R&S®FSQ-K91, -K91n and -K91ac WLAN Application Firmware

Operating Manual

1157.3135.42 – 08

Test & Measurement

Operating Manual

ROHDE&SCHWARZ

The Operating Manual describes the following and firmware applications

- R&S®FSQ-K91 (1157.3129.02)
- R&S®FSQ-K91n (1308.9387.02)
- R&S®FSQ-K91ac (1308.9170.02)

The contents are applicable to the following instruments.

- R&S®FSQ (1313.9100.xx)

The contents of this manual correspond to firmware version 4.75SP5 and higher.

Muehldorfstr. 15, 81671 Munich. Germany
Phone: +49 89 4129-0
Fax: +49 89 4129-12 164
E-mail: info@rohde-schwarz.com
Internet: http://www.rohde-schwarz.com

81671 Munich, Germany

The following abbreviations are used throughout this manual:
R&S®FSQ-K91 is abbreviated as R&S FSQ-K91.

Table of Contents

1 Introduction

The applications R&S FSQ-K91, -K91n and -K91ac (in the following abbreviated as "WLAN applications") extend the functionality of the R&S FSQ spectrum analyzer to enable Wireless LAN Tx measurements in accordance with IEEE standards IEEE 802.11a/b/g/j (R&S FSQ-K91), IEEE 802.11n (R&S FSQ-K91n) and IEEE 802.11ac (R&S FSQ-K91ac).

This manual describes how to use the WLAN applications. It contains instructions on how to prepare, execute and evaluate measurements and also contains many helpful hints and examples.

- Chapter "Introduction" (page 5) contains basic information about the WLAN application, including a "Quick Start Guide" that describes a basic WLAN measurement.
- Chapter "Measurements and Result Displays" (page 32) contains extensive information about the measurements and result displays that the WLAN application provides.
- Chapter "Configuration" (page 72) contains extensive information about measurement configuration and the parameters that the application provides.
- Chapter "Measurement Basics" (page 135) contains background information about the featured measurements.
- Chapter "Remote Control" (page 159) contains all remote control commands supported by the WLAN application.
- Chapter "Remote Control - Programming Examples" (page 303) contains programming examples for remote control operation of the application.
- Chapter "Warnings & Error Messages" (page 306) contains a list of possible warnings and error messages that may occur during measurements.

1.1 Introduction to IEEE 802.11 Tests

The R&S FSQ-K91 WLAN application extends the functionality of the R&S FSQ to enable accurate and reproducible Tx measurements of a WLAN device under test (DUT) in accordance with the standards specified for the device.

The following standards are currently supported (if the corresponding firmware option is installed):

- IEEE 802.11a
- IEEE 802.11b
- IEEE 802.11g (OFDM)
- IEEE 802.11g (DSSS)
- IEEE 802.11j
- IEEE 802.11n (SISO) (with option **R&S FSQ-K91n**)
- IEEE 802.11n (MIMO) (with option **R&S FSQ-K91n**)
- IEEE 802.11 ac (with option **R&S FSQ-K91ac**)
- IEEE 802.11 OFDM Turbo Mode

Features

- Modulation measurements
  - Constellation diagram
  - Constellation diagram for each OFDM carrier
  - I/Q offset and I/Q imbalance
  - Carrier and symbol frequency errors
  - Modulation error (EVM) for each OFDM carrier or symbol
  - Amplitude response and group-delay distortion (spectral flatness)
- Amplitude statistics (CCDF) and crest factor
- Transmit spectrum mask
- FFT, also over a selected part of the signal, e.g. preamble
- Payload bit information
- Capture time selectable up to 100 ms (depending on selected standard), multiple sweeps possible for large number of PPDUs
- Freq/Phase Err vs. Preamble

1.2 Installation

Installing the software

To get the full functionality of the WLAN application described in this document, make sure to install the latest firmware. The latest firmware is available for download on the R&S FSQ homepage at http://www.rohde-schwarz.com/product/fsq.html.

To perform a firmware update, proceed as follows.

1. Copy the downloaded data to a memory stick or similar USB device and connect it to the R&S FSQ.
2. Press the SETUP key.
3. Press the NEXT key.
4. Press the "Firmware Update" softkey.
5. In the submenu, again press the "Firmware Update"s oftkey.
6. Follow the instructions as displayed on the screen.

   When the installation is done, the analyzer will reboot.

Also refer to the documentation of the R&S FSQ for more comprehensive instructions on how to perform firmware updates.

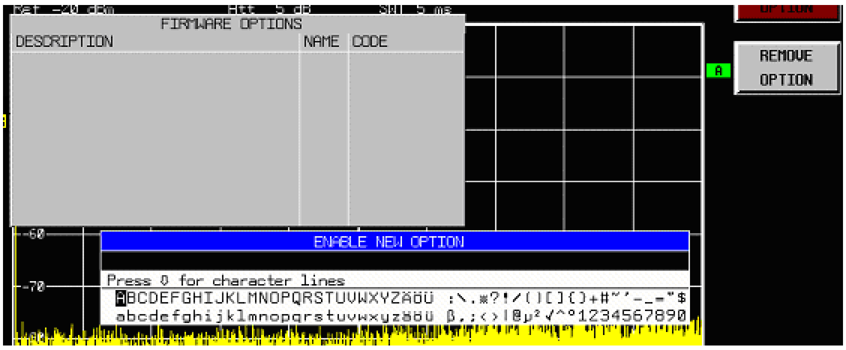
Activating the firmware option

Once the option has been installed, it needs to be activated with an option key.

1. Press the SETUP key
2. Press the "General Setup" softkey
3. Press the "Options" softkey.

   The R&S FSQ displays a list of currently active firmware applications.
4. Press the "Install Option" softkey.

   The R&S FSQ opens a dialog box to enter the option key.



5. Enter the option key supplied with the WLAN application.

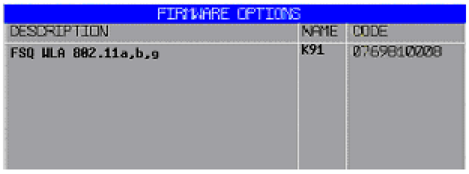
   If you are upgrading from an older version of the WLAN application (for example from the R&S FSQ-K90 to R&S FSQ-K91 or R&S FSQ-K91n), enter the upgrade key in addition to the original R&S FSQ-K90 option key.

   An additional key is also required for IEEE 802.11n and IEEE 802.11ac support.

   If the option key you have entered is valid, you have to reboot the R&S FSQ. The R&S FSQ displays a corresponding message box.

6. Press "OK" in the message box to reboot the R&S FSQ.

   When the R&S FSQ has rebooted, it displays a new hotkey at the bottom of the display labeled "WLAN". In addition, the "Firmware Options" dialog box contains an entry for the WLAN application(s).



1.3 Starting the Application

► Turn on the R&S FSQ.

If the WLAN application has been installed correctly, the hotkey bar at the bottom of the screen should contain a hotkey labeled "WLAN".

► Press the "WLAN" hotkey to start the WLAN application.

If you turn off the R&S FSQ while the WLAN application is active, the R&S FSQ will start up in the WLAN application when you turn it on again.

1.4 Exiting the Application

► To exit the WLAN application, press the "SPECTRUM" hotkey.

The R&S FSQ closes the WLAN application and enters Spectrum mode. The settings that were active before you started the WLAN application are restored.

1.5 Quick Start Guide

The Quick Start Guide helps you to become familiar with the WLAN application. It contains a basic single carrier WLAN measurement and a basic MIMO measurement.

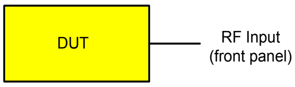
Both measurements use a basic configuration that allows you to perform the measurements quickly and efficiently.

1.5.1 Performing a Single Carrier Measurement

The DUT in this example generates an IEEE 802.11a signal with a 16QAM modulation.

Measurement setup

► Connect the DUT tot he RF input on the front panel of the R&S FSQ.



Preparing the measurement

1. Start the WLAN application.
2. Press the "General Settings" softkey

   The R&S FSQ opens the "General Settings" dialog box.
3. Select the the IEEE 802.11a standard from the "Standard" dropdown menu.
4. Select the "Frequency" field and enter the required measurement frequency.

   If you enter a valid frequency, the application updates the "Channel No" field (→ "Signal Characteristics").

   Note that you can also access the "Frequency" field directly by pressing the FREQ key.
5. Make sure to turn on auto leveling by adding the checkmark in the "Auto" field (→ "Level Settings") to enable automatic level detection.

   If auto leveling is on, the WLAN application automatically determines the ideal reference level prior to each measurement.

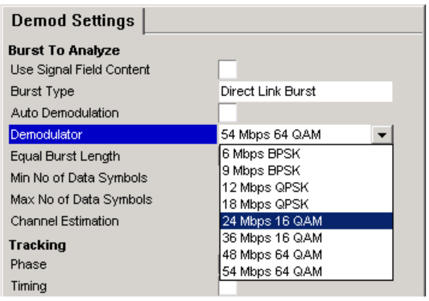
   Alternatively, you can start a measurement to determine the ideal reference level with the AUTO LVL hotkey.

All other settings in the "General Settings" dialog box are sufficient for this example.

6. Press the "Demod Settings" softkey.

   The R&S FSQ opens the "Demod Settings" dialog box.

7. Select the modulation scheme in the "Demodulator" field.



8. Close the "Demod Settings" dialog box with the WLAN hotkey.

Performing the Measurement

1. Press the RUN SGL hotkey to start the measurement.
2. During the measurement, the text "Running..." is displayed in the status bar at the bottom of the screen.

Measurement results are updated once the measurement has been completed. The results are displayed in graphical form. The display can be toggled to a tabular list of measurement results by pressing the *DISPLAY* softkey.

1.5.2 Performing a MIMO Measurement

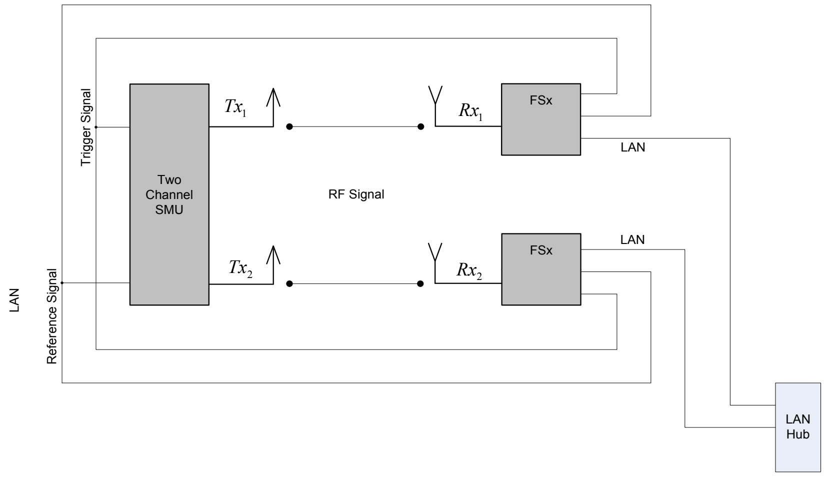
The DUT, in this case an R&S SMU, generates an IEEE 802.11n signal. The R&S SMU simulates a MIMO DUT with two transmission antennas.

The R&S SMU has to be equipped with two RF paths and the corresponding option for WLAN signal generation (R&S SMU-K54 for IEEE 802.11n signals).

To test both antennas simultaneously, two signal analyzers are required. However, only one analyzer needs to be equipped with the WLAN application.

Measurement setup

► Connect the DUT and analyzers as illustrated below.



► Connect the two analyzers to each other directly with a cross LAN cable or integrate them both in a LAN. The analyzer with the WLAN application (master) controls the second analyzer (slave) by providing the trigger signal to start the measurement.

► Connect the external reference REF OUT of the R&S SMU to the external reference REF IN of the analyzers.

Turn on the external reference for both analyzers in the spectrum analyzer base system.

► Connect the marker output of the R&S SMU to the Ext Trigger input of the analyzers.

► Establish a connection between the signal generator and the analyzers.

- Connect the Path A RF / Baseband connector directly to the first analyzer, and the Path B RF / Baseband connector directly to the second analyzer.

  or

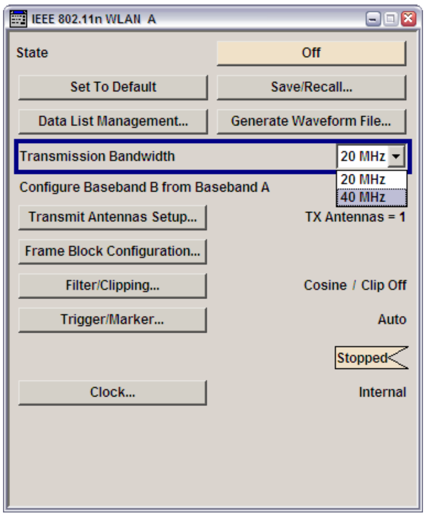
- Use the air interface with appropriate antennas.

Configuring the signal generator

Basically, it is sufficient to configure one Baseband and then configure the second Baseband from the first.

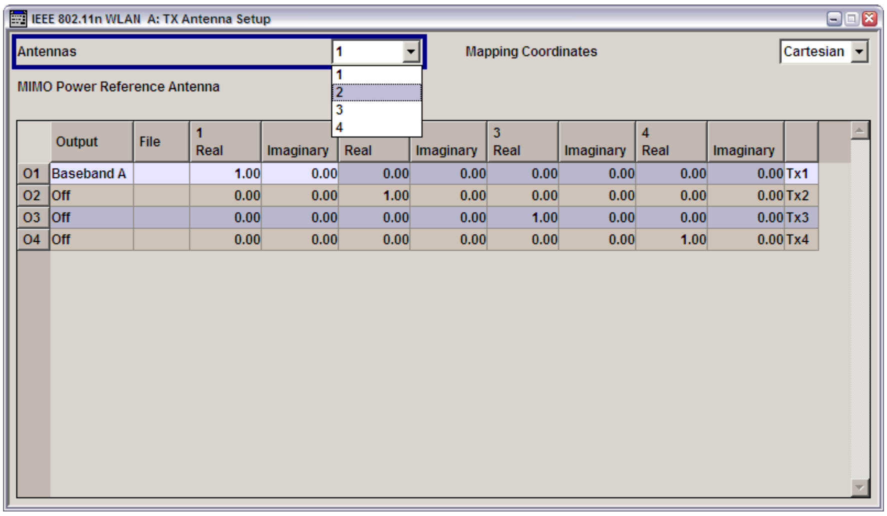
1. Select the signal path for "Baseband A".
2. Select the "IEEE 802.11n…" option to configure a WLAN signal.

   The R&S SMU opens the "IEEE 802.11n WLAN A" dialog box.



3. Select a "Transmission Bandwidth" of 40 MHz.
4. Press the "Transmit Antennas Setup…" button.

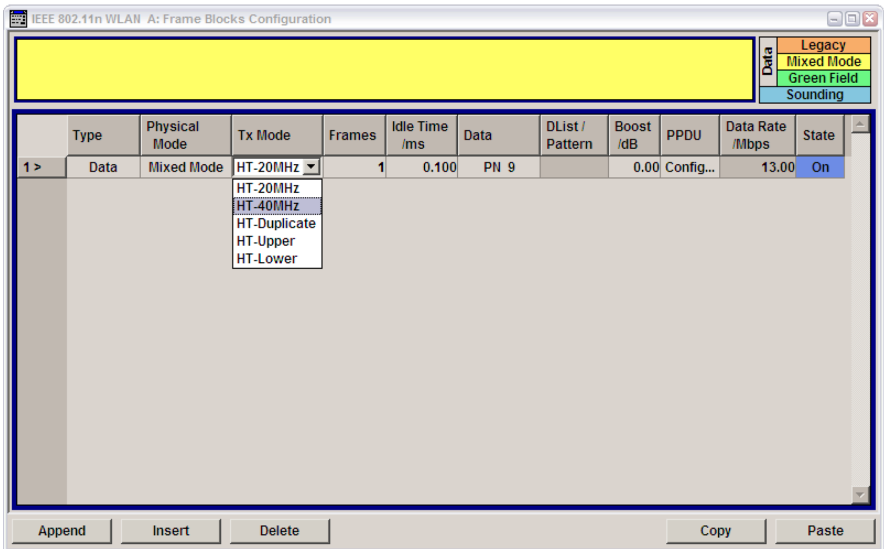
   The R&S SMU opens the "IEEE 802.11n WLAN A: Tx Antenna Setup" dialog box.



5. Select 2 antennas from the "Antennas" dropdown menu.
6. Return to the "IEEE 802.11n WLAN A" dialog box.

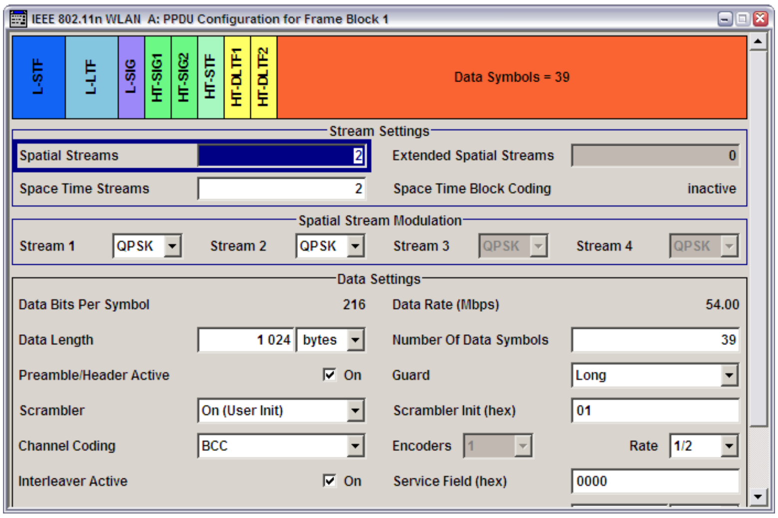
7. Press the "Frame Block Configuration…" button.

   The R&S SMU opens the "IEEE 802.11n WLAN A Frame Blocks Configuration" dialog box.



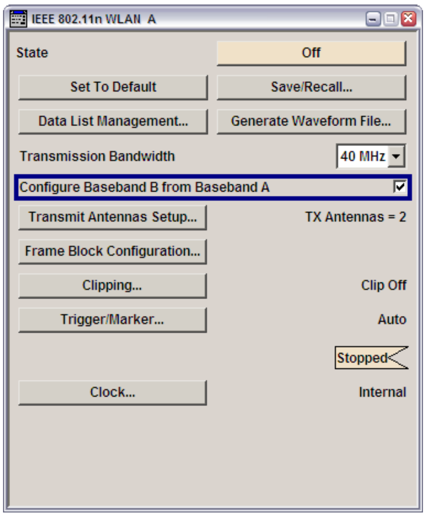
8. Select HT-40MHz from the "Tx Mode" dropdown menu.
9. Press the "PPDU Config…" button.

   The R&S SMU opens the "IEEE 802.11n WLAN A: PPDU Configuration for Frame Block 1" dialog box.



10. Select two "Spatial Streams" and two "Space Time Streams".

11. Return to the "IEEE 802.11n WLAN A" dialog box.



12. Select "Configure Baseband B from Baseband A".

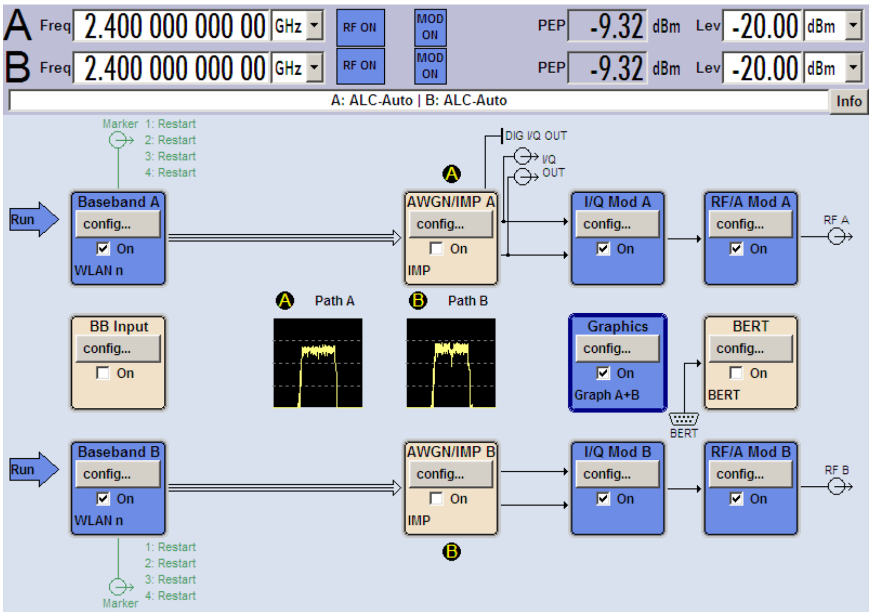
    The R&S SMU transfers the configuration of Path A to Baseband Path B. Thus, Baseband Path B also generates an IEEE 802.11n signal.

13. Press the "State" button to turn on the signal.

    Make also sure that both signal paths (RF/A Mod A and RF/B Mod B) are turned on.

14. Turn on the Graphics | Power Spectrum display.

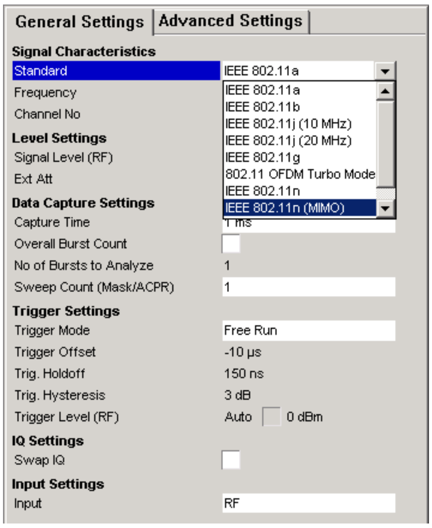
    These displays show the power spectrum for both antennas.



Configuring the spectrum analyzer

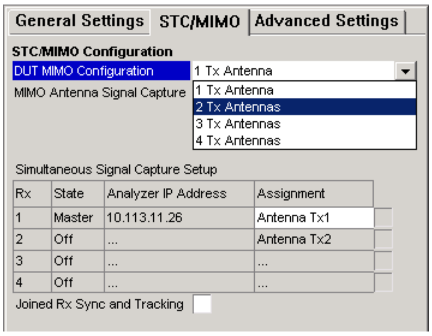
After configuring the signal generator, configure the spectrum analyzer.

1. Start the WLAN application.
2. Press the "General Settings" softkey to open the "General Settings" dialog.

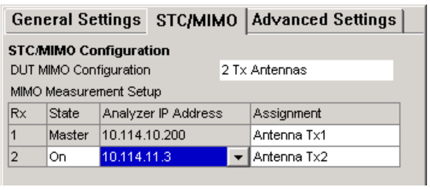


3. Select "IEEE 802.11n (MIMO)" from the "Standard" dropdown menu.
4. Define the RF Frequency the DUT is transmitting in the "Frequency" field.
5. Select the external "Trigger Mode".
6. Select the "STC/MIMO" tab with the left and right cursor keys.

   Changing the tabs is possible when the cursor (blue background) is positioned on the tab label. You can position the cursor with the up and down cursor keys, for example.
7. Select "2 Tx Antennas" from the "DUT MIMO Configuration" dropdown menu.

