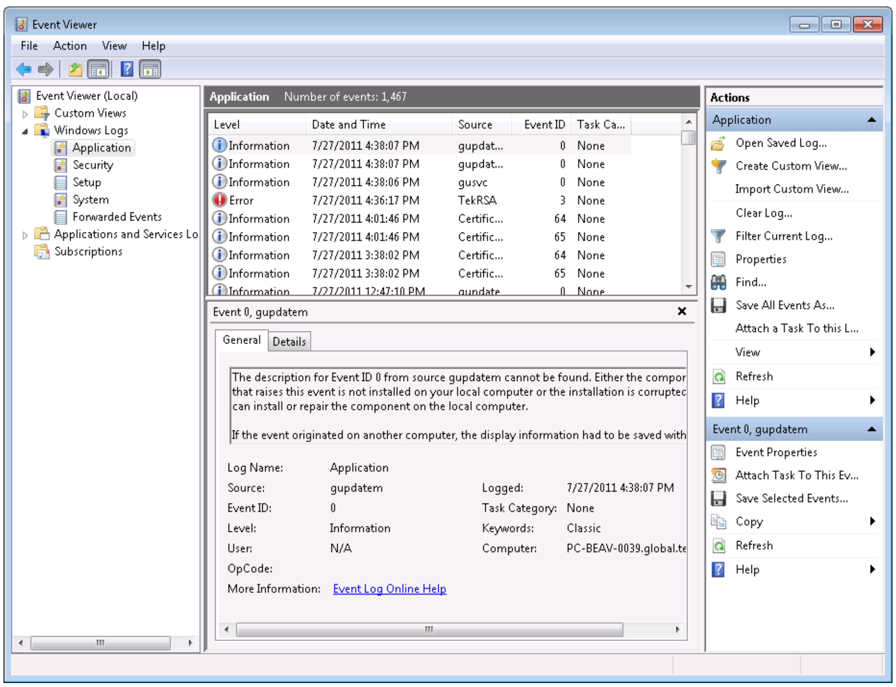
To clear this problem, set the Spectrum Length to Auto or manually increase the Spectrum Length (see Setup > Analysis > Spectrum Time tab). If Spectrum Length is coupled to Analysis Length, set Analysis Length to Auto or manually increase it (see Setup > Analysis > Analysis Time tab).

Displaying the windows event viewer

When the analyzer generates an error message, information about the error is logged to the Windows Event Viewer.

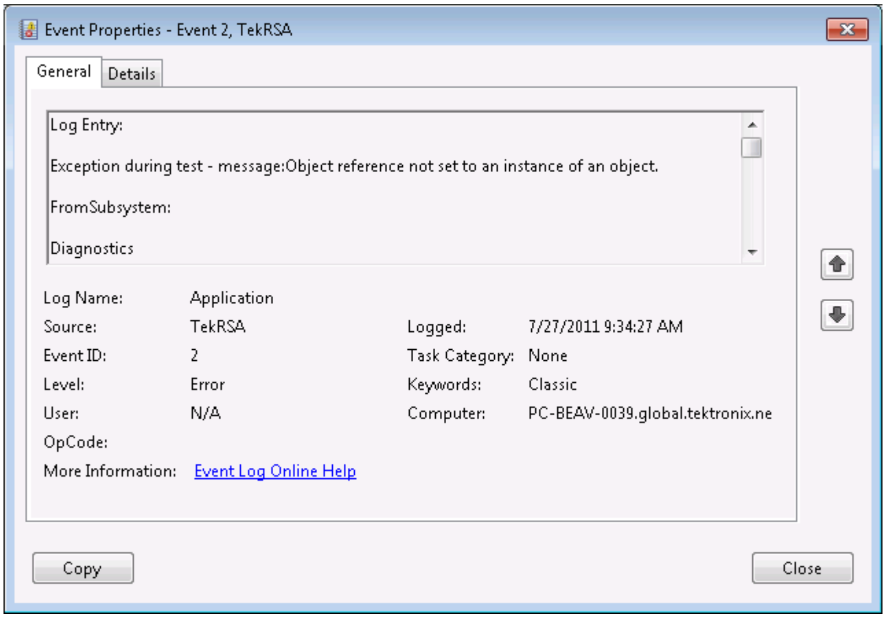
To display the Windows Event Viewer:

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.



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.



Dealing with sluggish instrument operation

Over time you might notice that acquisitions seem to be occurring sluggishly. This can occur if the disk is too full or if someone has accidently deleted the instrument cache file. While the instrument automatically recreates a missing 4 GB cache file, if the disk is too full when the replacement cache file is created, the cache file can be fragmented and result in sluggish performance.

If your instrument appears to be performing acquisitions slowly, do the following:

- Delete unnecessary files to create free space. After deleting unnecessary files, run a commercial disk defragmentation program.
- If removing unnecessary files and defragging the hard drive does not improve instrument performance, reinstall the operating system and application software. To do this, back up all your data and files, and then reinstall the instrument operating system. After reinstalling the operating system, reinstall the application software.

On-Standby switch

Use this button to power the instrument on or to shut down (set the instrument to standby).

Before shutting down, you should first exit the instrument application and any other active Windows applications to avoid error messages on shutdown or the next power up.

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 *www.tektronix.com/software*. Search by the product model number.