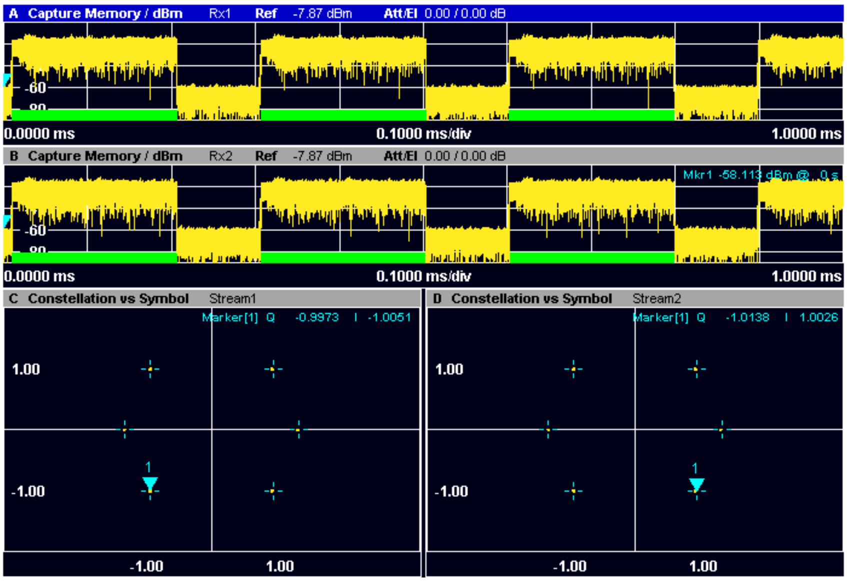


8. Enter the IP Address of the second signal analyzer in the "MIMO Measurement Setup" table.



9. Turn on the second analyzer in the "State" column.
10. Press the RUN SGL or RUN CONT hotkey.

    The application starts the measurement and shows the results.



1.6 Navigation

This section describes the navigation within the option. Navigation in this context means all forms of interaction with the option except for remote control. The different methods of interacting with the option are:

- Hotkeys
- Softkeys
- Hardkeys
- Numeric keypad
- Rotary knob
- Cursor keys
- External keyboard
- Mouse

1.6.1 Hotkeys

Hotkeys are allocated to the seven keys at the bottom edge of the screen. On initial startup of the WLAN application, the hotkeys provided are shown in Fig. 1. These hotkeys are present at all times after the option has been started.

Fig. 1 Initial hotkey menu

Pressing one of the hotkeys activates the associated hotkey. When active, the color of the hotkey turns green.

The hotkeys perform the following operations:

The SPECTRUM hotkey exits the WLAN application and returns to Spectrum mode with all previous settings restored.

The WLAN hotkey restores the main measurement menu of the WLAN application. All settings and dialog boxes are removed from the display, and the default softkey menu is displayed.

The WLAN hotkey remains green as long as the WLAN application is active.

The AUTO LVL hotkey starts an automatic level detection measurement.

If another measurement is running, it will be aborted before the automatic level detection measurement is started. If a continuous measurement is running when the AUTO LVL hotkey is pressed, the continuous measurement will resume after the automatic level detection has been completed.

Pressing the AUTO LVL hotkey while an automatic level detection measurement is running causes the measurement to be stopped immediately.

RUN SGL

The RUN SGL hotkey initiates a single measurement.

- Pressing RUN SGL while a single sweep measurement is running causes the application to stop the measurement.
- Pressing RUN SGL while a continuous measurement is running causes the application to abort that measurement before it initiates the single measurement.

RUN CONT

The RUN CONT hotkey initiates a continuous measurement.

Pressing RUN CONT while a continuous measurement is running causes the application to stop the measurement.

Pressing RUN CONT while a single measurement is running causes the application to abort that measurement before it initiates the continuous measurement.

REFRESH

The REFRESH hotkey updates the current measurement results to reflect the current measurement settings.

The REFRESH hotkey is available for all I/Q measurements. The REFRESH hotkey is available only when I/Q data is available.

SCREEN B

The SCREEN [A|B] hotkey selects the specified screen as the active screen.

In full screen mode, pressing the SCREEN [A|B] hotkey displays the specified screen.

Pressing the SCREEN [A|B] hotkey changes the label displayed in the hotkey, for example, pressing SCREEN A changes the label of the hotkey to SCREEN B. The label indicates which screen will become the active screen after the hotkey is pressed.

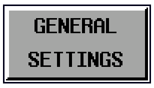
Note that in case of MIMO measurements with several windows in the result displays, this hotkey is labeled SCREEN…

1.6.2 Softkeys

1.6.2.1 Settings Softkeys

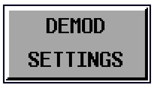
The softkeys are assigned to the nine keys on the right-hand side of the display. These enable quick access to all settings and measurement screens of the WLAN application.

The two softkeys at the top ("General Settings" and "Demod Settings") are always available (except when you are using the save / Recall, print or markers functionality). They open the corresponding dialog boxes whose features are described in "Measurements and Result Displays" on page 32.



General Settings

Configures signal characteristics, data capture, trigger functionality and I/Q settings.

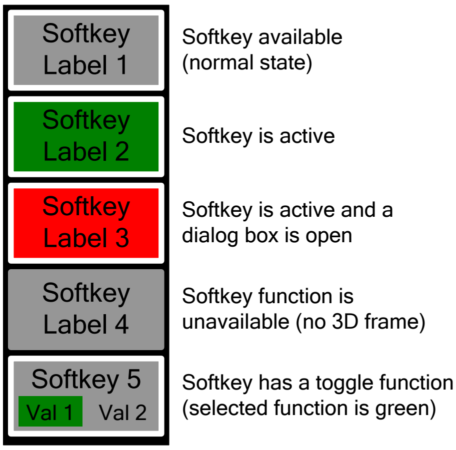


Demod Settings

Configures the type of PPDU to measure.

1.6.2.2 Other Softkeys

All other softkeys have different functions depending on the instrument state. Therefore, the labels (text) on the softkeys vary to reflect their current function. The state of the softkeys is indicated by different appearances and colors, as follows:



- When the function of a softkey is available, it is colored grey with a 3D border.
- When the function of a softkey is active, it is colored green with a 3D border.
- When the function of a softkey is active and a dialog box is displayed, it is colored red with a 3D border.
- When the function of a softkey is unavailable, it is colored grey without a 3D border. This may be the case if the function is not supported by the current configuration.
- When a softkey has several functions (toggle functionality), you can access the different functions by repeatedly pressing the softkey. The currently active function is colored green.
- When a softkey has no function, the application shows no label for that softkey.

1.6.3 Hardkeys

Hardkeys allow quick access to a particular parameter and various functions. The WLAN application supports the following hardkeys.

FREQ Opens the "General Settings" dialog box and selects the "Frequency" parameter for quick definition of the measurement frequency.

AMPT Opens the "General Settings" dialog box and selects the "Signal Level" parameter for quick definition of the expected signal level.

MKR Opens the Marker menu to configure markers.

MKR→ Opens the Marker To menu to position markers.

SWEEP Opens the "General Settings" dialog box and selects the "Capture Time" parameter for quick definition of the measurement time.

MEAS Opens the Measurement menu to configure and select measurements.

TRACE Opens the "General Settings" menu and selects the "Burst Count" parameter for quick definition of the PPDU count.

LINES Allows you to define limits for numerical results.

Available for the numerical Result Summary.

DISP Opens the Display menu to configure the display.

FILE Opens the file manager to save and restore measurement results and configuration.

PRESET Exits the WLAN application and restores the default configuration of the R&S FSQ.

HCOPY Opens a menu to configure the printer.

1.6.4 External Keyboard

The WLAN application allows you to control it with an external keyboard. It supports the following keys to interact with the application.

Number keys (0 to 9)	Allows you to enter any kind of number.
Decimal point (".")	Inserts a decimal point "." at the cursor position.
Minus key ("-")	If you are using it with numbers, the minus key changes the sign of the mantissa or the exponent of that number. If you are using it with alphanumeric characters, the minus key writes a dash character.
ESC key	Aborts the entry before it has been terminated. The previous value is restored. Closes the entry field after termination of input. Closes dialog boxes.
ENTER key	Terminates the input of dimension quantities. The new value is set. Activates the input of parameters or immediately sets the new value. Selects the highlighted item in dropdown menus.
Left and Right Cursor	Navigates between individual parameters within dialog boxes. Navigates between the individual items within dropdown menus. Moves the cursor left and right inside an entry window to reach a particular position in a string during alphanumeric entries.
Up and Down Cursor	Navigates between individual parameters within the setting views and some of the dialog boxes. Navigates between the individual items within dropdown menus. Increments or decrements the numeric value of a parameter.
CTRL keys	Controls and selects hotkeys in combination with the function keys. Each of the seven hotkeys is allocated a different function (F<x>) key. To access these hotkeys, press CTRL-F<x>.

CTRL-F1 CTRL-F2 CTRL-F3 CTRL-F4 CTRL-F5 CTRL-F6 CTRL-F7

Function Keys

Controls and selects softkeys

Each of the nine softkeys is allocated a different function (F<x>) key. To access these softkeys, F<x>.

Softkey 1	F1
Softkey 2	F2
Softkey 3	F3
Softkey 4	F4
...	
Softkey 9	F9

1.6.5 Mouse

The WLAN application supports a mouse to select parameters within dialog boxes or input fields. It also allows you to select hotkeys, softkeys or items from a dropdown menu with the mouse.

1.6.6 Selecting and Editing Parameters

You can change the values of parameters in different ways.

- Enter numeric or alphanumeric values
- Select an item from a dropdown menu
- Turn something on and off with a check box.

In all cases, the parameter has to be selected by placing focus on it. You can do so by navigating to the corresponding parameter with the cursor keys or the rotary knob.

The R&S FSQ provides the following methods to edit parameters. (As an alternative, you can use an external keyboard or mouse)

1.6.6.1 Numeric Keypad

The numeric keypad is provided for entering numeric parameters. It contains the following keys:

Number keys 0 to 9

The number keys allow you to enter a numeric value into fields that support numeric values.

The number keys also allow you to enter numbers into fields that support alphanumeric values. The number is entered at the cursor position in that case.

Decimal point (".")

Inserts a decimal point at the cursor position.

Minus sign ("-")

The minus key changes the sign of the mantissa or the exponent of that number, if you use it in a field that supports numeric values.

If you are using it with alphanumeric characters, the minus key writes a dash character.

Unit keys (GHz/-dBm, MHz/dBm, kHz/dB and Hz/dB)

Provides the numeric value entered with the selected unit and sets the parameter to that value.

The unit keys are all assigned the value "1" for dimensionless quantities or for level entries (e.g. in dB). The unit keys thus assume the function of an ENTER key.

BACK key

Deletes the character to the left of the cursor when you are entering alphanumeric values.

ESC/CANCEL key

– Aborts the entry of a new parameter value. The previous value is restored.
– Closes dialog boxes.

ENTER key

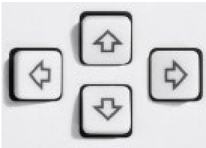
– Enables editing of the selected parameter (using numeric keys or rotary knob).
– Finishes the editing of a parameter value. The new value is set.
– For an alphanumeric value, the new value is set to the displayed value (using the current unit if applicable).
– In a drop-down menu, the parameter is set to the currently selected value in the list.

1.6.6.2 Rotary Knob

The rotary knob allows you to perform the following actions.

- In a dialog box, the rotary knob navigates between individual parameters. The currently selected parameter is highlighted blue.
- In dropdown menus, the rotary knob navigates between the individual values for the parameter.
- While changing a numeric parameter, its value is incremented (by turning clockwise) or decremented (by turning counterclockwise) at a defined step size (depending on the parameter).
- In dialog boxes, pressing the rotary knob activates the input or selection of values or immediately sets the new value. Thus, pressing the rotary knob is like pressing the ENTER key.
- In dropdown menus, pressing the rotary knob selects the required item.

1.6.6.3 Cursor Keys



The left () and right () cursor keys are used as follows.

- In a dialog box, the cursor keys navigate between individual parameters. The currently selected parameter is highlighted blue.
- In dropdown menus, the rotary knob navigates between the individual values for the parameter.
- Moves the cursor inside an entry field left and right to reach a particular position in the string during alphanumeric entry.

The up () and down () cursor keys are used as follows.

- In a dialog box, the cursor keys navigate between individual parameters. The currently selected parameter is highlighted blue.
- In dropdown menus, the rotary knob navigates between the individual values for the parameter.
- Increment or decrement the value of a parameter during numeric entry.

1.6.6.4 Selecting Parameters in Dialog Boxes

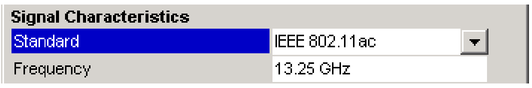
The application allows you to select parameters in different ways.

Selecting the parameter with the rotary knob

1. Open a dialog box (for example the "General Settings").
2. Turn the rotary knob until you reach a particular parameter.

   Turning the rotary knob clockwise selects a parameter below the current focus. Turning it counterclockwise selects a parameter above the current focus.

   When a parameter is in focus, its label turns blue.

   Press the rotary knob to edit the parameter. In case of numeric parameters, you can also edit the parameter by entering a numeric value from the numeric keypad without pressing ENTER first.

Selecting the parameter with the cursor keys

1. Open a dialog box (for example the "General Settings").
2. Press one of the cursor keys until you reach a particular parameter.

   Pressing the DOWN or RIGHT cursor keys selects a parameter below the current focus. Pressing the UP or LEFT cursor keys selects a parameter above the current focus.

   In a table, the cursor keys move the focus in the corresponding direction.

   When the focus is on a particular parameter, its label turns blue.

Selection using mouse

1. Move the cursor to a particular parameter
2. Press the left mouse button to put the focus on the parameter.

   When the focus is on a particular parameter, its label turns blue.

   Press the rotary knob or the ENTER key to edit the parameter. In case of numeric parameters, you can also edit the parameter by entering a numeric value from the numeric keypad without pressing ENTER first.

Selection using external keyboard

► Use the cursor keys to select a particular parameter (in the same way as using the cursor keys on the front panel).

   When the focus is on a particular parameter, its label turns blue.

   Press the rotary knob or the ENTER key to edit the parameter. In case of numeric parameters, you can also edit the parameter by entering a numeric value from the numeric keypad without pressing ENTER first.

1.6.6.5 Entering Numeric Values

The application allows you to enter numeric values in different ways.

1. Select a parameter.
2. Press the rotary knob to edit the parameter.

   In case of numeric parameters, you can edit the parameter by entering a numeric value from the numeric keypad without pressing ENTER first.

If the new value is not valid, a message box is displayed and the value you have entered is not accepted.

Entering values with the numeric keypad

1. Enter the required value using the number keys.
2. Finish the entry with one of the unit keys or the ENTER key for numbers without a unit.

Entering values with the cursor keys

1. Press the UP or DOWN cursor keys until you reach the required value.

   The application prevents the minimum and maximum values of the parameter from being exceeded and displays an "Out of range" message box if attempted.
2. Finish the entry with one of the unit keys or the ENTER key for numbers without a unit.

   Changing a numeric value with the cursor has a larger step size compared to changing a numeric value with the rotary knob.

   Each change of the parameter value takes place immediately. No other keys need to be pressed.

Entering values with the rotary knob

1. Turn the rotary knob until you reach the required value.

   Turning the rotary knob clockwise increases the value Turning it counterclockwise decreases the value.

   The application prevents the minimum and maximum values of the parameter from being exceeded and displays an "Out of range" message box if attempted.
2. Finish the entry with one of the unit keys or the ENTER key for numbers without a unit.

   Changing a numeric value with the cursor has a larger step size compared to changing a numeric value with the rotary knob.

   Each change of the parameter value takes place immediately. No other keys need to be pressed.

Entering values with an external keyboard

Using an external keyboard works the same way as when you are using the numeric keypad on the instrument.

Aborting the entry

► Press the ESC key while editing a parameter.

The original value is restored. The new entry is deleted.

1.6.6.6 Selecting Items from a Dropdown Menu

The application allows you to enter numeric values in different ways.

1. Select a parameter.
2. Press the rotary knob to open the dropdown menu.

Selecting items with the cursor keys

1. Press the UP and DOWN cursor keys to select an item in the dropdown menu.

   The currently selected value is highlighted blue.
2. Press the ENTER key or the rotary knob to activate the selected value.

Selecting items with the rotary knob

1. Turn the rotary knob until you reach the required item in the dropdown menu.

   The currently selected value is highlighted blue.
2. Press rotary knob to activate the selected value.

1.6.6.7 Using Checkboxes

A checkbox turns a parameter on and off (boolean settings).

The application shows a checkmark (✓) in the box when the setting is on. The checkbox is empty when the setting is off.

The application allows you to use checkboxes in different ways.

Using checkboxes with the rotary knob

► Press the rotary knob to toggle between the two states.

Using checkboxes with the numeric keypad

► Press the ENTER key to toggle between the two states.

Using checkboxes with a mouse

► Left-click on the checkbox to toggle between the two states.

Using checkboxes with an external keyboard

► Press the ENTER key to toggle between the two states.

1.6.7 Status Bar and Title Bar

1.6.7.1 Title Bar

The title bar is visible at the very top of the display when the WLAN application is active and no dialog boxes are displayed.

Fig. 2 Title Bar

The center of the title bar shows the currently selected WLAN standard. If the IEEE 802.11a standard is selected and a sample rate other than the default sample rate is specified, the sample rate used is displayed on the left-hand side of the title bar.

1.6.7.2 Status Bar

The main status bar is displayed at the bottom of the display, just above the hotkeys. When a parameter in a settings view is selected, the status bar will display the minimum and maximum settings for the selected parameter (see Fig. 3).

MIN:<XX.XX>	MAX:<XX.XX>

Fig. 3 Status Bar

When a parameter whose value is enumerated or boolean in type is selected in any dialog, the status bar will show "N/A" for the minimum and maximum, since the minimum and maximum values are "Not Applicable."

At other times, the status bar shows the current measurement status along with detailed information about the progress of any running measurement.

The status bar is also used to display warning and error messages to the user. In order to highlight these messages, warning messages are displayed with a blue background and error messages with a red background.

Refer to "Warnings & Error Messages" on page 306 for a list of warning and error messages.

1.7 Saving and Recalling Data

The FILE key opens a softkey menu to manage different types of files that you can use with the WLAN application.

Note that the application closes all dialog boxes when you start the file manager.

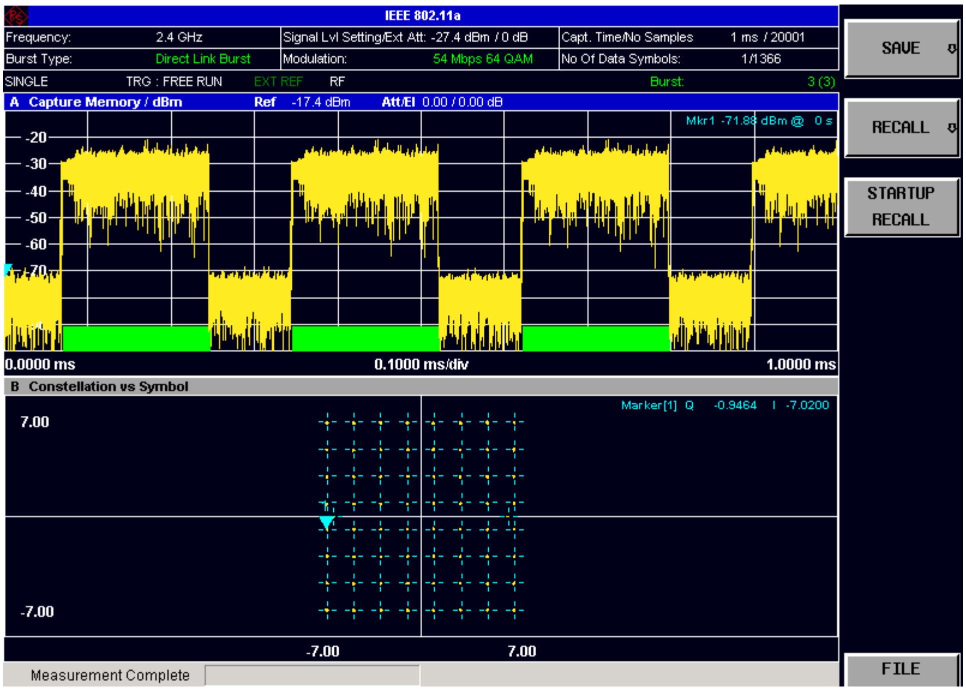


Fig. 4 Save/Recall softkey menu

The save / recall functionality provided by the WLAN application is exactly the same as that provided in Spectrum mode. Refer to the user manual for the spectrum analyzer for details about the save / recall functionality.

The save / recall functionality in the WLAN application supports saving and restoring the following items.

- Current Settings — All user settings provided by the WLAN application.
- WLAN Results — All current trace and table results.
- User Limits — All limit lines and table limit values.
- IQ Data — Allows the raw I/Q trace results to be stored. When restored, the data is reprocessed to generate results.

  Note: I/Q data can also be saved and restored using the Import / Export feature for .iqw format files.

► To close the save / recall softkey menu and return to the main softkey menu, press the *WLAN* hotkey.

1.8 Printing

This section of the user manual describes print functionality of the WLAN application.

The HCOPY key opens the Print softkey menu. Any dialog boxes are closed when you open the Save / Recall menu.

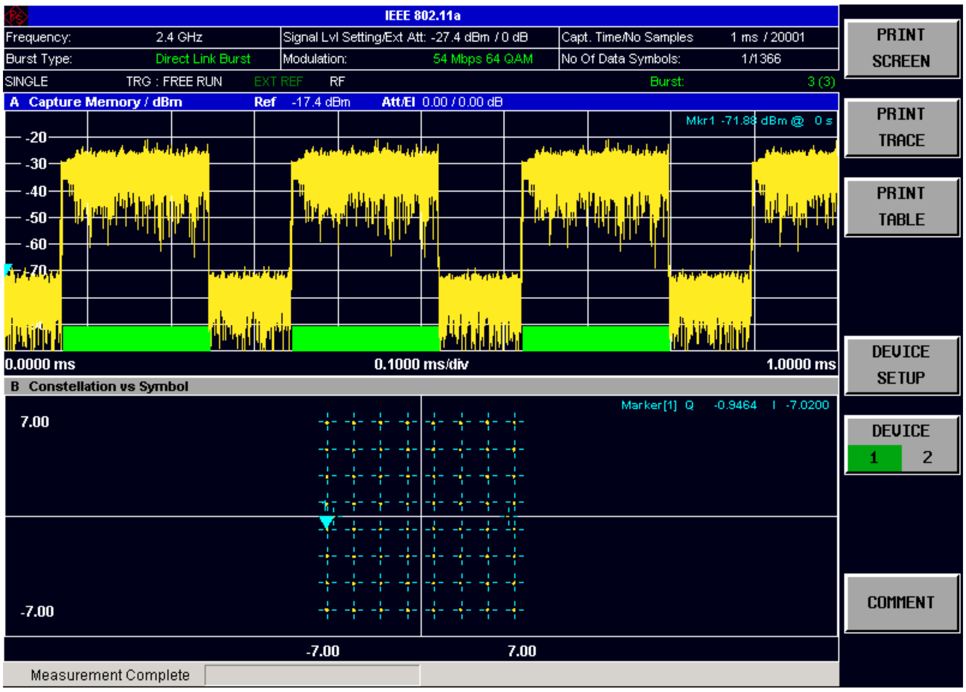


Fig. 5 Print softkey menu

The print functionality provided by the WLAN application is exactly the same as that provided in Spectrum mode. Refer to the user manual for the spectrum analyzer for details about the print functionality.

► To close the print softkey menu and return to the main softkey menu, press the WLAN hotkey.

2 Measurements and Result Displays

2.1 Performing Measurements

To start a measurement, press the RUN SGL hotkey (single) or RUN CONT hotkey (continuous).

The length of a single measurement or single sweep is defined by the "No of Bursts to Analyze" or the "Capture Time".

If you perform a continuous measurement, the application runs the measurement in an endless loop. The measurement only stops if you stop it on purpose. To stop continuous measurements, either press the RUN CONT hotkey again or start a single measurement with RUN SGL. If you stop the measurement with RUN CONT, the current data remains in the capture buffer.

While the measurement runs continuously, the WLAN application averages the data.

If one measurement is started while another measurement is in progress (for example, a single measurement is started while a continuous measurement is in progress), the first measurement will be aborted and the new measurement started immediately.

During a measurement, the text "*Running...*" is displayed in the Status Bar at the bottom of the screen. After successful completion of a single measurement, the Status Bar will display "*Measurement Complete*".

Remote:

INITiate[:IMMediate]

INITiate:CONTinuous <State>

In remote operation it is recommended to perform synchronized single measurements.

2.2 Measurements

The WLAN application provides two main measurement types:

- I/Q Measurements (see page 33)
- Frequency Sweep Measurements (see page 56)

2.2.1 I/Q Measurements

The following result displays are available in I/Q measurement mode:

- Power vs Time (PVT)
- EVM vs Symbol
- EVM vs Carrier
- Frequency Error vs Preamble
- Phase Error vs Preamble
- Spectrum Flatness and Group Delay
- Spectrum FFT
- Constellation
- Constellation vs Carrier
- Complementary Cumulative Distribution Function
- Bit Stream
- Signal Field
- PLCP Header

Note that all I/Q measurements process the same signal data and, thus, all I/Q measurement results are available after a single I/Q measurement.

You can use all available input sources for I/Q measurements (RF, analog baseband and digital baseband).

2.2.1.1 Capture Buffer

The Capture Buffer result display shows the power characteristics of the signal over time. The amount of data that is displayed depends on the Capture Time or the No of Bursts to Analyze.

All analyzed PPDUs are labeled with a green bar at the bottom of the result display. PPDUs which are analyzed but contain possible errors are labeled by a yellow bar.

In split screen mode, the Capture Buffer is always displayed in Screen A.

If you select the "Use Signal Field Content" parameter in the "Demod Settings" dialog box, only PPDUs that match the required criteria are marked with a green bar.

In case of the IEEE 802.11b standard, the Use Signal Field Content parameter is replaced by Use (PLCP) Header Content parameter.

For automatic signal demodulation check Use (PLCP) Header Content and Auto Demodulation.

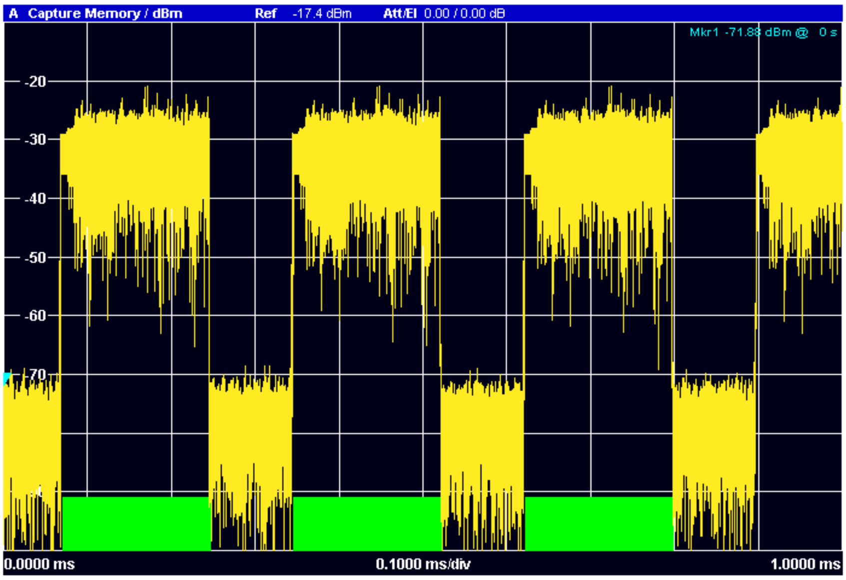


Fig. 6 Magnitude Capture Buffer results

Screen size

You can display I/Q measurement results in split screen mode or full screen mode.

Split screen mode allows both the Capture Buffer result display and the selected I/Q measurement results to be displayed simultaneously. Full screen mode shows either the Capture Buffer result display or the selected I/Q measurement results.

2.2.1.2 Power vs Time (PVT)

► Press the "PVT" softkey in the main measurement menu to select the Power vs Time result display.

The PVT result display shows the minimum, average and maximum power of the PPDUs that have been captured and evaluated or over a complete PPDU in case of a gated measurement.

The displayed results are calculated over all PPDUs available in the capture buffer.

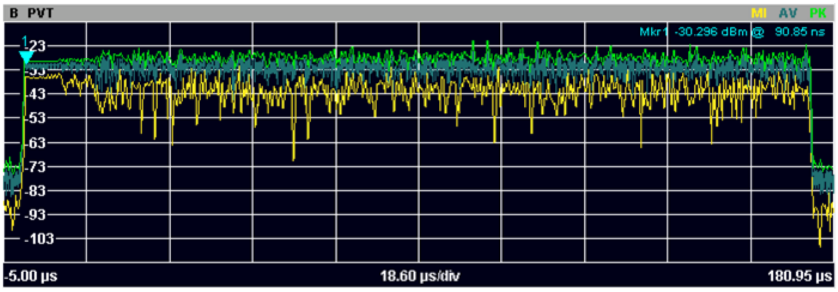
If you are performing a gated measurement and change the gate settings, you can update the results with the REFRESH hotkey.
The information in the result display depends on the WLAN standard.

The application allows you display the full PPDU (→ "Full Burst" softkey) or only the rising and falling edges / ramps of the PPDU (→ "Rising Falling" softkey and "Up Ramp" and "Down Ramp" softkeys).

- Full Burst

  If you display the full burst, the x-axis represents the length of one PPDU and shows its characteristics without interruption.

  Displaying full PPDUs is available for IEEE 802.11a, g (OFDM), j and n.

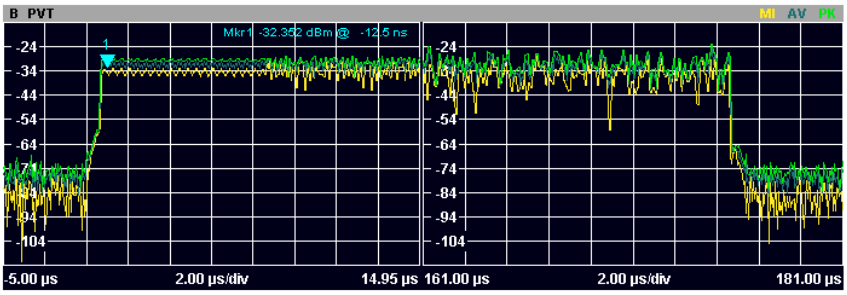


PvT results for a full PPDU (example based on an IEEE802.11a signal)

- Rising and falling edges

  If you display the rising and falling edges, the result display is split into two diagrams. The first diagram contains the rising edge of the PPDU, the second diagram the falling edge of the PPDU.

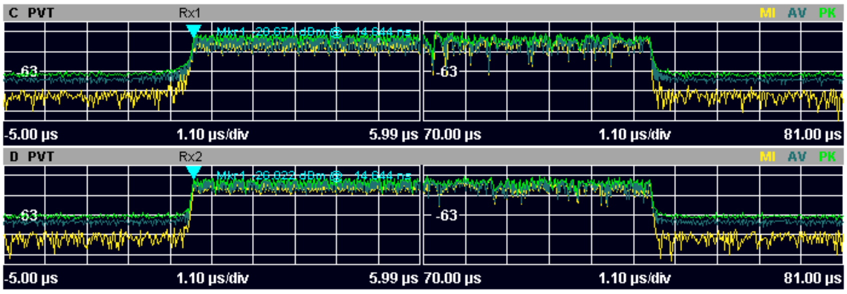
  Displaying the rising and falling edges of a PPDU is available for IEEE 802.11a, j, n, ac and Turbo Mode.



PvT results for the edges only (example based on an IEEE802.11a signal)

- MIMO measurements

  In case of MIMO measurements (IEEE 802.11n and ac), the result display is split into several smaller ones, each of which contains the information about one antenna. So, for example, if you have captured the data from two antennas, the result display would split into two diagrams. The first diagram contains the burst characteristics of the first antenna, the second diagram those of the second antenna.



PvT results for the edges only (example based on an IEEE802.11n MIMO signal with 2 antennas)

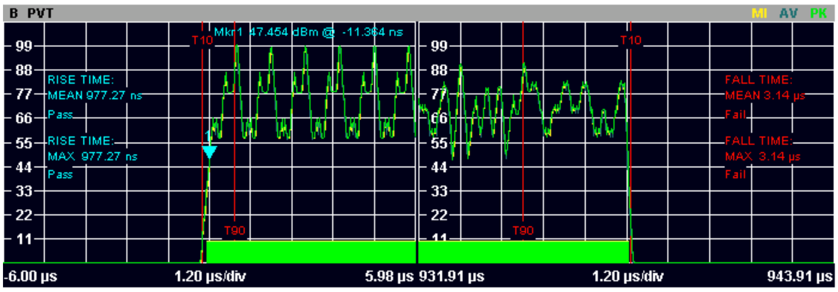
- Rising and falling ramps

  For measurements on IEEE 802.11b and g (Single Carrier) signals, the PvT results are a percentage of a reference power. You can either display the rising or falling ramp only, or both (→ "Up Ramp" and "Down Ramp" softkeys).

  For both rising and falling edges, two time lines are displayed, which mark the points 10 % and 90 % of the reference power. The time between these two points is compared against the limits specified by the IEEE 802.11 standard for the rising and falling edges.

  The reference power is either the maximum or mean power of a PPDU (→ "Ref Pow (Max Mean)" softkey).

  In addition, you can also define the length of a smoothing filter (→ "Average Length" softkey). For more information on the smoothing filter see "Working with modulated signals (smoothing filter)".



PvT results for the rising and falling ramps (example based on an IEEE802.11b signal)

Remote:

CONFigure:BURSt:PVT:SELect <Method>

CONFigure:BURSt:PVT:RPOWer <ReferencePower>

CONFigure:BURSt:PVT:AVERage <Samples>

Definition of the rise and fall time

The Rise Time and Fall Time are calculated according to the following algorithm:

1. Apply a smoothing filter across the PPDU power (adjustable average length)
2. If "REF POW" = 'MAX':

   Search for maximum power $P_{\max}$ across the entire PPDU. Set $P_{ref} = P_{\max}$.

   If "REF POW" = 'MEAN':

   Calculate mean power P_{mean} of the entire PPDU. Set $P_{ref} = P_{mean}$.
3. Rise Time
   a. Search for the first crossing of $0.5 \cdot P_{ref}$ from the left.
   b. Search backward for the 10 % crossing $0.1 \cdot P_{ref}$ and note t_{10} .
   c. Search forward for the 90 % crossing $0.9 \cdot P_{ref}$ and note t_{90} .
   d. Return $T_{Rise} = t_{90} - t_{10}$.
4. Fall Time
   a. Search for the first crossing of $0.5 \cdot P_{ref}$ from the right.
   b. Search forward for the 10 % crossing $0.1 \cdot P_{ref}$ and note t_{10} .
   c. Search backward for the 90 % crossing $0.9 \cdot P_{ref}$ and note t_{90} .
   d. Return $T_{Fall} = t_{10} - t_{90}$.

Working with modulated signals (smoothing filter)

Since the single carrier modes of IEEE 802.11b and g use linear modulation formats like BPSK or QPSK, the transmit signal power varies between symbol sampling times. These power variations are determined by the transmit filter, which isn't defined in the standard. The WLAN application allows fine tuning of the PVT measurements on signals with high crest factors by an adjustable moving average filter and two different reference power settings.

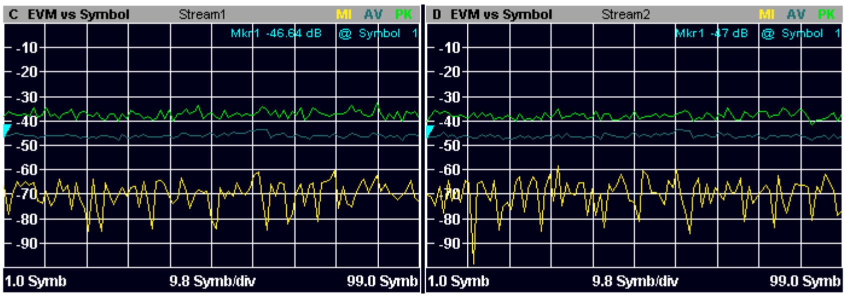
The reference power equals the 100 % setting for the rise / fall time calculation. Either the maximum PPDU power or the mean PPDU power can be chosen as reference power. Using the mean PPDU power, rare power spikes within the PPDU do not influence the rise / fall time measurement.

A moving average filter with sufficient length eliminates the influence of the modulation on the power measurement and will therefore lead to a smoother trace. While a long average length leads to more stable measurement results, it naturally increases the rise / fall times compared to no averaging.

2.2.1.3 EVM vs Symbol

► Press the "EVM vs Symbol" softkey in the EVM measurement menu to select the EVM vs Symbol result display.

The EVM vs Symbol result display shows the EVM measured over all demodulated symbols in the current capture buffer. The results are displayed on a per-symbol basis, with blue vertical lines marking the boundaries of each PPDU. Note that PPDU boundary lines are only displayed if the number of analyzed PPDUs is less than 250.



EVM vs Symbol (example based on an IEEE 802.11n MIMO signal)

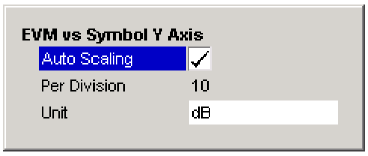
For IEEE 802.11a, j, g (OFDM), n and ac, the minimum, average and maximum traces are displayed.

For IEEE 802.11b & g (Single Carrier), two EVM traces are displayed. The trace labeled "VEC ERR IEEE" shows the error vector magnitude as defined in the IEEE 802.11b & g standards. For the trace labeled "EVM", a commonly used EVM definition is applied, which is the square root of the momentary error power normalized by the averaged reference power. For details of this measurement, refer to chapter 4.

Remote: CONFigure:BURSt:EVM:ESYMbol[:IMMediate]

EVM vs Symbol: Y-axis Scaling

Auto Scaling



Turns automatic scaling of the y-axis on and off.

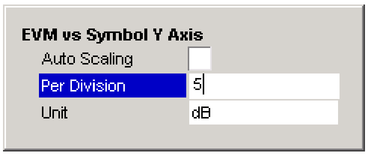
When you turn this feature on, the application automatically scales the y-axis after each sweep.

When you turn it off, use "Per Division" to determine the scale of the y-axis.

Auto scaling is always on when the unit displayed on the y-axis is dB.

Remote: DISPlay[:WINDow<1|2>]:TRACe:Y[:SCALe]:AUTO <State>

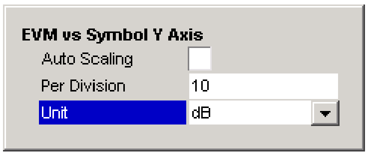
Per Division



Defines the scaling of the y-axis when auto scaling is inactive.

Remote: DISPlay[:WINDow<1|2>]:TRACe:Y[:SCALe]:PDIVision <Size>

Unit



Selects the unit of the y-axis.

Remote: UNIT:EVM <Unit>

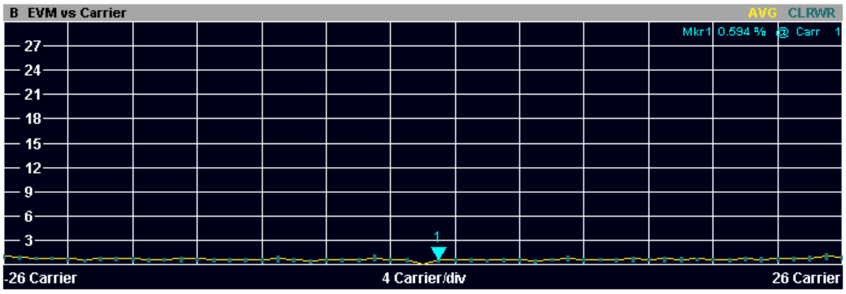
2.2.1.4 EVM vs Carrier

Available for IEEE 802.11a, g (OFDM), j, n, ac, Turbo Mode.

► Press the "EVM vs Carrier" softkey in the EVM measurement menu to select the EVM vs Carrier result display.

The EVM vs Carrier result display shows all EVM values recorded on a per-carrier basis over all recorded symbols in all PPDUs.

The result display contains one trace each for the minimum, average and maximum results.



EVM vs Carrier (example based on an IEEE802.11a signal)

The scaling of the y-axis can be modified to allow the results to be scaled to an optimum level.

► Press the "Y Axis/Div" softkey to open a dialog box that controls the scale of the y-axis. For more information see "EVM vs Symbol: Y-axis Scaling" on page 38.

Remote: CONFigure:BURSt:EVM:ECARrier[:IMMediate]

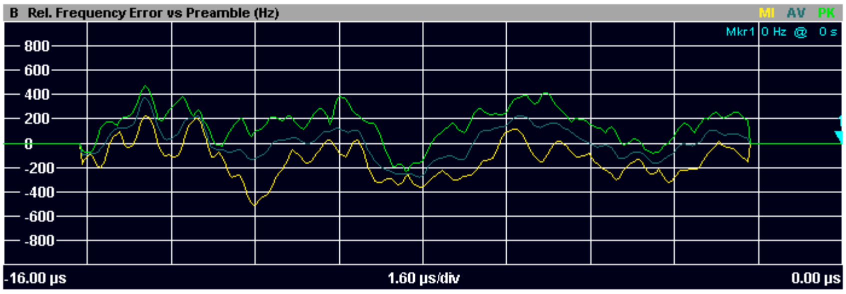
2.2.1.5 Frequency Error vs Preamble

► Press the "Error (Freq Phase)" softkey in the EVM measurement menu to select the Frequency Error vs Preamble result display.

Note that the softkey also selects the Phase Error vs Preamble result display. The Frequency Error vs Preamble is selected if the "FREQ" label on the softkey is highlighted.

The Frequency Error vs Preamble result display shows the relative frequency error values recorded over the preamble part of the PPDU.

A minimum, average and maximum trace are displayed.



Frequency Error vs Preamble Results (example based on an IEEE802.11a signal)

► Press the "Y Axis/Div" softkey to open a dialog box that controls the scale of the y-axis. For more information see "EVM vs Symbol: Y-axis Scaling" on page 38.

Remote:

CONFigure:BURSt:PREamble[:IMMediate]

CONFigure:BURSt:PREamble:SELect <ResultType>

2.2.1.6 Phase Error vs Preamble

► Press the "Error (Freq Phase)" softkey in the EVM measurement menu twice to select the Phase Error vs Preamble result display.

  Note that the softkey also selects the Frequency Error vs Preamble result display. The Phase Error vs Preamble is selected if the "PHASE" label on the softkey is highlighted.

The Phase Error vs Preamble result display shows the relative phase error values recorded over the preamble part of the PPDU.

A minimum, average and maximum trace are displayed.

► Press the "Y Axis/Div" softkey to open a dialog box that controls the scale of the y-axis. For more information see "EVM vs Symbol: Y-axis Scaling" on page 38.

Remote:

CONFigure:BURSt:PREamble[:IMMediate]

CONFigure:BURSt:PREamble:SELect <ResultType>

2.2.1.7 Spectrum Flatness and Group Delay

Available for IEEE 802.11a, g (OFDM), j, n, ac and Turbo Mode.

► Press the "Spectrum Flatness" or "Spectrum (Flat Grdel)" softkey in the Spectrum measurement menu to select the Spectrum Flatness and / or Group Delay result display.

  The information in the Spectrum Flatness and Group Delay result displays depends on the standard.

  - IEEE 802.11a, g (OFDM), j and Turbo Mode

    The Spectrum Flatness and Group Delay results are displayed in the same diagram. The Spectrum Flatness is represented by a yellow trace, the Group Delay by a green trace.

    The left diagram axis shows the scale of the Channel Flatness (in dB). The right diagram axis shows the scale of the Group Delay (in ns).

  - IEEE 802.11n, ac

    The Spectrum Flatness and Group Delay results are displayed in separate result display.

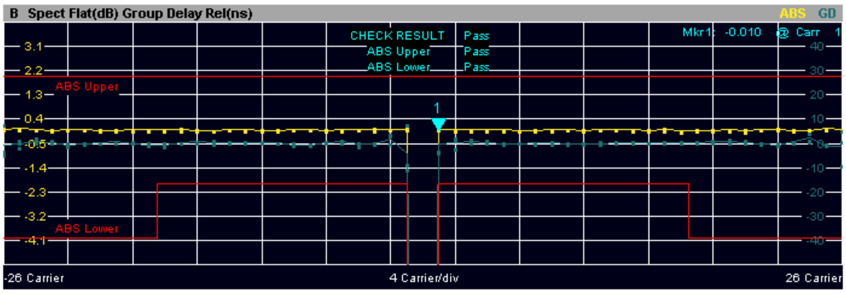
    Pressing the "Spectrum (Flat Grdel)" softkey once selects the Spectrum Flatness results, pressing it twice selects the Group Delay results.

Spectrum Flatness

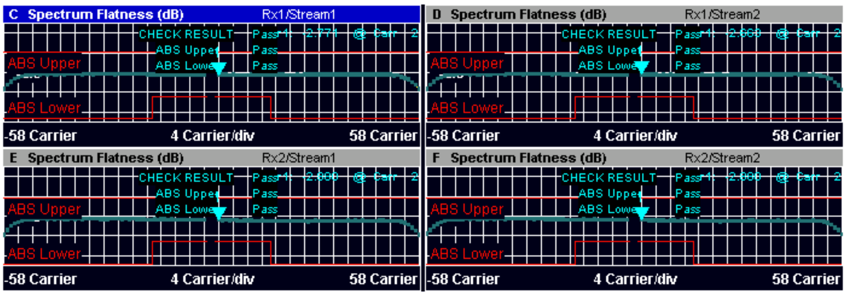
The Spectrum Flatness result display shows the absolute power of a carrier. You can use it, for example, to determine the spectral distortion caused by the DUT (for example the transmit filter).

The results are averaged over all symbols of all recorded PPDUs.

The red lines are the limits for the Spectrum Flatness as defined by IEEE, one upper and one lower limit line. The shape of the limit line depends on the selected standard. The WLAN application tests the signal against these limits and shows the results in the diagram area (pass or fail).



Spectrum Flatness (yellow trace) and Group Delay (green trace) results (example based on an IEEE802.11a signal)



Spectrum Flatness (example based on an IEEE802.11n MIMO signal)

Remote:

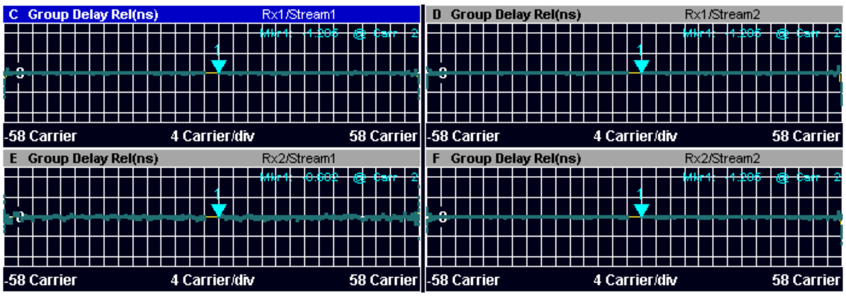
CONFigure:BURSt:SPECtrum:FLATness[:IMMediate]

CONFigure:BURSt:SPECtrum:FLATness:SELect

Group Delay

The Group Delay result display shows the derivation of phase over frequency.

Note that the trace displayed in the Group Delay result display is mean adjusted.



Group Delay results (example based on an IEEE802.11n MIMO signal)

In case of measurements on IEEE 802.11n and ac signals, the Spectrum Flatness and Group Delay measurements allow for the selection between the Physical and Effective Channel model. The Effective Channel model is the composition of the physical channel and the MIMO encoder.

The "Chan Sel (PHY EFF)" softkey is located in the side menu (→ NEXT hotkey) of the Spectrum measurements.