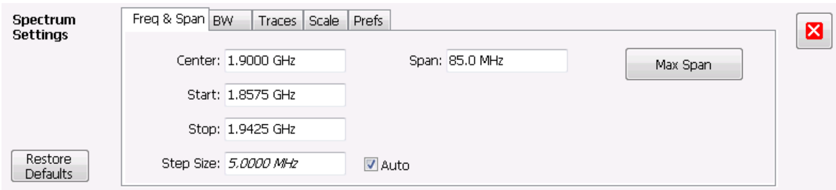
To add additional software options or features, you will need an option key from Tektronix. In some instances, you may need to upgrade the product software before adding the new option key. Follow the installation instructions provided with your software option.

Settings

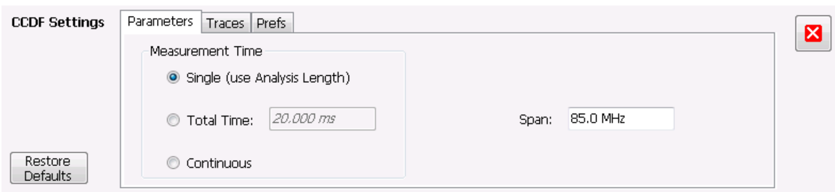
Menu Bar: Setup > Settings

Front Panel / Application Toolbar: 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.



The control panel for the CCDF display is shown in the following figure.



Settings Control Panels

Acquire

AM Settings

Amplitude Settings

Amplitude vs Time Settings

Analysis Settings

Audio Spectrum Settings

Audio Summary Settings

CCDF Settings

Channel Power and ACPR Settings

OFDM Channel Response Settings (*OFDM*) (*WLAN*)

Configure In/Out Settings

Constellation Settings

DPX Spectrum Settings

EVM vs Time Settings

Eye Diagram Settings

FM Settings

Frequency Deviation vs Time Settings

Frequency vs Time Settings

Magnitude Error Settings

MCPR Settings

Occupied Bandwidth Settings

OFDM Constellation Settings

OFDM EVM Settings

OFDM Magnitude Error Settings

OFDM Phase Error Settings

OFDM Power Settings

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OFDM Symbol Table Settings

Phase Error vs Time Settings

Phase Noise Settings

Phase vs Time Settings

PM Settings

Pulse Statistics Settings

Pulse Table Settings

Pulse Trace Settings

RF I Q vs Time Settings

Mask Test Limits Settings

Spectral Emissions Mask Settings

Settling Time Settings

Signal Quality Settings

Spectrogram Settings

Spectrum Settings

Spurious Settings

Symbol Table Settings

Time Overview Settings

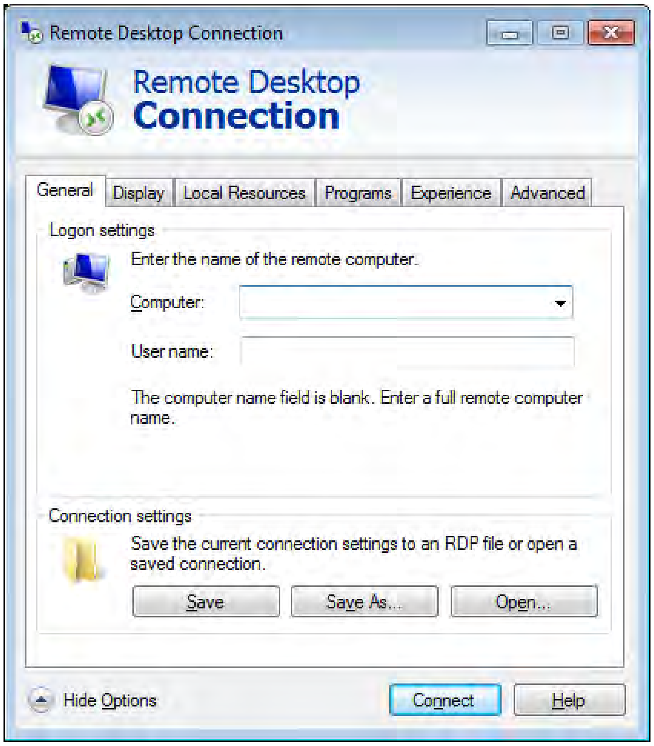
Trellis Diagram Settings

Remote login

You can access the instrument across a network using Windows Remote Desktop Connection.

To access the instrument using Windows Remote Desktop Connection for the first time:

1. On the PC from which you want to remotely access the instrument, select **Start** > **All Programs** > **Accessories** > **Remote Desktop Connection**.
2. In the Remote Desktop Connection window, click the **Options** button to display all the available settings if they are not already visible.



3. Enter the name of the instrument in the **Computer** field. (To find out the name of the instrument, go to the Windows desktop, right-click the Computer icon, and select **Properties**. The computer name will appear on the control panel window.)
4. Enter **OEM** in the **User name** field.
5. Click **Connect** to initiate the connection.
6. Enter **spearfish** as the password when prompted.

Glossary

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* on page 740.

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:

%RippleWatts =10 0× RatioPos+RatioNeg

Where:

RatioNeg= DelNeg RefNeg +1 ^{2} -1

RatioPos= DelPos RefPos +1 ^{2} -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:

%RippleVolts =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* on page 734).

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.

Signal Strength

Signal Strength locates the direction of a signal using a directional antenna and an audio tone and a visual display.

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/Spot

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. This is called a spot in the EMC-EMI display.

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Special Characters

Numerics

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