Remote:

CONFigure:BURSt:SPECtrum:FLATness[:IMMediate]

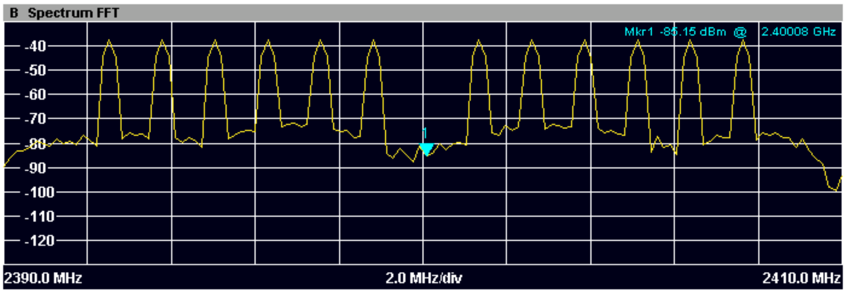
CONFigure:BURSt:SPECtrum:FLATness:SELect

CONFigure:BURSt:SPECtrum:FLATness:CSELect

2.2.1.8 Spectrum FFT

► Press the "Spectrum FFT" softkey in the Spectrum measurement menu to select the Spectrum FFT result display.

The Spectrum FFT result display shows the power over the selected signal bandwidth obtained from a FFT performed over the range of data in the Capture Buffer which lies within the gate lines. If the gate start or gate length are altered, the results can be updated to reflect these changes by pressing the REFRESH hotkey.



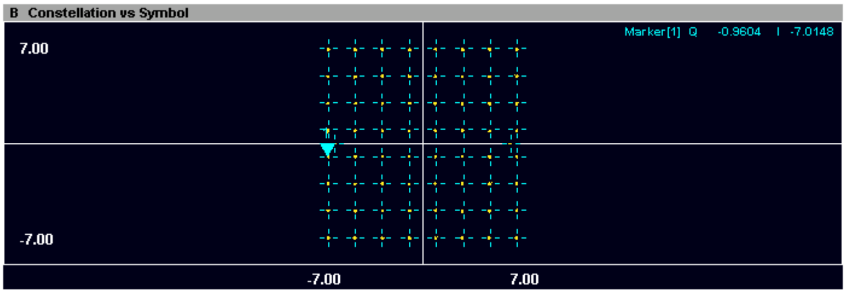
Spectrum FFT results (example based on an IEEE802.11a signal)

Remote: CONFigure:BURSt:SPECtrum:FFT[:IMMediate]

2.2.1.9 Constellation

► Press the "Constell" softkey in the Constellation measurement menu to select the Constellation result display.

The Constellation diagram shows the inphase and quadrature phase results over all recorded symbols in all PPDUs. The ideal points for the selected modulation scheme are displayed as crosses for reference purposes.



Constellation diagram (example based on an IEEE802.11a signal

Remote: CONFigure:BURSt:CONStellation:CSYMbol[:IMMediate]

Evaluation range for the constellation diagram

By default the application displays the constellation points for all carriers that have been evaluated.

However, you can filter the results.

► Press the "Carrier Selection" softkey.

The application opens a dialog box to filter the displayed results.

You can select to display the results for:

- A particular carrier (by its number)
- All pilot carriers
- All carriers (default)

The amount of data displayed in the Constellation results display can be reduced by selecting the carrier or carriers for which data is to be displayed.

Carrier selection is not available when the IEEE 802.11b or g (Single Carrier) standards are selected.

Remote: CONFigure:BURSt:CONStellation:CARRier:SELect <Carrier>

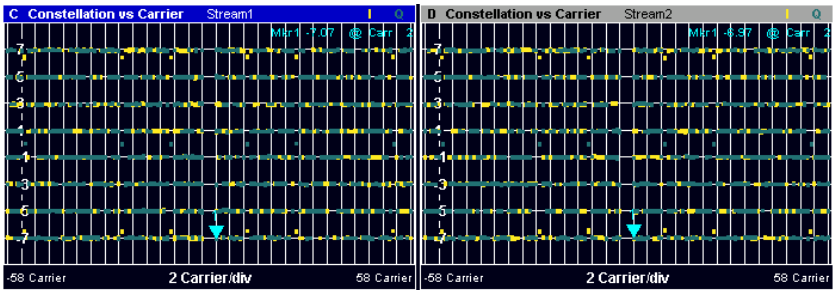
2.2.1.10 Constellation vs Carrier

Available for IEEE 802.11a, g (OFDM), j, n, ac, Turbo Mode.

► Press the "Constell vs Carrier" softkey in the Constellation measurement menu to select the Constellation vs Carrier result display.

The Constellation vs Carrier result display shows the inphase and quadrature phase results over the full range of the measured input data plotted on a per-carrier basis.

The magnitude of the inphase and quadrature part is shown on the y-axis; both are displayed as separate traces (I → yellow color, Q → green color).



Constellation vs Carrier results (example based on an IEEE802.11n MIMO signal)

Remote: CONFigure:BURSt:CONStellation:CCARrier[:IMMediate]

2.2.1.11 Complementary Cumulative Distribution Function (CCDF)

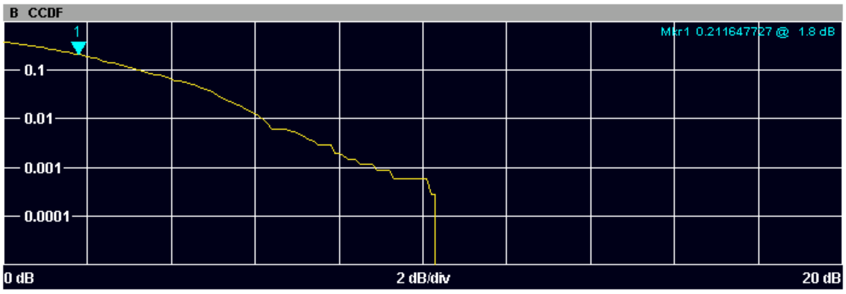
► Press the "CCDF" softkey in the Statistics measurement menu to select the CCDF result display.

The CCDF result display shows the probability of an amplitude within the gating lines exceeding the mean power measured between the gating lines.

The x-axis displays power relative to the measured mean power.

The y-axis shows the cumulative distribution of the power levels as a percentage.

If the gate start or gate length is altered, the results can be updated to reflect these changes by pressing the REFRESH hotkey.



CCDF results (example based on an IEEE802.11a signal)

Remote: CONFigure:BURSt:STATistics:CCDF[:IMMediate]

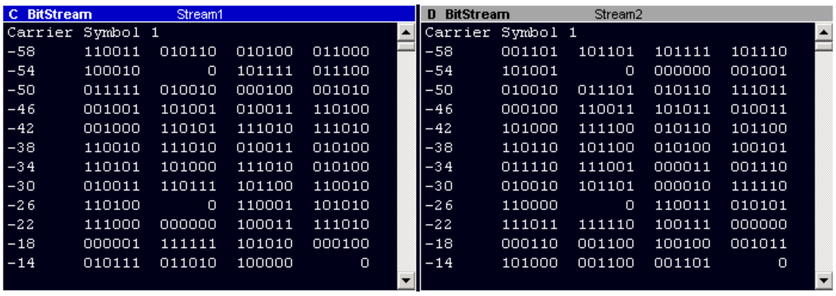
2.2.1.12 Bit Stream

► Press the "Bit Stream" softkey in the Statistics measurement menu to select the Bit Stream result display.

This result display shows the demodulated payload data stream over all analyzed PPDUs.

Multi-carrier measurements

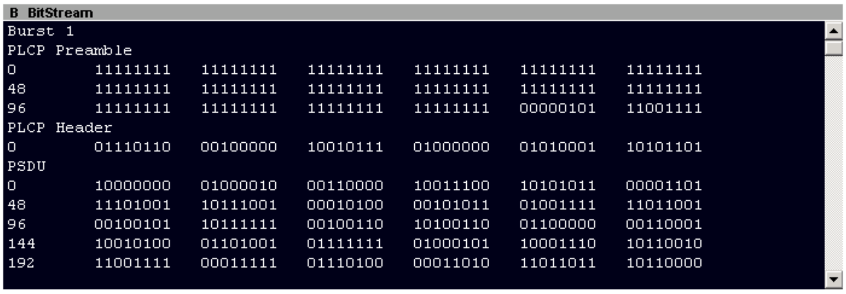
In case of multicarrier measurements (IEEE 802.11a, g (OFDM), n, ac and Turbo Mode) the results are grouped by symbol and carrier.



Bit Stream results grouped by symbol and carrier (example based on an IEEE802.11n MIMO signal)

Single-carrier measurements

For single-carrier measurements (IEEE 802.11b, g (DSSS)) the results are grouped by PPDU.



Bit Stream results grouped by PPDU (example based on an IEEE802.11b signal)

If no other dialog box is active, you can scroll through the results with the rotary knob or the cursor keys.

Remote: CONFigure:BURSt:STATistics:BSTRream[:IMMediate]

2.2.1.13 Signal Field

Available for IEEE 802.11a, g, j, n, ac, Turbo Mode.

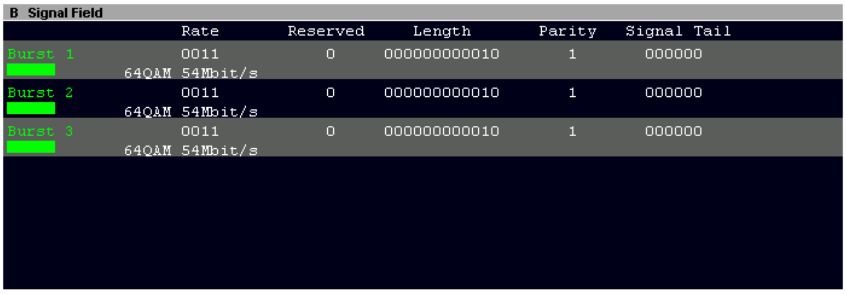
► Press the "Signal Field" softkey in the Statistics measurement menu to select the Signal Field result display.

This result display shows the decoded data from the "Signal" field of each analyzed PPDU. This field contains information on the modulation used for transmission.

The analyzed PPDUs depends on your selection. You can select the type of PPDUs to be analyzed in the demodulation settings:

- Burst To Analyze Settings, (IEEE 802.11a, b, g, j, n (SISO) and Turbo Mode)
- Bursts to Analyze (Advanced) (IEEE 802.11n (MIMO)
- PPDU to Analyze (Advanced) (IEEE 802.11ac)

The signal field information is provided as a decoded bit sequence and, where appropriate, also in human-readable form, beneath the bit sequence for each PPDU.



Signal Field results (example based on an IEEE802.11n signal)

Availability of the Signal Field results

Note that the result display is available if you have turned on "Use Signal Field Content" (→ "Burst To Analyze Settings").

The contents of the Signal Field result display depends on the IEEE standard.

IEEE 802.11a, g and j

Burst <x> Shows the number of the PPDU.
A green bar represents a PPDU that has been decoded successfully.

Rate Shows the symbol rate per second.

Reserved Shows the reserved bit.

Length Shows the length of the payload in OFDM symbols.

Parity Shows the parity bit.

Signal Tail Shows the tail of the signal. The signal tail is preset to 0.

IEEE 802.11n (SISO)

Burst <x> Shows the number of the PPDU.
A green bar represents a PPDU that has been decoded successfully.

MCS Shows the Modulation and Coding Scheme (MCS) index of the PPDU.

HTLength Shows the length of the payload in OFDM symbols.

CRC Shows the cyclic redundancy code.

Short GI Shows the length of the guard interval of the PPDU.
0: short guard interval.
1: long guard interval.

20/40 BW Shows the channel bandwidth of the PPDU.
0: 20 MHz
1: 40 MHz

IEEE 802.11n, ac (MIMO)

For each analyzed PPDU in the signal, the Signal Field results contain the HT-SIG1 and HT-SIG2 as a bit sequence (in some cases also in human readable form).

The first line of the list header indicates the HT-SIG field assigned to the corresponding bit sequence. The second line of the list header shows the demodulation settings that select the type of PPDU considered in the measurement ("logical filter"). The value inside the white rectangle indicates the logical filter setting that currently applies to this property.

PPDU <x> Shows the number of the PPDU.
A green bar represents a PPDU that has been decoded successfully.

Format Shows the format of the PPDU that has been detected.

MCS Shows the Modulation and Coding Scheme (MCS) index of the PPDU.

BW Shows the channel bandwidth of the PPDU.
0: 20 MHz
1: 40 MHz
The actual bandwidth is also displayed below the code.

HTLength Shows the length of the payload in OFDM symbols.

Nstbc Shows the space-time block coding.

GI Shows the length of the guard interval of the PPDU.
0: short guard interval (S).
1: long guard interval (L).

Ness Shows the number of extension spatial streams (N_{ESS})

CRC Shows the cyclic redundancy code of bits 0 - 23 in HT-SIG1 and bits 0 - 9 in HT-SIG2.

Tail Shows the tail bits of the PPDU.

If no other dialog box is active, you can scroll through the results with the rotary knob or the cursor keys.

Remote: CONFigure:BURSt:STATistics:SFIeld[:IMMediate]

Error messages and warnings

When you perform MIMO measurements, the application shows a warning message if a PPDU could not have been properly analyzed. The corresponding PPDU is highlighted in a color other than green.

Note that PPDUs that cause one of the following error message will be included in the calculation of overall measurement results. Thus they might distort measurement results.

`Info: Comparison between HT-SIG Payload Length and Estimated Payload Length not performed due to insufficient SNR`

The WLAN application compares the HT-SIG length against the length estimated from the PPDU power profile. In case of a mismatch, the corresponding entry is highlighted orange. In case of very bad signal quality, this comparison is suppressed and this message is displayed.

`Warning: HT-SIG of PPDU was not evaluated`

Decoding of the HT-SIG is not possible because there is not enough data in the capture buffer. This could result in potential PPDU truncation.

`Warning: Mismatch between HT-SIG and estimated (SNR+Power) PPDU length`

The HT-SIG length and the length estimated – by the WLAN application – from the PPDU power profile are different.

`Warning: Physical Channel estimation impossible / Phy Chan results not available Possible reasons: channel matrix not square or singular to working precision`

The Physical Channel results could not be calculated. The reason could be:

- The spatial mapping can not be applied due to a rectangular mapping matrix (the number of space time streams is not equal to number of transmit antennas).
- The estimated channel matrices are singular to working precission (inverting not possible).

`Warning: Payload Channel Estimation requires Number of PPDU Payload Symbols >= Number of Space Time Streams Used Preamble Channel Estimation instead!`

In case Channel Estimation = Payload is selected but the number of payload symbols < number of space time streams, this warning is risen. To fix it

- select to Channel Estimation = Preamble or
- increase the number of PPDU payload symbols ≥ number of space time streams.

```
Warning: IQ Offset matrix singular to working precission
Possible reasons:
1. Number of Space Time Streams < Number of Rx Antennas
2. Number of PPDU Payload Symbols < Number of Space Time Streams
IQ Offset results not available
```

The reason for this could be:

- make the number of Space Time Streams identical to the Number of Rx Antennas
- increase the number of PPDU payload symbols ≥ number of space time streams.

```
Warning: IQ Imbalance matrix singular to working precission
Possible reasons:
1. Number of Space Time Streams < Number of Rx Antennas
2. Number of PPDU Payload Symbols < Number of Space Time Streams
IQ Imbalance results not available
```

The reason for this could be:

- make the number of Space Time Streams identical to the Number of Rx Antennas
- increase the number of PPDU payload symbols ≥ number of space time streams.

Dismissed PPDUs

In case a required PPDU property does not match the corresponding property from the list, the PPDU is dismissed. An appropriate message is provided. In addition, the corresponding PPDU in the Capture Buffer is not highlighted by a bar.

Note that PPDUs that cause one of the following error messages are not considered in the calculation of measurement results.

```
Hint: PPDU requires at least one payload symbol
```

Currently at least one payload symbol is required in order to successfully analyze the PPDU. I.e. null data packet (NDP) sounding PPDUs will generate this message.

```
Hint: PPDU dismissed due to a mismatch with the PPDU format to be analyzed
```

The properties causing the mismatches for this PPDU are highlighted.

```
Hint: PPDU dismissed due to mismatching Nof space time streams to be analyzed
```

The "Number of Space Time Streams" property causes a mismatch for this PPDU.

```
Hint: PPDU dismissed due to truncation
```

For example during the signal capture process the first or the last PPDU was truncated.

`Hint: PPDU dismissed due to HT-SIG inconsistencies`

One or more of the following HT-SIG decoding results are outside of specified range: MCS index, Number of additional STBC streams, Number of space time streams, CRC Check failed, non zero tail bits.

`Hint: Channel matrix singular to working precision`

Channel equalizing (for Burst Length Detection, fully and user compensated measurement signal) is not possible because the estimated channel matrix is singular to working precision.

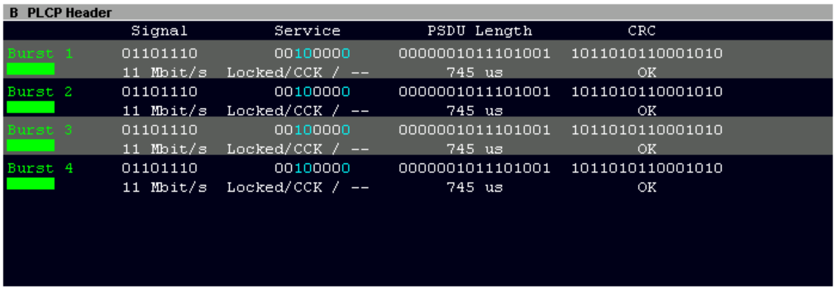
2.2.1.14 PLCP Header

Available for IEEE 802.11b and g (single carrier).

► Press the "PLCP Header" softkey in the Statistics measurement menu to select the PLCP Header result display.

The PLCP Header results display shows the decoded data from the PLCP header of the PPDU.

Burst	Shows the number of the decoded PPDU. A green bar represents a PPDU that has been decoded successfully.
Signal	Shows the signal field. The number below the bit sequence represents the decoded data rate.
Service	Shows the service field. Bits that currently used are displayed in a blue font. The meaning of the highlighted bits is shown below: **Bit 0 to 1** **Bit 2:** Shows "---" if the symbol clock is not locked. Shows "Locked" if the symbol clock is locked. **Bit 3** Shows "---" if the data rate is below 5.5 Mbit/s. Shows "CCK" if CCK modulation has been selected. Shows "PPBC" if PPBC modulation has been selected. **Bit 7** Shows "---" if the length extension bit is not set. Shows ">8/11" if the length extension bit is set.
PSDU Length	Shows the length field. The number below the bit sequence represents the decoded time to transmit the PSDU.
CRC	Shows the CRC field. "OK" is displayed if the CRC passes. If it fails, "FAILED" is displayed.



PLCP Header Results (example based on an IEEE802.11b signal)

If necessary, you can scroll through the results with the cursor keys or the rotary knob.

Remote: CONFigure:BURSt:STATistics:SFIeld[:IMMediate]

2.2.2 Frequency Sweep Measurements

The following measurement results are obtained in frequency sweep mode:

- Spectrum Emission Mask
- Spectrum ACPR (IEEE 802.11a, b, g, n, ac & Turbo Mode)
- Spectrum ACP (IEEE 802.11j)

Frequency sweep measurements use different signal data than I/Q measurements. Thus, it is not possible to run an I/Q measurement and then view the results in the frequency sweep measurement and vice versa. Also, because each of the frequency sweep measurements use different settings to obtain signal data, it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

All frequency sweep measurements run in full screen mode. Frequency sweep measurements are only available when RF input is selected.

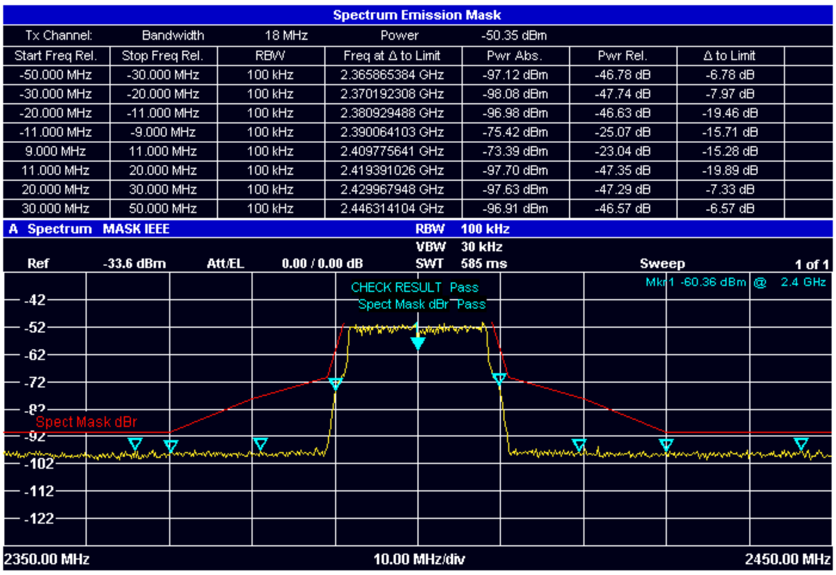
2.2.2.1 Spectrum Emission Mask

► Press the "Spectrum Mask" softkey in the Spectrum measurement menu to select the Spectrum Emission Mask (SEM) measurement.

The Spectrum Mask results display shows power against frequency. The span of the results corresponds to the signal bandwidth. Thus, it depends on the selected standard.

A limit line representing the spectrum mask specified for the selected standard is displayed and an overall pass/fail status is displayed for the obtained results against this limit line.

The application automatically sets some markers to indicate the peak levels in the corresponding SEM range.



Spectrum Emission Mask

Tx Channel: Bandwidth 18 MHz Power -50.35 dBm

Start Freq Rel.	Stop Freq Rel.	RBW	Freq at Δ to Limit	Pwr Abs.	Pwr Rel.	Δ to Limit
-50.000 MHz	-30.000 MHz	100 kHz	2.365865384 GHz	-97.12 dBm	-46.78 dB	-6.78 dB
-30.000 MHz	-20.000 MHz	100 kHz	2.370192308 GHz	-98.08 dBm	-47.74 dB	-7.97 dB
-20.000 MHz	-11.000 MHz	100 kHz	2.380929488 GHz	-96.98 dBm	-46.63 dB	-19.46 dB
-11.000 MHz	-9.000 MHz	100 kHz	2.390064103 GHz	-75.42 dBm	-25.07 dB	-15.71 dB
9.000 MHz	11.000 MHz	100 kHz	2.409775641 GHz	-73.39 dBm	-23.04 dB	-15.28 dB
11.000 MHz	20.000 MHz	100 kHz	2.419391026 GHz	-97.70 dBm	-47.35 dB	-19.89 dB
20.000 MHz	30.000 MHz	100 kHz	2.429967948 GHz	-97.63 dBm	-47.29 dB	-7.33 dB
30.000 MHz	50.000 MHz	100 kHz	2.446314104 GHz	-96.91 dBm	-46.57 dB	-6.57 dB

Fig. 7 Spectrum Emission Mask measurement (example based on an IEEE802.11a signal)

If the "Sweep Count (Mask/ACP)" parameter in the "General Settings" dialog box is set to any value other than 1, the measurement is performed over the specified number of sweeps.

When the measurement is performed over multiple sweeps a max hold trace is displayed as well as an average trace.

Remote: CONFigure:BURSt:SPECtrum:MASK[:IMMediate]

SEM Settings

The Spectrum Emission Mask measurement can be configured in the "SEM Settings" dialog box. The corresponding softkey is located in the side menu. You can acces the side menu with the NEXT hotkey.

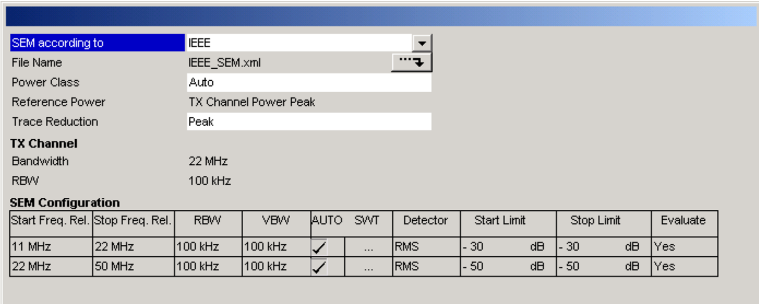


Fig. 8 ACP Settings view

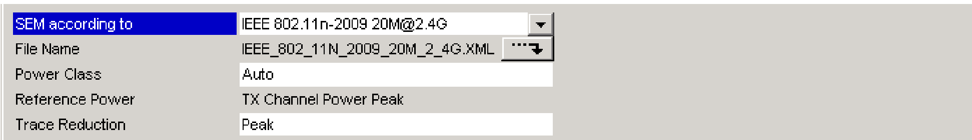
Remote:

CONFigure:BURSt:SPECtrum:MASK:SELect <Standard>

[SENSe:]POWer:SEM <SEMType>

[SENSe:]POWer:SEM:TRACe:REDuction <Method>

SEM according to



Selects the Spectrum Emission Mask definition for the measurement. The contents of the dropdown menu depend on the selected standard.

If you select the "User" entry, you can select a custom SEM in the "File Name" field. You can create a custom SEM in an xml file and copy it to the R&S FSQ. For more information on the contents and structure of SEM files refer to the documentation of the R&S FSQ.

IEEE 802.11a, b, g, j an Turbo Mode support the following SEM definitions.

- ETSI – Settings and limits are as specified in the standard
- IEEE – Settings and limits are as specified in the standard
- User – Settings and limits are configured via an XML file

Remote: [SENSe:]POWer:SEM <SEMType>

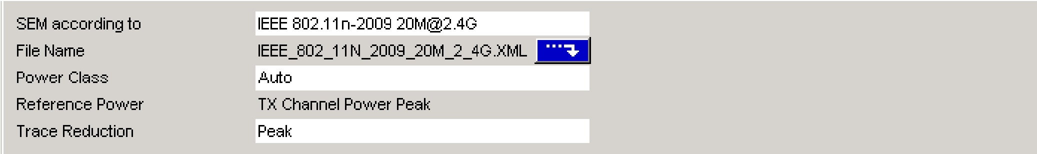
For a list of supported SEM configurations for IEEE 802.11n and 802.11ac, see the table below.

SEM Settings	The spectrum emission mask measurement is performed according to the standard	Remote Control Command

IEEE 802.11n-2009 20M@2.4G	IEEE Std 802.11n™-2009
	Figure 20-17: Transmit spectral mask for 20 MHz channel
		`SENS:POW:SEM 'IEEE_2009_20_2_4'`
		Supported for backwards compatibility:
		`SENS:POW:SEM IEEE`

IEEE 802.11n-2009 40M@2.4G	IEEE Std 802.11n™-2009 Figure 20-18: Transmit spectral mask for a 40 MHz channel	`SENSe:POWer:SEM 'IEEE_2009_40_2_4'`
IEEE 802.11n-2009 20M@5G	IEEE Std 802.11n™-2009 Figure 20-17: Transmit spectral mask for 20 MHz channel	`SENSe:POWer:SEM 'IEEE_2009_20_5'`
IEEE 802.11n-2009 40M@5G	IEEE Std 802.11n™-2009 Figure 20-18: Transmit spectral mask for a 40 MHz channel	`SENSe:POWer:SEM 'IEEE_2009_40_5'`
IEEE 802.11mb/D08 20M@2.4G	IEEE Std 802.11n™-2009 Figure 20-17: Transmit spectral mask for 20 MHz transmission IEEE Draft P802.11-REVmb™/D8.0, March 2011 Figure 19-17: Transmit spectral mask for 20 MHz transmission in the 2.4 GHz band	`SENSe:POWer:SEM 'IEEE_D08_20_2_4'`
IEEE 802.11mb/D08 40M@2.4G	IEEE Std 802.11n™-200 Figure 20-18: Transmit spectral mask for a 40 MHz channel IEEE Draft P802.11-REVmb™/D8.0, March 2011 Figure 19-18: Transmit spectral mask for a 40 MHz channel in the 2.4 GHz band	`SENSe:POWer:SEM 'IEEE_D08_40_2_4'`
IEEE 802.11mb/D08 20M@5G	IEEE Draft P802.11-REVmb™/D8.0, March 2011 Figure 19-19: Transmit spectral mask for 20 MHz transmission in the 5 GHz band	`SENSe:POWer:SEM 'IEEE_D08_20_5'`
IEEE 802.11mb/D08 40M@5G	IEEE Draft P802.11-REVmb™/D8.0, March 2011 Figure 19-20: Transmit spectral mask for a 40 MHz channel in the 5 GHz band	`SENSe:POWer:SEM 'IEEE_D08_40_5'`
IEEE 802.11ac/D1.1 20M@5G	IEEE P802.11ac™/D1.1, August 2011 Figure 22-17: Transmit spectral mask for a 20 MHz channel	`SENSe:POWer:SEM 'IEEE_AC_D1_1_20_5'`
IEEE 802.11ac/D1.1 40M@5G	IEEE P802.11ac™/D1.1, August 2011 Figure 22-18: Transmit spectral mask for a 40 MHz channel	`SENSe:POWer:SEM 'IEEE_AC_D1_1_40_5'`
IEEE 802.11ac/D1.1 80M@5G	IEEE P802.11ac™/D1.1, August 2011 Figure 22-19: Transmit spectral mask for a 80 MHz channel	`SENSe:POWer:SEM 'IEEE_AC_D1_1_80_5'`

File Name



Shows the name of the file that contains the data of the current spectrum emission mask.

The file type is .xml. If you press the arrow button (), the WLAN application opens the file manager to locate and select a SEM file. If you select a SEM not included in the "SEM According To" dropdown menu, the application automatically selects "User" in that field.

Remote: MMEMory:LOAD:IQ:STATe 1,<FileName>

the "Reference Power" settin

Reference Power

Selects the calculation method of the reference power.

TX Channel Power Peak	The Tx Channel peak power is used as reference power.
TX Channel Power	The TX Channel power is used as reference power.

Remote: CONFigure:BURSt:PVT:RPOWer <ReferencePower>

Trace Reduction

Selects the method of data reduction used to draw the trace for each frequency segment of the Spectrum Emission Mask.

The SEM measurement captures the data according to the detector setting defined for each frequency segment. The detector for each frequency segment is defined in the SEM definition (xml file).

Peak	Uses the peak value of the captured data to draw the complete trace.
Trace detector	Uses the value according to the detector setting as defined in the SEM definition file to draw the trace. If the Peak detector has been defined for a frequency segment, the trace reduction does not have an effect on the trace for that frequency segment. If the RMS detector has been defined for a frequency segment, the trace will be smoother compared to the Peak detector.

Remote: [SENSe:]POWer:SEM:TRACe:REDuction <Method>

Bandwidth

Shows the bandwidth of the Tx channel.

Remote: ---

RBW

Shows the resolution bandwidth used to determine the reference power in the frequency segment of the Tx channel.

Remote: ---

SEM Configuration

The SEM configuration shows the settings and limits applied over specified frequency ranges around the TX channel. The settings displayed depend on the selected "Link Direction" and "Power Class".

For more information about the parameters refer to the documentation of the R&S FSQ.

SEM Configuration

Start Freq. Rel.	Stop Freq. Rel.	RBW	VBW	AUTO	SWT	Detector	Start Limit	Stop Limit	Evaluate
9 MHz	11 MHz	100 kHz	30 kHz	✓	...	RMS	0 dB	- 20 dB	Yes
11 MHz	20 MHz	100 kHz	30 kHz	✓	...	RMS	- 20 dB	- 28 dB	Yes
20 MHz	30 MHz	100 kHz	30 kHz	✓	...	RMS	- 28 dB	- 45 dB	Yes
30 MHz	50 MHz	100 kHz	30 kHz	✓	...	RMS	- 45 dB	- 45 dB	Yes

Fig. 9 SEM Configuration

2.2.2.2 Spectrum ACPR

Available for IEEE 802.11a, b, g, n, ac & Turbo Mode.

► Press the "Spectrum ACPR" softkey in the Spectrum measurement menu to select the Adjacent Channel Power Relative (ACPR) measurement.

The Spectrum ACPR (Adjacent Channel Power (Relative)) measurement provides information about leakage into adjacent channels. The results show the relative power measured in the three nearest channels on either side of the measured channel.

This measurement is similar to the Adjacent Channel Power measurement provided by the Spectrum Analyzer.

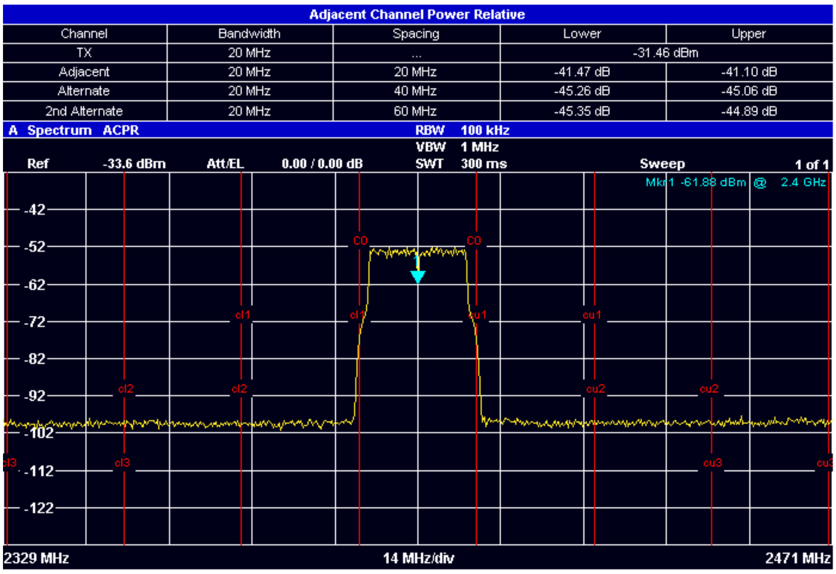


Fig. 10 Spectrum ACPR Results

If the "Sweep Count (Mask/ACPR)" parameter in the "General Settings" dialog box is set to any value other than 1, the measurement is performed over the specified number of sweeps. When the measurement is performed over multiple sweeps, a max hold trace is displayed as well as an average trace.

Remote: CONFigure:BURSt:SPECtrum:ACPR[:IMMediate]

2.2.2.3 Spectrum ACP

Available for IEEE 802.11j.

► Press the "ACP (Rel Abs)" softkey in the Spectrum measurement menu to select the Adjacent Channel Power (ACP) measurement.

  Pressing the softkey repeatedly switches between relative and absolute display of the results.

The ACP (absolute and relative) measurement provides information about leakage into adjacent channels. The results show the absolute and relative power measured in the three nearest channels on either side of the Tx channel.

If the "Sweep Count (Mask/ACP)" parameter in the "General Settings" dialog box is set to any value other than 1, the measurement is performed over the specified number of sweeps. When the measurement is performed over multiple sweeps, a max hold trace is displayed as well as an average trace.

If the current measurement frequency and measurement type (relative or absolute) have a limit specified by the standard, the limit is displayed and the result is displayed in either green or red depending on whether the result passes or fails the corresponding limit.

Remote:

CONFigure:BURSt:SPECtrum:ACPR[:IMMediate]

[SENSe:]POWer:ACHannel:MODE <Mode>

2.3 Measurement Results

The header table below the title bar shows the overall measurement settings used to obtain the current measurement results.

IEEE 802.11a					
Frequency:	2.4 GHz	Signal Lvl Setting/Ext Att:	-27.5 dBm / 0 dB	Capt. Time/No Samples	1 ms / 20000
Burst Type:	Direct Link Burst	Modulation:	54 Mbps 64 QAM	No Of Data Symbols:	1/1366
SINGLE	TRG : EXT	RF		Burst:	3 (3)

Fig. 37 Overall measurement settings summary for IEEE 802.11a , g (OFDM), j and Turbo Mode

IEEE 802.11b					
Frequency:	2.4 GHz	Ref Level / Ext. Att:	-26.1 dBm / 0 dB	Capt. Time/No Samples	5 ms / 220000
Preamble Type:	Long PLCP	Modulation:	11 Mbps CCK	PSDU Data Length:	8/32760 µs
SINGLE	TRG : EXT	RF		Burst:	4 (4)

Fig. 38 Measurement settings summary for IEEE 802.11b & g (Single Carrier)

IEEE 802.11n					
Frequency/Fs:	2.4 GHz / 40 MHz	Signal Lvl Setting/Ext Att:	-27.5 dBm / 0 dB	Capt. Time/No Samples	1 ms / 40000
PPDU/MCS Index/GI:	Mixed40/1/16	Meas Setup:	1 TX x 1 RX	No Of Data Symbols:	1/1366
SINGLE	TRG : EXT	RF		Burst:	2 (2)

Fig. 11 Measurement settings summary for IEEE 802.11n SISO

IEEE 802.11ac					
Frequency/Fs:	5.2 GHz / 160 MHz	Signal Lvl Setting/Ext Att:	-16.1 dBm / 0 dB	Capt. Time/No Samples	5 ms / 800001
PPDU/MCS Index/GI:	VHT80/9/L64	Meas Setup:	1 TX x 1 RX	No Of Data Symbols:	1/1366
SINGLE	TRG : FREE RUN	RF		Burst:	24 (24)

Fig. 12 Measurement settings summary for IEEE 802.11ac

The header table includes the following information.

Frequency
Current center frequency of the signal analyzer. The frequency should match the frequency of the signal to get valid data.

Fs
Current sample rate used to sample the signal.

Available for IEEE 802.11n.

Signal Level Setting
Expected mean signal level of the input signal.

Available for IEEE 802.11a, g (OFDM), j, n, ac and Turbo Mode.

Ref Level
Current reference level of the analyzer. The reference level usually corresponds to the peak level of the signal.

Available for IEEE 802.11b & g (Single Carrier).

External Att
Current external attenuation of the analyzer. External attenuation is attenuation applied before the signal enters the RF input or one of the baseband inputs.

Note that the external attenuation is an offset added or substrated by the software. It does not have an effect on the hardware settings of the signal analyzer (reference level and internal attenuation).

Positive values correspond to attenuation, negative values correspond to gain.

Example:

External Att = 10 dB means that the signal is attenuated by 10 dB before it enters the RF input.

External Att = -20 dB means that the signal is amplified by 20 dB before it enters the RF input.

Capture Time
Current signal capture time.

The capture time defines the amount of data the application captures during one sweep.

No Samples
Number of samples captured during the capture time with the selected sample rate.

Burst Type
Type of PPDU currently being analyzed.

For more information on PPDU types see "Burst Type" (→ Demod Settings).

Available for IEEE 802.11a, g (OFDM), j and Turbo Mode.

Preamble Type
Type of preamble of currently analyzed PPDUs.

For more information on preamble types see "Preamble Type" (→ Demod Settings).

Available for IEEE 802.11b & g (Single Carrier).

PPDU/MCS Index/GI
Type of PPDU, MCS Index and Guard Interval of currently analyzed PPDUs.

For more information on PPDU frame formats, guard intervals and MCS index see

- "Burst Type to Measure" (802.11n)
- "MCS Index to Use" (802.11n)
- "Guard Interval Length" (802.11n)
- "PPDU Format to Measure" (802.11ac)
- "MCS Index to Use" (802.11ac)
- "Guard Interval Length" (802.11ac)

Available for IEEE 802.11n and ac.

Modulation
Current modulation of the analyzed PPDU.

The modulation is either determined by the "Auto Demodulation" or the "PSDU Mod to Analyze" (→ Demod Settings).

Available for IEEE 802.11a, b, g, j, n (SISO) & Turbo Mode.

Meas Setup
Current MIMO setup (number of Tx and Rx antennas.

Available for 802.11n (MIMO) and ac.

No Of Data Symbols
Current minimum and maximum number of data symbols that a PPDU may have if it is to be considered in results analysis.

Available for IEEE 802.11a, g (OFDM), j, n, ac and Turbo Mode.

PSDU Data Length
Current minimum and maximum number of data bytes that a PPDU may have if it is to be considered in results analysis.

Available for IEEE 802.11b & g (Single Carrier) only.

Sweep Mode
Current sweep mode.

- CONT for continuous measurements
- SGL for single measurements.

For more information see "Performing Measurements".

Trigger Mode (TRG)
Current trigger source.

- FREE RUN for free run measurements
- EXT for external trigger

For more information see "Trigger Settings" (→ General Settings).

If you perform gated measurements, acorresponding label is displayed here.

Input Path
Current input source.

For more information see "Input" (→ General Settings).

Burst x of y (z)
Currently analyzed PPDU (x) out of the total number of PPDUs to analyze (y). Shown

The number in brackets (z) is the number of analyzed PPDUs in the current capture buffer.

This PPDU information is displayed when the "Overall Burst Count" (→ General Settings) is turned on.

2.3.1 Result Summary

The Result Summary is displayed in the "List" display mode. It contains the measurement results in numerical form and provides a limit check to confirm if results comply with the selected IEEE standard.

The table layout depends on the selected IEEE standard.

2.3.1.1 IEEE 802.11a, b, g and j

► Press the "Display List" softkey to access the Result Summary.

For each result, the minimum, mean and maximum values are displayed.

The application also checks the results against the defined limits.

If the result passes the limit check, the value of the result is displayed in a green font. If it fails the limit check, the font turns red and the result is labeled with a '*' sign. If no limits are defined for a result type, it is displayed in white color.

The limit values, if defined, are displayed in the column next to the results.

For more information on limits see "Limit Values in the Result Summary".

For some results, the table contains the values in more than one unit.

Result Summary						
No. of Bursts	3					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Carriers	0.64	0.66	5.62	0.69	5.62	%
	- 43.85	- 43.55	- 25.00	- 43.22	- 25.00	dB
EVM Data Carriers	0.65	0.67	5.62	0.70	5.62	%
	- 43.76	- 43.46	- 25.00	- 43.10	- 25.00	dB
EVM Pilot Carriers	0.56	0.58	39.81	0.61	39.81	%
	- 45.08	- 44.76	- 8.00	- 44.24	- 8.00	dB
IQ Offset	- 63.63	- 62.55	- 15.00	- 61.41	- 15.00	dB
Gain Imbalance	- 0.08	- 0.06		- 0.04		%
	- 0.01	- 0.01		- 0.00		dB
Quadrature Error	0.00	0.01		0.01		°
Center Frequency Error	1.08	2.70	± 48000	4.19	± 48000	Hz
Symbol Clock Error	0.10	0.02	± 20	- 0.21	± 20	ppm
Burst Power	- 31.37	- 31.37		- 31.37		dBm
Crest Factor	9.99	9.99		9.99		dB

Fig. 13 ***Result Summary Table***

No. of Bursts	Shows the number of PPDUs that have been analyzed
EVM All Carriers	Shows the EVM of the payload symbols over all carriers
EVM Data Carriers	Shows the EVM of the payload symbols over all data carriers
EVM Pilot Carriers	Shows the EVM of the payload symbols over all pilot carriers
I/Q Offset	Shows the transmitter center frequency leakage relative to the total Tx channel power
Gain Imbalance	Shows the amplification of the quadrature phase component of the signal relative to the amplification of the in-phase component
Quadrature Error	Shows the deviation of the quadrature phase angle from the ideal 90°
Center Frequency Error	Shows the frequency error between the signal and the current center frequency
Symbol Clock Error	Shows the clock error between the signal and the sample clock of the R&S FSQ in parts per million (ppm)
Burst Power	Shows the power of the PPDU
Crest Factor	Shows the ratio of the peak power to the mean power of the signal

2.3.1.2 IEEE 802.11n and ac

In case of measurements on MIMO systems, the result summary is split into several tables.

► Press the "Display Global" softkey to access the Global Result Summary that contains results of the overall measurement.

► Press the "Display List STC" softkey to access a result summary that contains results specific to each transmission channel in the measurement.

  Note that if the "Display Global" softkey is visible, you have to press the softkey once to get access to the "Display List STC" softkey and vice versa.

Global Result Summary

For each result, the minimum, mean and maximum values are displayed.

The application also checks the results against the defined limits.

If the result passes the limit check, the value of the result is displayed in a green font. If it fails the limit check, the font turns red and the result is labeled with a '*' sign. If no limits are defined for a result type, it is displayed in white color.

The limit values, if defined, are displayed in the column next to the results.

For more information on limits see "Limit Values in the Result Summary".

For some results, the table contains the results in more than one unit.

Global Result Summary						
Recognised Bursts	6					
Analyzed Bursts	6					
Analyzed Bursts Phy Chan	6					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Carriers	0.52	0.53	7.94	0.55	7.94	%
	- 45.71	- 45.52	- 22.00	- 45.15	- 22.00	dB
EVM Data Carriers	0.52	0.53	7.94	0.56	7.94	%
	- 45.67	- 45.49	- 22.00	- 45.09	- 22.00	dB
EVM Pilot Carriers	0.47	0.50	39.81	0.53	39.81	%
	- 46.62	- 46.00	- 8.00	- 45.59	- 8.00	dB
Center Frequency Error	- 0.51	0.68	± 60000	12.77	± 60000	Hz
Symbol Clock Error	0.02	- 0.10	± 25	- 0.43	± 25	ppm

Fig. 14 Global Result Summary, IEEE 802.11 n (MIMO)

Recognized Bursts	Shows the number of PPDUs that have been recognized in the current capture buffer.
Analyzed Bursts	Shows the total number of PPDUs that have been analyzed and are taken into account for the result statistics.
Analyzed Bursts Phy. Chan	Shows the number of PPDUs in the physical channel that have been analyzed
EVM All Carriers	Shows the EVM of the payload symbols over all carriers
EVM Data Carriers	Shows the EVM of the payload symbols over all data carriers
EVM Pilot Carriers	Shows the EVM of the payload symbols over all pilot carriers
Center Frequency Error	Shows the frequency offset between the signal and the current center frequency
Symbol Clock Error	Shows the clock error between the signal and the sample clock of the R&S FSQ in parts per million (ppm)

STC Result Summary

The STC Result Summary shows results for any particular transmission channel in the measurement. It is available with different content.

The application also checks the results against the defined limits.

If the result passes the limit check, the value of the result is displayed in a green font. If it fails the limit check, the font turns red and the result is labeled with a '*' sign. If no limits are defined for a result type, it is displayed in white color.

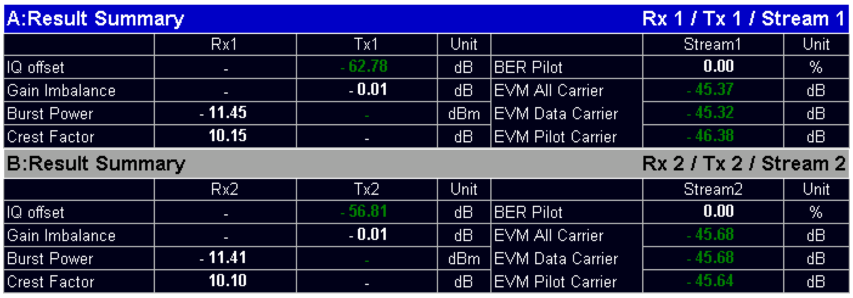
The limit values, if defined, are displayed in the column next to the results.

For more information on limits see "Limit Values in the Result Summary".

For some results, the table contains the results in more than one unit.

STC Overview (Split Screen Mode of the MIMO Result Summary)

The STC Overview result summary contains a combined summary for all results specific for each antenna. For a more detailed result summary for each antenna see "STC Detail" below.



A:Result Summary — Rx 1 / Tx 1 / Stream 1

	Rx1	Tx1	Unit		Stream1	Unit
IQ offset	-	- 62.78	dB	BER Pilot	0.00	%
Gain Imbalance	-	- 0.01	dB	EVM All Carrier	- 45.37	dB
Burst Power	- 11.45	-	dBm	EVM Data Carrier	- 45.32	dB
Crest Factor	10.15	-	dB	EVM Pilot Carrier	- 46.38	dB

B:Result Summary — Rx 2 / Tx 2 / Stream 2

	Rx2	Tx2	Unit		Stream2	Unit
IQ offset	-	- 56.81	dB	BER Pilot	0.00	%
Gain Imbalance	-	- 0.01	dB	EVM All Carrier	- 45.68	dB
Burst Power	- 11.41	-	dBm	EVM Data Carrier	- 45.68	dB
Crest Factor	10.10	-	dB	EVM Pilot Carrier	- 45.64	dB

Fig. 15 Overview STC Result Summary, IEEE 802.11 n (MIMO)

For each transmission channel (receiving antenna Rx<n>, transmitting antenna Tx<n> and stream<n>), the result summary shows the following results.

I/Q Offset	Shows the transmitter center frequency leakage relative to the total Tx channel power
Gain Imbalance	Shows the amplification of the quadrature phase component of the signal relative to the amplification of the in-phase component
Burst Power	Shows the power of the PPDU.
Crest Factor	Shows the ratio of the peak power to the mean power of the signal
BER Pilot	Shows the bit error rate of the pilot carriers
EVM All Carriers	Shows the EVM of the payload symbols over all carriers
EVM Data Carriers	Shows the EVM of the payload symbols over all data carriers
EVM Pilot Carriers	Shows the EVM of the payload symbols over all pilot carriers

STC Detail

For each transmission channel there is a detailed STC Result Summary.

The results are the same as in the STC Overview, but with more details. The result summary shows the minimum, mean and maximum values for each result. It also contains the limit check results for several values.

If the result passes the limit check, the value of the result is displayed in a green font. If it fails the limit check, the font turns red and the result is labeled with a '*' sign. If no limits are defined for a result type, it is displayed in white color.

For more information on limits see "Limit Values in the Result Summary".

► In the STC Overview, select the screen of the antenna in question.

► Press the DISP key.

► Press the "Full Screen" softkey.

The application displays the STC results in full screen mode.

Tx 2				
	Min	Mean	Max	Unit
IQ Offset	- 57.43	- 56.81	- 55.96	dB
Gain Imbalance	- 0.11	- 0.09	- 0.07	%
	- 0.01	- 0.01	- 0.01	dB
Quadrature Error	0.00	0.01	0.02	°
Burst Power	-	-	-	dBm
Crest Factor	-	-	-	dB
Rx 2				
	Min	Mean	Max	Unit
Burst Power	- 11.41	- 11.41	- 11.41	dBm
Crest Factor	10.09	10.10	10.11	dB
Stream 2				
	Min	Mean	Max	Unit
BER Pilot	0.00	0.00	0.00	%
EVM All Carriers	0.50	0.52	0.54	%
	- 45.94	- 45.68	- 45.29	dB
EVM Data Carrier	0.50	0.52	0.55	%
	- 45.96	- 45.68	- 45.23	dB
EVM Pilot Carrier	0.48	0.52	0.56	%
	- 46.40	- 45.64	- 45.10	dB

Fig. 16 STC Overview Result Summary, IEEE 802.11 n (MIMO)

2.3.2 Limit Values in the Result Summary

The application allows you to change and customize the limit values for results that are tested against a limit.

► Press LINES key.

► Select a limit value with the rotary knob or the cursor keys.

The selected limit is highlighted in blue.

► Press the ENTER key.

► Enter a new limit value.

Customizing limits is possible in all WLAN standards. However, it is not possible in the STC Result Summary (MIMO results).

Result Summary						
No. of Bursts	3					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Carriers	0.64	0.66	5.62	0.69	5.62	%
	- 43.85	- 43.55	- 25.00	- 43.22	- 25.00	dB
EVM Data Carriers	0.65	0.67	5.62	0.70	5.62	%
	- 43.76	- 43.46	- 25.00	- 43.10	- 25.00	dB
EVM Pilot Carriers	0.56	0.58	39.81	0.61	39.81	%
	- 45.08	- 44.76	- 8.00	- 44.24	- 8.00	dB
IQ Offset	- 63.63	- 62.55	- 15.00	- 61.41	- 15.00	dB
Gain Imbalance	- 0.08	- 0.06		- 0.04		%
	- 0.01	- 0.01		- 0.00		dB
Quadrature Error	0.00	0.01		0.01		°
Center Frequency Error	1.08	2.70	± 48000	4.19	± 48000	Hz
Symbol Clock Error	0.10	0.02	± 20	- 0.21	± 20	ppm
Burst Power	- 31.37	- 31.37		- 31.37		dBm
Crest Factor	9.99	9.99		9.99		dB

Fig. 17 Editing Limit Values

Remote: CALCulate:LIMit:BURSt:… commands in the CALCulate:LIMit Subsystem.

Limits are modified for the currently selected modulation scheme. Each modulation scheme may have its own set of user-defined limits.

Pressing the "Default Current" softkey resets all limits for the current modulation scheme to the values specified in the selected standard.

Remote: ---

► Pressing the "Default All" softkey resets all limits for all modulation schemes to the values specified in the selected standard.

Remote: CALCulate<1|2>:LIMit<1>:BURSt:ALL DEFault | <Limit>,<Limit>,…

The results displayed in this table are for the entire measurement. If a specific number of PPDUs has been requested that requires more than one sweep, the result summary is updated at the end of each sweep. The number of PPDUs measured and the number of PPDUs requested are displayed to show the progress through the measurement.

If more than one PPDU is evaluated (several analyzed PPDUs in the capture buffer or with the help of Overall Burst Count), the Min/Mean/Max columns show the minimum, mean or maximum values of the PPDU results.

3 Configuration

3.1 General Settings

The "General Settings" tab of the "General Settings" dialog box contains settings to define the basic measurement configuration.

► Press the "General Settings" softkey to open the "General Settings" dialog box.

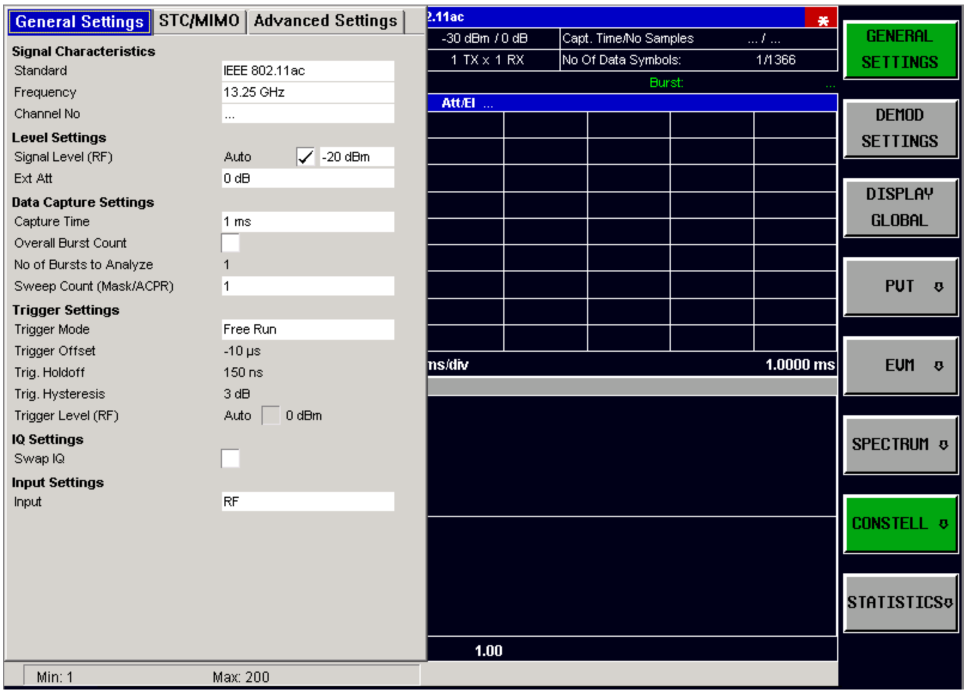


Fig. 18 General Settings view

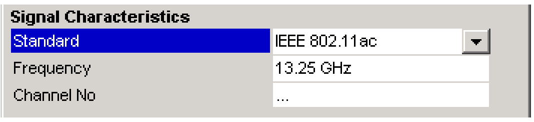
The "General Settings" tab contains the following sets of parameters.

- Signal Characteristics on page 73
- Level Settings on page 75
- Data Capture Settings on page 78
- Trigger Settings on page 80
- I/Q Settings on page 83
- Input Settings on page 83

3.1.1 Signal Characteristics

The "Signal Characteristics" contain settings to configure the expected input signal.

3.1.1.1 Standard



Selects the WLAN standard you want to measure against.

The availability of many settings as well as the applied limits and limit lines depend the selected standard.

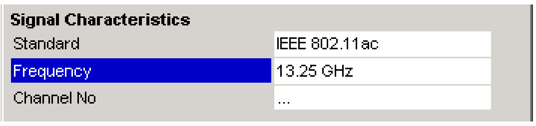
The WLAN application supports the following IEEE standards.

- IEEE 802.11a
- IEEE 802.11b
- IEEE 802.11g
- IEEE 802.11j
- IEEE 802.11n
- IEEE 802.11ac
- IEEE 802.11 OFDM Turbo Mode

The available standards depend on the options that have been installed.

Remote: CONFigure:STANdard <Standard>

3.1.1.2 Frequency



Defines the center frequency of the signal you want to measure.

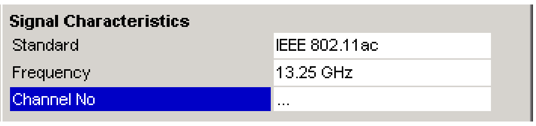
When you change the frequency, the application automatically updates the Channel No.

In case you are using the baseband input, you can also change the frequency. However, the frequency range is limited depending on the I/Q Path you have selected:

- IQ Path = I or Q: Range = 0 to 35 MHz
- IQ Path = I + j*Q: Range = -35 to 35 MHz

Remote: [SENSe:]FREQuency:CENTer <Frequency>

3.1.1.3 Channel No



Defines the channel you want to measure.

When you change the channel number, the application automatically updates the Frequency.

Available for measurements on the RF input.

Remote: CONFigure:CHANnel <Channel>

3.1.2 Level Settings

The "Level Settings" contain settings to configure the level of the expected signal.

3.1.2.1 Automatic Level Detection (Auto Level)

Turns automatic detection of the ideal reference level on and off.

When you turn on automatic level detection, the application measures the signal and determines the ideal reference level before each sweep. Because of this additional measurement, this process slightly increases the measurement time. You can define the measurement time of that measurement with the Auto Level Time.

Automatic level detection also optimizes RF attenuation and the internal preamplifier.

Alternatively, you can perform an automatic level detection whenever necessary with the AUTO LVL hotkey.

Remote: CONFigure:POWer:AUTO <State> | ONCE

Automatic vs manual selection of the reference level

Automatic level detection is an easy and fast method to determine the ideal level settings. However, there might be situations when it is better to select the level settings manually.

- If measurement speed is an issue.

  For measurement speed issues also see "Trigger Settings".

- If you want to prevent damage to the mechanical attenuator.

  During the auto level measurement, the application tries different attenuation levels. This process requires multiple switching operations.

- If you want to measure signals near 0 Hz.

  In that case, the level detection algorithm does not work reliably.

- If the idle periods between PPDUs are longer than the auto level time.

  In this case, the application might not be able to capture a (complete) PPDU during the auto level measurement.

  Adjust the auto level time accordingly in such cases. Note however, that measurement times increase accordingly, especially if more than one sweep is necessary to determine the ideal reference level.

  Note:

  If you are using auto leveling and your signal contains PPDUs with different power levels, make sure that the auto level time is sufficient to capture the PPDU with the highest power level.

For more information on defining level settings manually, see "Advanced Settings".

3.1.2.2 Ref Level / Signal Level (RF Input)

Defines the expected mean level (signal level) or peak level (reference level) of the RF input signal.

The signal level is updated after an automatic level detection measurement has been executed when RF input is selected.

Note that the signal level corresponds to the reference level in case of IEEE 802.11b and 802.11g (Single Carrier) measurements.

For all other standards, the application automatically sets the reference level to a value 10 dB higher than the expected signal level. This is due to the high Crest Factor of those signals.

Available for measurements on the RF input.

Remote: CONFigure:POWer:EXPected:RF <Level>

3.1.2.3 Signal Level (Baseband Input)

"Reference Level" or "Signal Level" define the expected level of the analog baseband input signal.

The Ref Level (Baseband) is updated after an automatic level detection measurement has been executed when baseband input is selected.

Note that the signal level corresponds to the reference level in case of IEEE 802.11b and 802.11g (Single Carrier) measurements.

For all other standards, the application automatically sets the reference level to a value 10 dB higher than the expected signal level. This is due to the high Crest Factor of those signals.

Available for measurements on the analog baseband input (R&S FSQ-B71).

Remote: CONFigure:POWer:EXPected:IQ <Level>

3.1.2.4 Ext Att

Defines the external attenuation applied to the RF signal.

External attenuation is attenuation applied before the signal enters the RF input or one of the baseband inputs.

Note that the external attenuation is an offset added or substrated by the software. It does not have an effect on the hardware settings of the signal analyzer (reference level and internal attenuation).

All displayed power level values will be shifted by this value.

Positive values correspond to attenuation, negative values correspond to gain.

Remote: DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

3.1.2.5 Full Scale Level

Defines the expected level of the digital baseband input signal.

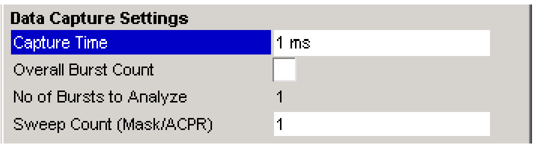
Available for measurements on the digital baseband input (R&S FSQ-B17).

Remote: DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel:IQ <Level>

3.1.3 Data Capture Settings

The "Data Capture Settings" contain settings that configure the amount of data that is captured.

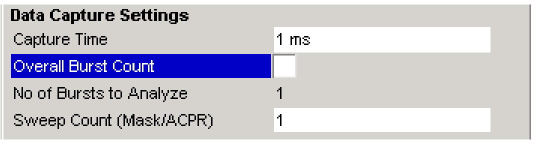
3.1.3.1 Capture Time



Defines the time (and therefore the amount of I/Q data) to be captured in a single measurement sweep.

Remote: [SENSe:]SWEep:TIME <SweepTime>

3.1.3.2 Overall Burst Count



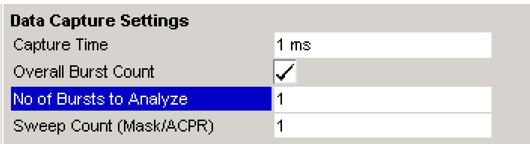
Turns the analysis of a particular number of PPDUs on and off.

When you turn the overall PPDU count on, you can define a particular number of PPDUs that should be captured and analyzed. In that case, the application captures data , until the required number of PPDUs has been captured (even if it has to perform several consecutive sweeps).

If the overall PPDU count is off, the application analyzes all PPDUs that have been found in the capture buffer.

Remote: [SENSe:]BURSt:COUNt:STATe <State>

3.1.3.3 No of Bursts to Analyze



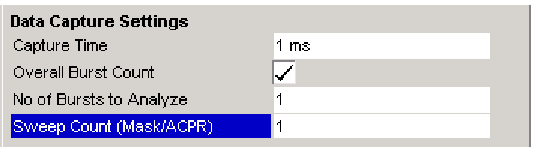
Defines the number of PPDUs to be analyzed.

If a single sweep is not sufficient to capture the defined number of PPDUs, the application continues to capture data until the required number of PPDUs of the selected type has been captured.

Available if Overall Burst Count is on.

Remote: [SENSe:]BURSt:COUNt <PPDUs>

3.1.3.4 Sweep Count (Mask/ACPR)



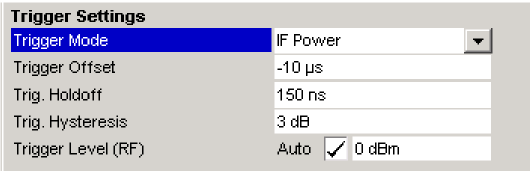
Defines the number of sweeps that the application performs in case of frequency sweep measurements (ACPR and Spectrum Mask).

Remote: [SENSe:]SWEep:COUNt <Sweeps>

3.1.4 Trigger Settings

The "Trigger Settings" contains settings to configure triggered measurements.

3.1.4.1 Trigger Mode



Selects the source of the trigger for the measurement sweep.

The application supports the following trigger sources:

- Free Run

  The measurement sweep starts immediately after you start the measurement.

- External

  Triggers the measurement via a TTL signal applied to the EXT TRIGGER/GATE interface on the rear panel of the R&S FSQ. You can define the level of this trigger signal with Trigger Level.

- IF Power

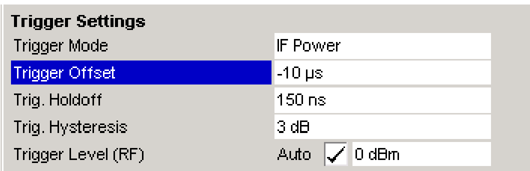
  The measurement sweep starts when the signal power meets or exceeds the specified power trigger level.

The IF Power trigger mode is not available for ETSI Spectrum Mask measurements. If an ETSI Spectrum Mask measurement is selected while the power trigger is active, the trigger mode automatically changes to Free Run.

If you are using the digital baseband input (R&S FSQ-B17), the only possible trigger setting is Free Run.

Remote: TRIGger[:SEQuence]:MODE <TriggerSource>

3.1.4.2 Trigger Offset

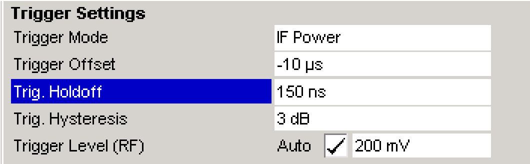


Defines the time offset between the trigger event and the start of the sweep. A negative value starts the measurement prior to the trigger event (pre-trigger).

Unavailable for Free Run measurements.

Remote: TRIGger[:SEQuence]:HOLDoff <Delay>

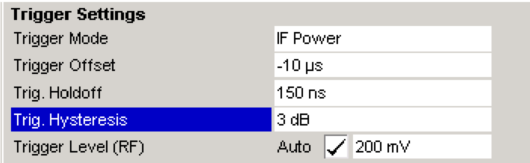
3.1.4.3 Trigger Holdoff



Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote: TRIGger[:SEQuence]:IFPower:HOLDoff <Holdoff>

3.1.4.4 Trigger Hysteresis

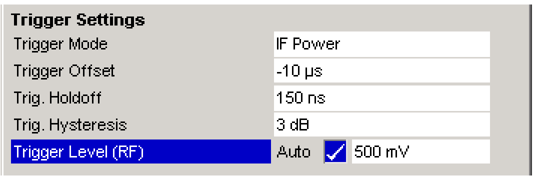


Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Settting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote: TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

3.1.4.5 Trigger Level



Defines the trigger level for the external and IF power trigger.

In case of an External trigger, the trigger level is a value in Volt. In case of an IF Power trigger, the trigger level is a value in dBm.

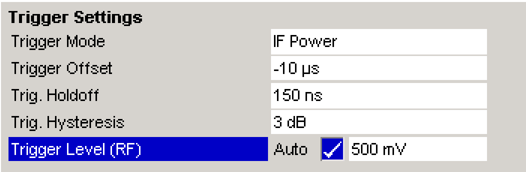
The label of the field changes, depending on the type of input source (Trigger Level (RF) or Trigger Level (Baseband))

Remote:

TRIGger[:SEQuence]:LEVel[:EXTernal] <Level>

TRIGger[:SEQuence]:LEVel:POWer <Level>

3.1.4.6 Auto Trigger Level



Turns automatic detection of the ideal IF power trigger level on and off.

When you turn automatic trigger level detection on, the application measures and determines the power trigger level automatically at the start of each measurement sweep. This ensures that the power trigger level is always set to the best level for obtaining accurate results but will result in slightly increased measurement times.

Available for IF Power trigger.

Remote: TRIGger[:SEQuence]:LEVel:POWer:AUTO <State>

3.1.5 I/Q Settings

The "I/Q Settings" contain settings to configure the inphase and quadrature phase of the input signal.

3.1.5.1 Swap I/Q

Selects normal or inverted I/Q modulation.

- Off

  Normal I/Q modulation.

- On

  I and Q signals are interchanged.

Available if the *I/Q Path* is "I + j * Q".

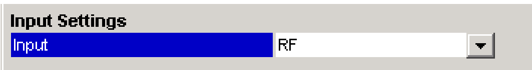
Remote: [SENSe:]SWAPiq <State>

3.1.6 Input Settings

The "Input Settings" contain settings to configure the input source.

The "Input Settings" require options R&S FSQ-B17 (digital baseband) or R&S FSQ-B71 (analog baseband).

3.1.6.1 Input



Selects the input source.

The RF input is always available.

The analog baseband is available with option R&S FSQ-B71.

The digital baseband input is available with option R&S FSQ-B17.

Remote: INPut:SELect <Source>

3.2 STC / MIMO Settings

The "STC / MIMO" tab of the "General Settings" dialog box contains settings to control MIMO measurements (IEEE 802.11n and ac only).

► To select the "STC / MIMO" tab, set the focus on the tab (becomes blue) and move the cursor to the left or right.

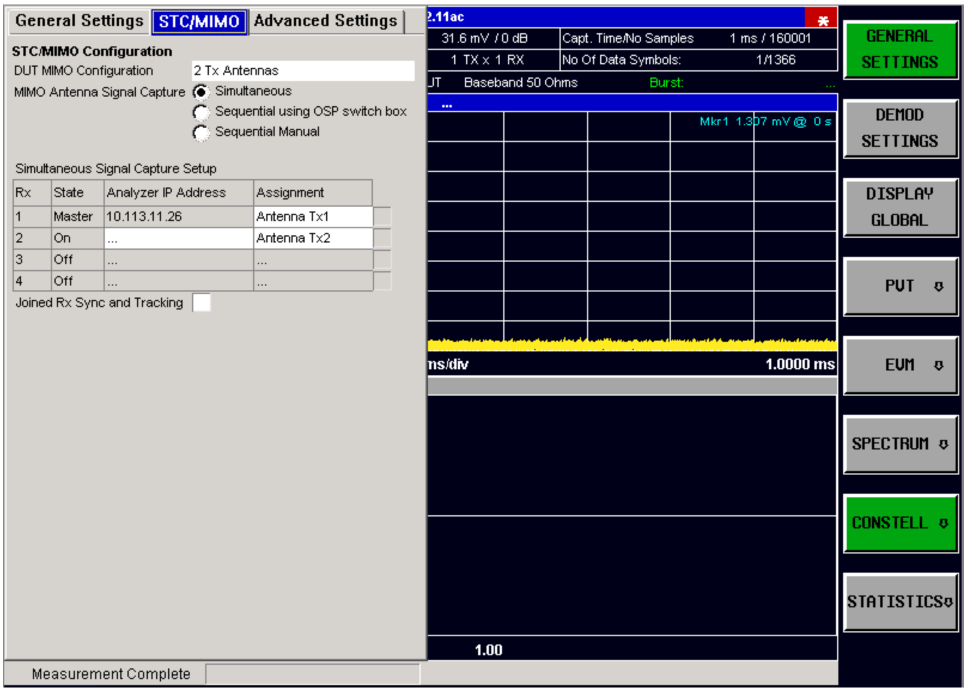
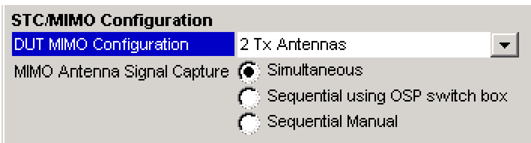


Fig. 19 STC/MIMO Settings

The "STC / MIMO" tab contains the following sets of parameters.

- DUT MIMO Configuration on page 84
- MIMO Antenna Signal Capture on page 85

3.2.1 DUT MIMO Configuration

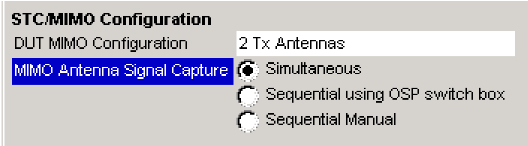


Selects the number of Tx antennas of the device under test (DUT).

Currently, up to 4 Tx Antennas are supported.

Remote: CONFigure:WLAN:DUTConfig <Antennas>

3.2.2 MIMO Antenna Signal Capture



Selects the MIMO measurement method and thus the way multiple signals are captured.

- Simultaneous signal capture
- Sequential signal capture using an R&S®OSP switch box
- Sequential manual signal capture

The layout and contents of the dialog box depend on the method you have chosen. The configuration options for each method are described below.

Note that each mode supports RF and Analog Baseband signal input.

Remote: CONFigure:WLAN:MIMO:CAPTure:TYPe <Mode>

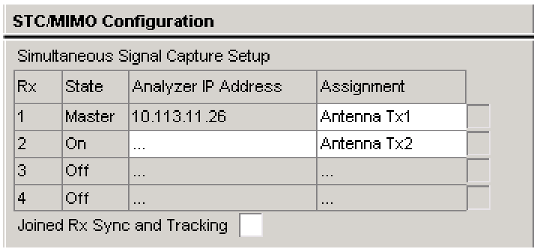
3.2.2.1 Simultaneous signal capture

Captures all data streams simultaneously. Measurements on more than one antenna require a corresponding number of signal analyzers.

One of these analyzers acts as the master analyzer that controls the other analyzers. Except for the master, you can include or exclude the analyzers from the test setup as you like. When the slave analyzers capture data, they transfer this data to the master for evaluation.

All analyzers have to be connected to the master via a LAN. Therefore, you have to state the IP address for each analyzer in the setup in the "Simultaneous Signal Capture Setup". You can enter the IP address via the numeric hardkeys or the online keyboard that opens when you select the "Analyzer IP Address" field.

The setup allows you to assign antennas to an analyzer arbitrarily.



"Joined Rx Sync and Tracking" turns antenna synchronization and tracking on and off.

- On

  Rx antennas are synchronized and tracked jointly.

- Off

  Rx antennas are synchronized and tracked separately.

Remote:

CONFigure:WLAN:ANTMatrix:ADDRess<analyzer> <IPAddress>

CONFigure:WLAN:ANTMatrix:ANTenna<analyzer> <Antenna>

CONFigure:WLAN:ANTMatrix:STATe<analyzer> <State>

CONFigure:WLAN:RSYNc:JOINed <State>

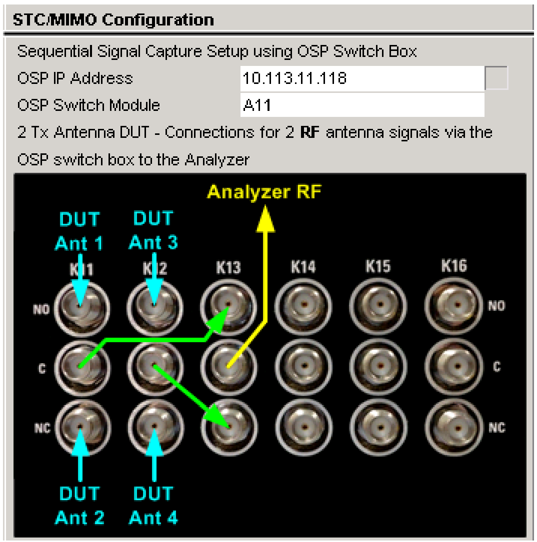
3.2.2.2 Sequential signal capture using an R&S®OSP switch box

Captures all data streams in a sequential order. Measurements on more than one antenna require one signal analyzer and an R&S®OSP Switch Box, including option R&S®OSP-B101. The data streams are captured sequentially, with each antenna being connected to the switch box.

The analyzer and the switch box have to be connected via a LAN. State the IP Address of the switch box in the corresponding input field.

The analyzer and DUT both have to be connected to the R&S®OSP-B101 (module). The module can be in one of three slots of the R&S®OSP. Select the slot the module is in from the "OSP Switch Module" dropdown menu.

The dialog box also contains a diagram that represents the R&S®OSP-B101 module. This diagram shows you the way to connect the DUT antennas correctly to the switch box.



- Cyan colored arrows represent the connections between the Tx antennas of the DUT and the corresponding SMA plugs of the R&S®OSP-B101 option.
- Green colored arrows represent auxiliary connections of SMA plugs of the R&S®OSP-B101 option.
- Yellow colored arrows represent the connection between the SMA plug of the R&S®OSP-B101 option with the RF or analog baseband input of the analyzer.

For sequential MIMO measurements the DUT has to transmit identical PPDUs over time! For example the signal field has to be identical for all PPDUs.

IP address of the switch box

Depending of the switch box model, you can figure out its IP address as follows.

- In case of an R&S®OSP130 switch platform, the IP address is shown in the front display.
- In case of an R&S®OSP120 switch platform connect an external monitor to get the IP address or use the default IP address of the OSP switch platform. For details read the R&S®OSP operation manual.

Remote:

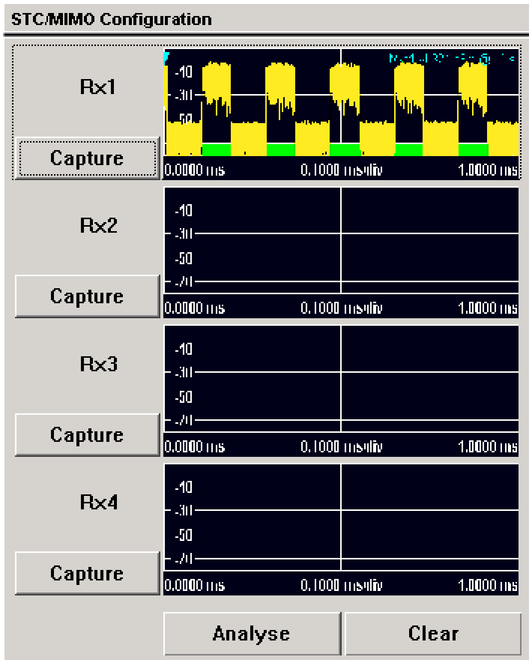
CONFigure:WLAN:MIMO:OSP:ADDRess <IPAddress>

CONFigure:WLAN:MIMO:OSP:MODule <Module>

3.2.2.3 Sequential manual signal capture

Captures each data stream individually on one analyzer. Each antenna has to be connected manually to the analyzer, before its data stream is captured.

The dialog box consists of four panels, each of which shows a preview of the capture buffer recorded for one antenna (Rx 1 to Rx4).



When you have connected an antenna to the R&S FSQ, press the "Capture" button. The application then starts to capture that data stream. When the application is done capturing the data, it shows the capture buffer in the corresponding preview panel, with the detected PPDUs highlighted by green bars.

You can then proceed to connect the next antenna and capture the data stream of it. Do this until all required data streams have been captured.

When you are done, press the "Analyze" button to perform the final analysis of all four antennas. The application then shows the results in the usual manner in the main result displays.

For sequential MIMO measurements the DUT has to transmit identical PPDUs over time! For example the signal field has to be identical for all PPDUs.

In case this condition is not met, the subsequent procedure will not generate reasonable measurement results!

Remote:

CONFigure:WLAN:MIMO:CAPTure:TYPe <Mode>

CONFigure:WLAN:MIMO:CAPTure <SignalPath>

CALCulate<1|2>:BURSt[:IMMediate]

3.3 Advanced Settings

The "Advanced Settings" tab of the "General Settings" dialog box contains settings to define the detailed measurement configuration of the signal analyzer.

► To select the "Advanced Settings" tab, set the focus on the tab (becomes blue) and move the cursor to the left or right.

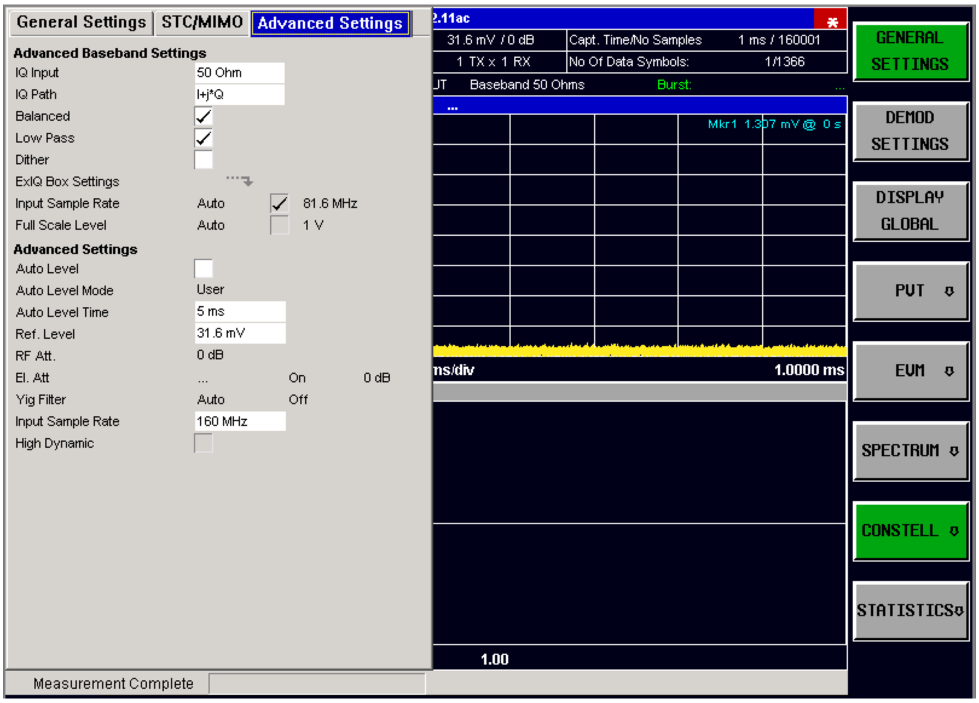


Fig. 20 ***Advanced Settings***

The "Advanced Settings" tab contains the following sets of parameters.

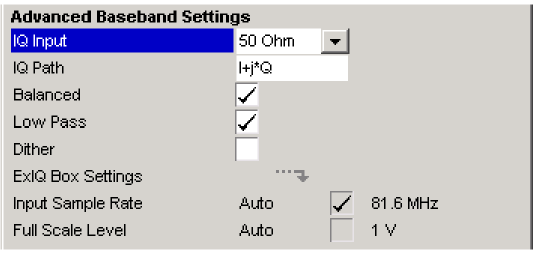
- Advanced Baseband Settings on page 90
- Advanced Level Settings on page 95
- Peak Vector Error (IEEE) (IEEE 802.11b & g only) on page 99

3.3.1 Advanced Baseband Settings

The "Advanced Baseband Settings" contain settings to configure the baseband input.

Available for measurements on the baseband input with R&S FSQ-B17 or -B71.

3.3.1.1 I/Q Input



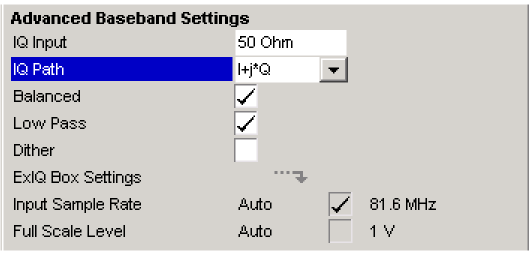
Selects the impedance of the baseband input.

You can select an impedance of 50 Ω and 1 kΩ or 1 MΩ (depending on the device).

Available for the analog baseband input (R&S FSQ-B71).

Remote: INPut:IQ:IMPedance <Impedance>

3.3.1.2 I/Q Path



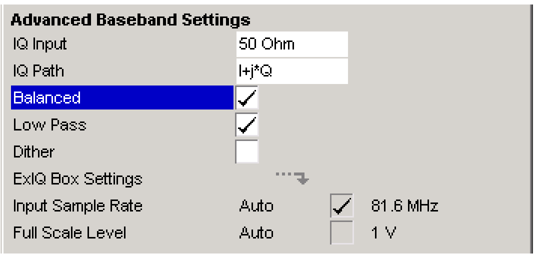
Selects the input path of baseband inputs.

You can use either a single input (I or Q) or both. In case of single inputs, Swap I/Q becomes unavailable.

Available for the analog baseband input (R&S FSQ-B71).

Remote: INPut:IQ:TYPE <Path>

3.3.1.3 Balanced



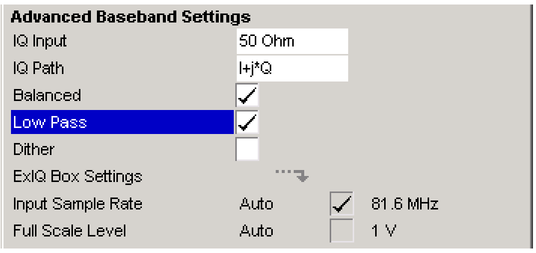
Turns symmetric (or balanced) input on and off.

If active, a ground connection is not necessary. If you are using an assymetrical (unbalanced) setup, the ground connection runs through the shield of the coaxial cable that is used to connect the DUT

Available for the analog baseband input (R&S FSQ-B71).

Remote: INPut:IQ:BALanced[:STATe] <State>

3.3.1.4 Low Pass



Turns an anti-aliasing low pass filter on and off.

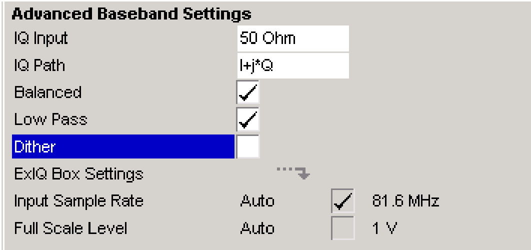
The filter has a cut-off frequency of 36 MHz and prevents frequencies above from being mixed into the usable frequency range. Note that if you turn the filter off, harmonics or spurious emissions of the DUT might be in the frequency range above 36 MHz and might be missed.

You can turn it off for measurement bandwidths greater than 30 MHz.

Available for the analog baseband input (R&S FSQ-B71).

Remote: [SENSe:]IQ:LPASs[:STATe] <State>

3.3.1.5 Dither



Adds a noise signal into the signal path of the baseband input.

Dithering improves the linearity of the A/D converter at low signal levels or low modulation. Improving the linearity also improves the accuracy of the displayed signal levels.

The signal has a bandwidth of 2 MHz with a center frequency of 38.93 MHz.

Available for the analog baseband input (R&S FSQ-B71).

Remote: [SENSe:]IQ:DITHer[:STATe] <State>

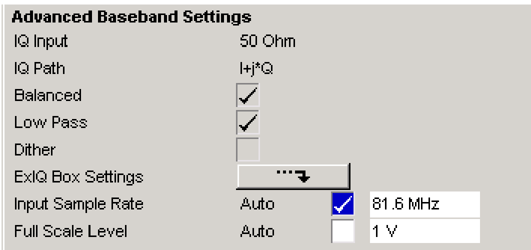
3.3.1.6 ExIQ Box Settings

ExIQ Box Settings opens a dialog box to configure an ExIQ Box.

Available if an ExIQ Box is connected.

For more information refer to the documentation of the R&S ExIQ Box.

3.3.1.7 Input Sample Rate Auto



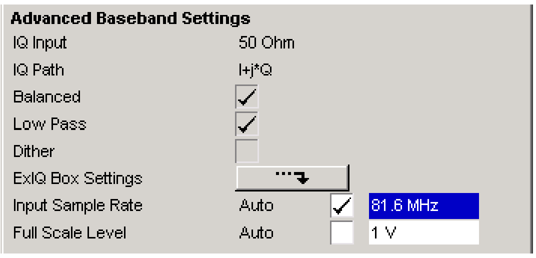
Turns automatic detection of the input sample rate on and off.

When you turn on automatic detection of the sample rate, the application determines the sample rate from the LVDS interface. Otherwise, you have to define the sample rate manually.

Available for the digital baseband input (R&S FSQ-B17).

Remote: INPut<1|2>:DIQ:SRATe:AUTO <State>

3.3.1.8 Input Sample Rate



Defines the sampling rate of the I/Q data received from the digital baseband input.

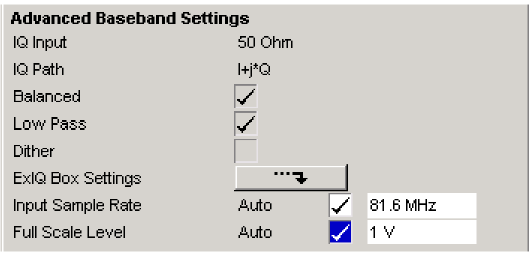
In case it is not the sampling rate expected by the WLAN application, an internal resampler resamples the data to the expected sample rate.

This allows measuring signals generated with slow I/Q-Mode, for example.

Available for the digital baseband input (R&S FSQ-B17).

Remote: INPut<1|2>:DIQ:SRATe <SampleRate>

3.3.1.9 Full Scale Level Auto



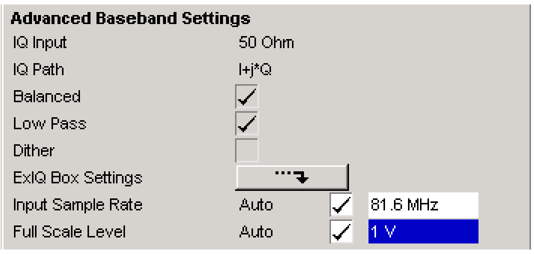
Turns automatic detection of the full scale level on and off.

When you turn on automatic detection of the full scale level, the application determines the sample rate from the LVDS interface. Otherwise, you have to define the sample rate manually.

Available for the digital baseband input (R&S FSQ-B17).

Remote: INPut<1|2>:DIQ:RANGe:AUTO <State>

3.3.1.10 Full Scale Level



Defines the the expected voltage of the digital baseband input signal.

Available for the digital baseband input (R&S FSQ-B17).

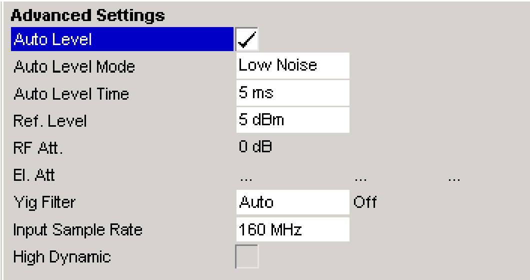
If you change the full scale level in the "Advanced Settings", its value is automatically adjusted in the "General Settings" tab.

Remote: INPut<1|2>:DIQ:RANGe[:UPPer] <Level>

3.3.2 Advanced Level Settings

The "Advanced Level Settings" contain settings to configure advanced level characteristics.

3.3.2.1 Auto Level



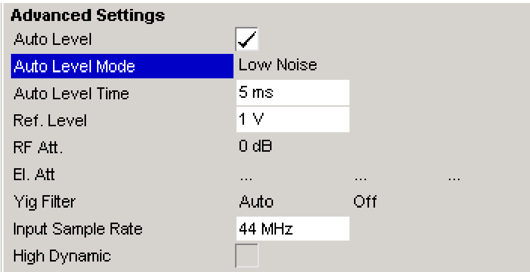
Turns automatic detection of the ideal reference level on and off.

For more information see "Automatic Level Detection (Auto Level)".

This parameter is the same as the auto level in the "General Settings" tab.

Remote: CONFigure:POWer:AUTO <State> | ONCE

3.3.2.2 Auto Level Mode



Selects the method auto leveling is done with.

- Low Noise

  Reduces the inherent noise as much as possible to determine the reference level.

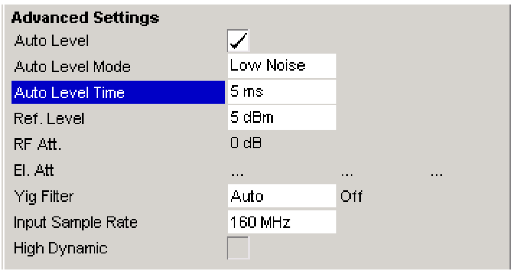
- Low Distortion

  Reduces the inherent spurious products as much as possible to determine the reference level.

Available if "Auto Level" is on and for frequencies above 3.6 GHz. Otherwise the setting is disabled and "Low Noise" is selected.

Remote: CONFigure:POWer:AUTO:MODE <Mode>

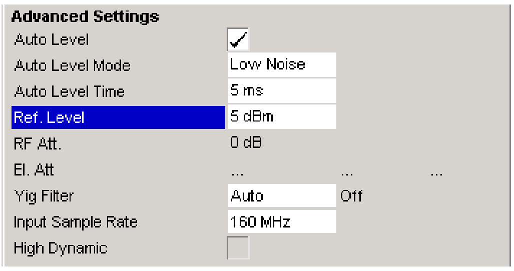
3.3.2.3 Auto Level Time



Defines the measurement time for the auto leveling measurement.

Remote: CONFigure:POWer:AUTO:SWEep:TIME <Time>

3.3.2.4 Ref Level



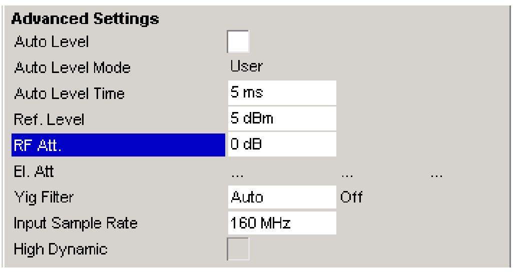
Defines the reference level.

This parameter is the same as the reference level in the "General Settings" tab. For more information see "Ref Level / Signal Level (RF Input)".

Available if auto leveling is turned off.

Remote: DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel[:RF] <Level>

3.3.2.5 RF Att



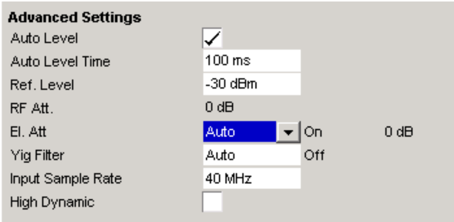
Defines the attenuation of the mechanical attenuator.

Available if auto leveling is turned off.

If you are using auto leveling, RF attenuation is coupled to the reference level. Otherwise, the attenuation is independent from the reference level and can be defined manually.

Remote: INPut:ATTenuation <Attenuation>

3.3.2.6 Electronic Attenuation (El Att)



Defines the characteristics of electronic attenuation.

- Mode

  Selects manual or automatic control of the electronic attenuator.

- State

  Turns the electronic attenuator on and off (for Mode = manual).

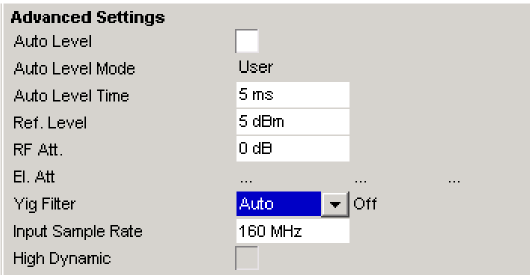
- Settings

  Defines the attenuation of the electronic attenuator.

Electronic attenuation is available if the frequency allows the use of the electronic attenuator and if the electronic attenuator has been installed.

Remote: INPut:EATT:AUTO <State>

3.3.2.7 YIG Filter



Defines the characteristics of the YIG filter.

- Mode

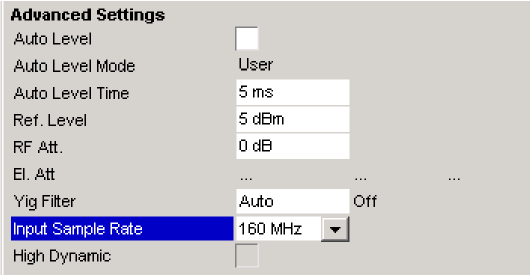
  Selects manual or automatic control of the YIG filter.

- State

  Turns the YIG filter on and of (for Mode = manual).

Remote: INPut:FILTer:YIG[:STATe] <State>

3.3.2.8 Input Sample Rate



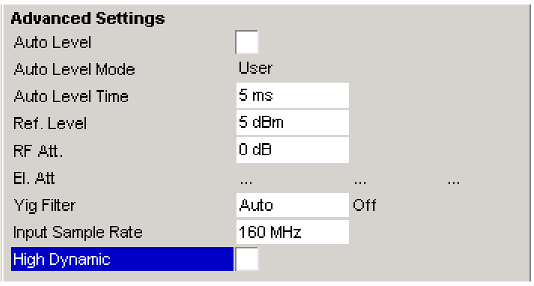
Defines the sampling rate applied to I/Q measurements.

For input sample rates greater than 40 MHz, option R&S FSQ-B72 Bandwidth Extension is required.

- In case of IEEE 802.11a measurements, the input sample rate can be defined continuously.
- In case of IEEE 802.11n measurements, the input sample rate is a discrete set (20 MHz, 40 MHz, 80 MHz).
- In case of IEEE 802.11ac measurements, the input sample rate is a discrete set (20 MHz, 40 MHz, 80 MHz, 160 MHz)

Remote: TRACe:IQ:SRATe <SampleRate>

3.3.2.9 High Dynamic



Turns the bypass of the bandwidth extension R&S FSQ-B72 on and off if you are using a wideband filter. The signal instead passes through the normal signal path.

If active, high dynamic results in a higher resolution because the normal signal path uses a 14-bit ADC. However, all signals to the left or right of the spectrum of interest are folded into the spectrum itself.

The high dynamic functionality is available only if R&S FSQ-B72 is installed and the sample rate is in the range from 20.4 MHz to 40.8 MHz.

High dynamics is automatically turned on if option R&S FSQ-B72 is installed, and the sample rate is set between 20.4 MHz and 40.8 MHz.

Remote: TRACE:IQ:FILTer:FLATness <Filter>

3.3.3 Peak Vector Error (IEEE) (IEEE 802.11b & g only)

The "Peak Vector Error (IEEE)" settings contain settings related to the calculation of Peak Vector Error results.

3.3.3.1 Meas Range (IEEE 802.11b & g)

Selects the range the Peak Error Results are calculated over.

You can select if the results are calculated over the complete PPDU (all symbols) or over the PSDU only.

Remote: CONFigure:WLAN:PVERror:MRANge <Range>

3.4 Demod Settings

The "Demod Settings" tab of the "Demodulation Settings" dialog box contains settings to define the characteristics of the signal modulation.

► Press the "Demod Settings" softkey to open the "Demod Settings" dialog box.

Demodulation settings

The availability of the demodulation settings depends on the selected IEEE standard. Refer to the description of each parameter for more information.

The "Demod Settings" tab contains the following sets of parameters.

- Burst To Analyze Settings on page 101
- Tracking Settings on page 109
- Synchronisation Settings on page 111
- Filter Settings (IEEE 802.11b & g) on page 112
- Advanced Demod Settings (IEEE 802.11n (MIMO)) on page 114
- Advanced Demod Settings (IEEE 802.11ac) on page 119
- MIMO Settings (IEEE 802.11n (MIMO), ac) on page 124

When you select a demodulation parameter. The status bar shows information about valid values for that parameter.

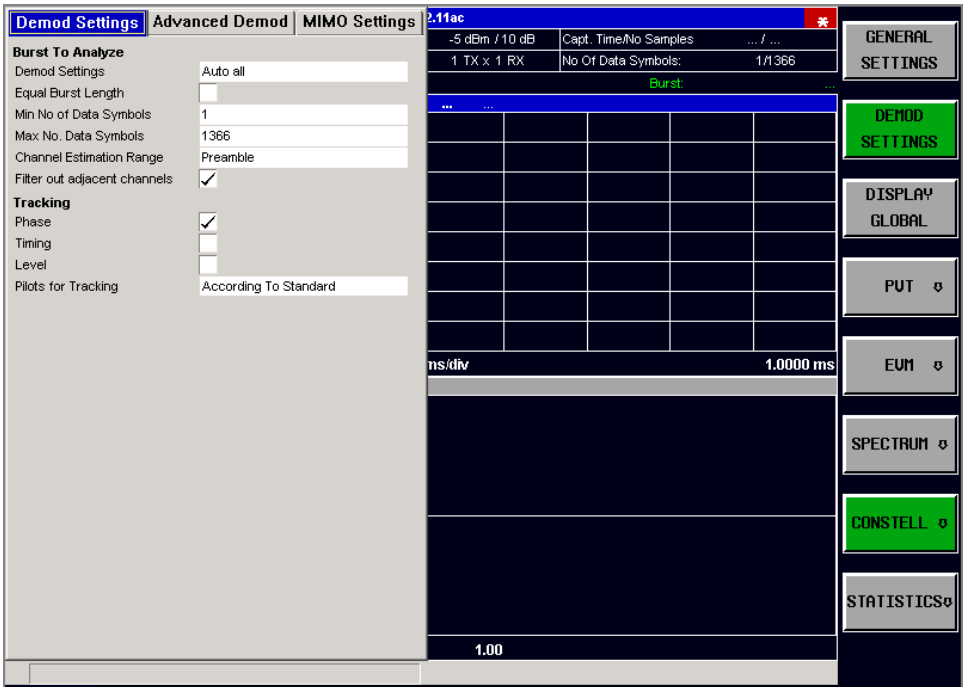


Fig. 21 Demod Settings view (screenshot from IEEE 802.11ac)

3.4.1 Burst To Analyze Settings

The "Burst to Analyze" settings contain settings to define characteristics of the PPDUs that are considered during signal analysis.

3.4.1.1 Use Signal Field Content

Available for IEEE 802.11a, g (OFDM), j, n (SISO) & Turbo Mode.

Turns decoding of the signal symbol field of the captured PPDUs on and off.

When you turn this feature on, the application analyzes PPDUs based on the signal field content. The signal field contains information about modulation and bitrate of a PPDU. Only if the modulation and bitrate of the PPDU matches that of the signal field, the PPDU is analyzed.

You can select the expected modulation scheme with "PSDU Mod to Analyze".

When you turn the feature off, the application tries to analyze all PPDUs based on the expected modulation scheme, regardless of their actual modulation scheme. This process may lead to invalid measurement results.

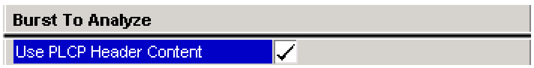
Example

The expected modulation scheme is "54 Mbps 64 QAM". "Use Signal Field Content" is off. In that case, a QPSK modulated PPDU would be misinterpreted as a 64QAM modulated PPDU.

Remote: [SENSe:]DEMod:FORMat:SIGSymbol <State>

3.4.1.2 Use (PLCP) Header Content

Available for IEEE 802.11b & g (Single Carrier).



Turns decoding of the PLCP header of the captured PPDUs on and off.

When you turn this feature on, the application analyzes PPDUs based on the PLCP header. The PLCP header contains information about modulation and bitrate of a PPDU. Only if the modulation and bitrate of the PPDU matches that of the PLCP header, the PPDU is analyzed.

You can select the expected modulation scheme with "PSDU Mod to Analyze".

When you turn the feature off, the application tries to analyze all PPDUs based on the expected modulation scheme, regardless of their actual modulation scheme. This process may lead to invalid measurement results.

Example

The expected modulation scheme is "54 Mbps 64 QAM". "Use PLCP Header Content" is off. In that case, a QPSK modulated PPDU would be misinterpreted as a 64QAM modulated PPDU.

Note that the parameter is labeled "Use Header Content" for IEEE 802.11g (Single Carrier) signals.

Remote: [SENSe:]DEMod:FORMat:SIGSymbol <State>

3.4.1.3 Demod Settings

Available for IEEE 802.11n (MIMO), ac.

Selects the contents of the "Advanced Demod Settings" tab.

"Auto All" selects "Auto, same as first burst" for all settings in the "Advanced Demod" tab.

"Manual (Advanced MIMO Settings)" uses the demodulation settings you have selected manually.

Remote: [SENSe:]DEMod:FORMat[:BCONtent]:AUTO <State>

3.4.1.4 Burst Type

Available for IEEE 802.11a, g, j & Turbo Mode.

Selects the type of PPDU to be considered in the measurement. Only one PPDU type can be selected for measurement results.

The following PPDU types are supported.

- Direct Link Burst (IEEE 802.11a, j, n and Turbo Mode
- OFDM (IEEE 802.11g)
- Long DSSS-OFDM (IEEE 802.11g)
- Short DSSS-OFDM (IEEE 802.11g)
- Long PLCP (IEEE 802.11g)
- Short PLCP (IEEE 802.11g)

Remote: [SENSe:]DEMod:FORMat:BANalyze:BTYPe <PPDUType>

3.4.1.5 PPDU Frame Format

Available for IEEE 802.11n (SISO).

Selects the frame format type of the PPDU to be considered in the measurement.

The following PPDU formats are supported.

- Mixed (20 MHz and 40 MHz)
- Greenfield (20 MHz and 40 MHz)

Remote: [SENSe:]DEMod:FORMat:BANalyze:BTYPe <PPDUType>

3.4.1.6 Preamble Type

Available for IEEE 802.11b

Selects the PPDU preamble type to be considered in the measurement.

The following preamble types are supported.

- Short PLCP
- Long PLCP

Remote: [SENSe:]DEMod:FORMat:BANalyze:BTYPe <PPDUType>

3.4.1.7 Auto Demodulation

Available for IEEE 802.11a, b, g, j, n (SISO) & Turbo Mode

Turns automatic demodulation of the measured data on and off.

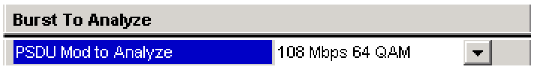
If on, the modulation applied to the input data is determined from the modulation type of the first complete PPDU within the captured data.

The "Auto Demodulation" feature uses the data held in the signal field of the PPDU and is thus available when "Use Signal Symbol Field Content" has been turned on.

Remote: [SENSe:]DEMod:FORMat[:BCONtent]:AUTO <State>

3.4.1.8 PSDU Mod to Analyze

Available for IEEE 802.11a, b, g, j, n (SISO) & Turbo Mode.



Selects the modulation scheme of the PPDUs to be considered in the measurement.

Only PPDUs with the selected modulation are considered in measurement analysis.

Available when "Use Signal Field Content" has been turned on.

Remote: [SENSe:]DEMod:FORMat:BANalyze <Modulation>

3.4.1.9 Auto Guard Interval

Available for IEEE 802.11n (SISO).

Turns automatic detection of the guard interval on and off.

When you turn the feature on, the application automatically determines the guard interval from the input signal.

When you turn it off, you can select the guard interval manually.

Remote: CONFigure:WLAN:GTIMe:AUTO <State>

3.4.1.10 Guard Interval

Available for IEEE 802.11n (SISO).

Selects the guard interval of the PPDUs to be considered in the measurement.

- Short

  Analyzes PPDUs with a short guard interval.

- Long

  Analyzes PPDUs with a long guard interval.

Remote: CONFigure:WLAN:GTIMe:SELect <GuardInterval>

3.4.1.11 Equal Burst Length

Turns analysis of PPDUs with an equal range of data symbols / bytes on and off.

The behavior of the feature depends on the selected standard.

IEEE 802.11a, j, n, ac & Turbo Mode

When you turn the feature on, the application analyzes only PPDUs with the number of symbols defined by No of Data Symbols.

When you turn the feature off, you can define a range of data symbols with Min No of Data Symbols and Max No of Data Symbols. In that case, the application analyzes all PPDUs that have a number of symbols within that range.

IEEE 802.11b & g (Single Carrier and OFDM)

When you turn the feature on, the application analyzes only PPDUs with the number of symbols or duration defined by the Payload Length.

When you turn the feature off, you can define a range of data bytes or payload length with Min Payload Length and Max Payload Length. In that case, the application analyzes all PPDUs that have a number of bytes within that range or payload length.

Remote:

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:EQUal <State>

[SENSe:]DEMod:FORMat:BANalyze:DURation:EQUal <State>

[SENSe:]DEMod:FORMat:BANalyze:DBYTes:EQUal <State>

3.4.1.12 No of Data Symbols

Available for IEEE 802.11a, j, n, ac & Turbo Mode

Defines the number of data symbols a PPDU must have for it to be considered in the measurement.

Available when Equal Burst Length has been turned on.

Remote: [SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>

3.4.1.13 Min No of Data Symbols

Available for IEEE 802.11a, j, n, ac & Turbo Mode

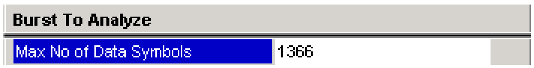
Defines the minimum number of data symbols a PPDU must have for it to be considered in the measurement.

Available when Equal Burst Length has been turned off.

Remote: [SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>

3.4.1.14 Max No of Data Symbols

Available for IEEE 802.11a, j, n, ac & Turbo Mode.



Defines the maximum number of data symbols a PPDU may have for it to be considered in the measurement.

Available when Equal Burst Length has been turned off.

Remote: [SENSe:]DEMod:FORMat:BANalyze:SYMbols:MAX <Symbols>

3.4.1.15 Payload Length

Available for IEEE 802.11b & g

Defines the duration and number of data symbols (IEEE 802.11g OFDM) or bytes (IEEE 802.11b and g Single Carrier) a PPDU must have for it to be considered in the measurement.

Available when Equal Burst Length has been turned on.

Remote:

[SENSe:]DEMod:FORMat:BANalyze:DURation:MIN <Duration>

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>

3.4.1.16 Min Payload Length

Available for IEEE 802.11b & g

Defines the minimum duration and number of data symbols (IEEE 802.11g OFDM) or bytes (IEEE 802.11b and g Single Carrier) a PPDU must have for it to be considered in the measurement.

Available when Equal Burst Length has been turned off.

Remote:

[SENSe:]DEMod:FORMat:BANalyze:DURation:MIN <Duration>

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>

3.4.1.17 Max Payload Length

Available for IEEE 802.11b & g

Defines the minimum duration and number of data symbols (IEEE 802.11g OFDM) or bytes (IEEE 802.11b and g Single Carrier) a PPDU may have for it to be considered in the measurement.

Available when Equal Burst Length has been turned off.

Remote:

[SENSe:]DEMod:FORMat:BANalyze:DURation:MAX <Duration>

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:MAX <Symbols>

3.4.1.18 Channel Estimation Range

Available for (IEEE 802.11a, g (OFDM), j, n, ac & Turbo Mode.

Selects the method and accuracy of EVM result calculation.

- Preamble

  EVM results are calculated according to the selected standard. In this case, channel estimation is done in the preamble only.

- Payload

  EVM results are calculated more accurately. In this case, channel estimation is done in the payload.

Remote: [SENSe:]DEMod:CESTimation <State>

3.4.1.19 Source of Payload Length

Available for IEEE 802.11n, ac.

Selects the source of data symbols used for signal analysis.

- From HT signal

  Number of data symbols for signal analysis is taken from the signal field.

- Estimate from signal

  Number of data symbols is estimated by the application.

Remote: CONFigure:WLAN:PAYLoad:LENGth:SRC <Method>

3.4.1.20 Filter Out Adjacent Channels

Available for (IEEE 802.11n (MIMO), ac).

Turns suppression of power outside the analyzed WLAN channel on and off.

Note that the signal must be oversampled by the factor two or higher for this to work. Oversampling is the ratio between the sample rate and the nominal channel bandwidth used for signal analysis.

Remote: [SENSe:]BANDwidth:[RESolution]:FILTer <State>

3.4.2 Tracking Settings

The "Tracking Settings" settings contain settings to compensate errors in measurement results.

3.4.2.1 Phase

Turns common phase error compensation on and off.

When you turn the feature on, the results are compensated for phase error on a per-symbol level.

Remote: [SENSe:]TRACking:PHASe <State>

3.4.2.2 Timing

Turns timing error compensation on and off.

When you turn the feature on, the results are compensated for timing error on a per-symbol level.

Remote: [SENSe:]TRACking:TIME <State>

3.4.2.3 Level

Turns level error compensation on and off.

When you turn the feature on, the results are compensated for level error on a per-symbol level.

Remote: [SENSe:]TRACking:LEVel <State>

3.4.2.4 Pilots for Tracking

Available for IEEE 802.11n, ac.

Selects the pilot sequence used for tracking purposes.

- According to standard

  The pilot sequence is determined according to the corresponding WLAN standard.

- Detected

  The pilot sequence detected in the WLAN signal to be analyzed is used by the WLAN application.

Remote: [SENSe:]TRACking:PILots <Method>

3.4.3 Synchronisation Settings

The "Synchronization Settings" settings contain settings to configure channel synchronization.

3.4.3.1 FFT Start Offset

Available for IEEE 802.11a, g (OFDM), j, n, ac, Turbo Mode).

Selects the method of FFT start offset determination.

- Peak

  The peak of the fine timing metric is used to determine the FFT start offset.

- Guard Interval Center

  The guard interval center is used as FFT start offset.

- Auto

  The measurement application determines the optimal FFT start offset.

In case of IEEE 802.11n MIMO and 802.11ac, the FFT Start Offset is part of the "Advanced Demod" dialog box.

Remote: [SENSe:]DEMod:FFT:OFFSet <StartOffset>

3.4.3.2 Power Interval Search

Available for IEEE 802.11n (SISO).

Turns a search and subsequent analysis on power intervals within the signal on and off.

When you turn the feature on, the application looks for power intervals within the signal and analyzes these intervals. This improves the measurement speed for signals with a low duty cycle. Note that the application can yield valid results only if the PPDUs in the signal have the same power level.

Turn the search off if you are measuring signals with significant power level fluctuations. This gives reliable PPDU synchronization results.

Remote: [SENSe:]DEMod:TXARea <State>

3.4.4 Filter Settings (IEEE 802.11b & g)

The "Synchronization Settings" settings contain settings to configure characteristics of the filter to be used.

For all filter settings, the list of filter files can be found in D:\User\Filters. Additional filter files (*.vaf) files can be added to this directory, and the list of files for the filter settings will automatically be updated the next time the application is started. Additional filter files can be created from MatLab and converted into an *.vaf format with the Windows Software FILTWIZ downloadable from the R&S homepage together with a short manual "Introduction to "Filtwiz"".

3.4.4.1 Transmit Filter

Selects the transmit filter to be used.

- Auto

  Selects the default filter.

- DefReceive

  Selects the default receive filter.

- DefTransmit

  Selects the default transmit filter.

Remote:

[SENSe:]DEMod:FILTer:CATalog?

[SENSe:]DEMod:FILTer:MODulation <TxFilter>, <RxFilter>

3.4.4.2 Receive Filter

Selects the receive filter to be used.

The settings provided by default are:

Auto	Specifies the default filter
DefRecieve	Default receive filter
DefTransimt	Default transmit filter

Remote:

[SENSe:]DEMod:FILTer:CATalog?

[SENSe:]DEMod:FILTer:MODulation <TxFilter>, <RxFilter>

3.4.4.3 Equalize Filter Length

Defines the length of the equalizer filter impulse response. For measurements at the transmitter, a filter length up to 10 chips is usually sufficient. Longer filter lengths may be needed for multipath propagation channels.

Remote: [SENSe:]DEMod:FILTer:EFLength <Chips>

3.5 Advanced Demod Settings (IEEE 802.11n (MIMO))

The "Advanced Demod" settings contain settings to select characteristics of the PPDUs you want to analyze. In addition, you can configure characteristics of the filter to be used.

► To select the "Advanced Demod" tab, set the focus on the tab (becomes blue) and move the cursor to the left or right.

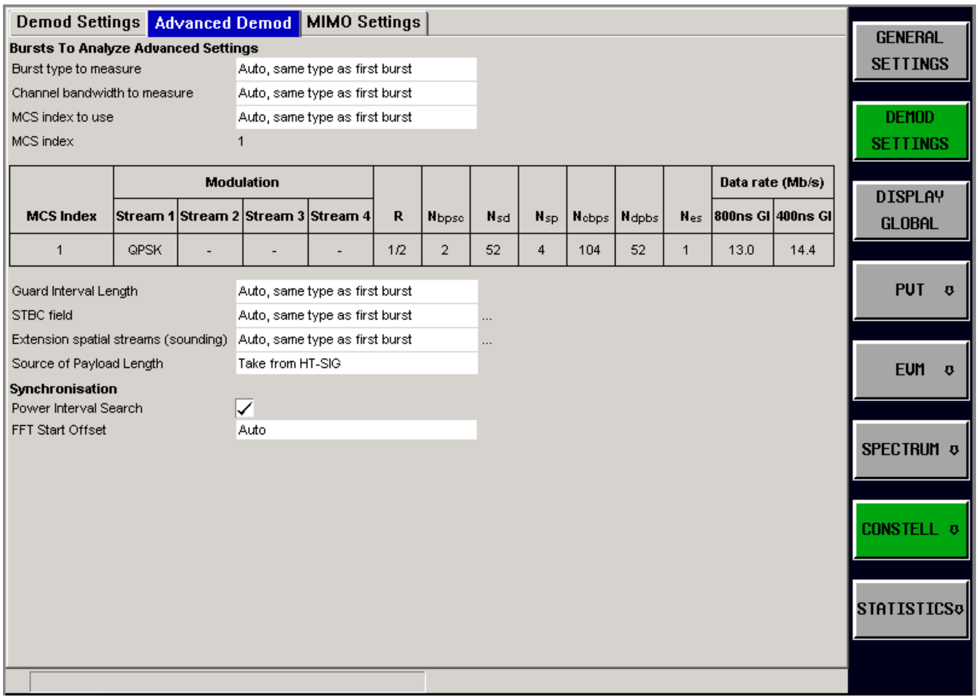


Fig. 22 Advanced Demod Settings (screenshot from IEEE 802.11n (MIMO)

3.5.1 Bursts to Analyze (Advanced)

The "Burst to Analyze" settings contain settings to define characteristics of the PPDUs that are considered during signal analysis.

3.5.1.1 Burst Type to Measure

Selects the type of PPDU to be considered in the measurement.

Auto, same type as first burst	All PPDUs identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the PPDU type.
Meas only mixed mode	Only mixed mode PPDUs are analyzed.
Meas only Greenfield	Only Greenfield mode PPDUs are analyzed.
Demod all as mixed mode	All PPDUs are analyzed as Mixed Mode PPDUs.
Demod all as Greenfield	All PPDUs are analyzed as Greenfield PPDUs.

Remote: [SENSe:]DEMod:FORMat:BANAlyze:BTYPe:AUTO:TYPE <PPDUType>

3.5.1.2 Channel Bandwidth to Measure

Selects the channel bandwidth of the PPDUs considered in the analysis.

Auto, same type as first burst	All PPDUs using a channel bandwidth identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the bandwidth.
Meas only 20 MHz signal	Only PPDUs with a 20 MHz channel bandwidth are analyzed.
Meas only 40 MHz signal	Only PPDUs with a 40 MHz channel bandwidth are analyzed.
Demod all as 20 MHz signal	All PPDUs are analyzed as 20 MHz channel bandwidth PPDUs.
Demod all as 40 MHz signal	All PPDUs are analyzed as 40 MHz channel bandwidth PPDUs.

Remote: [SENSe:]BANDwidth:CHANnel:AUTO:TYPE <PPDUType>

3.5.1.3 MCS Index to Use

Selects the Modulation and Coding Scheme (MCS) index of the PPDUs to be considered in the measurement.

Auto, same type as first burst	All PPDUs using an MCS index identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the MCS Index.
Meas only the specified MCS	Only PPDUs with a manually selected MCS Index are analyzed.
Demod all with specified MCS	All PPDUs are analyzed as PPDUs with the manually selected MCS Index, regardless of the actual MCS Index.

Remote: [SENSe:]DEMod:FORMat:MCSindex:MODE <PPDUType>

3.5.1.4 MCS Index

Selects the Modulation and Coding Scheme (MCS) index of the PPDUs to be considered in the measurement.

Available if you have selected "Meas Only the Specified MCS" or "Demod All with Specified MCS" as the MCS Index to Use.

The range is 0 to 76

Remote: [SENSe:]DEMod:FORMat:MCSindex <MCSIndex>

3.5.1.5 Guard Interval Length

Selects the guard interval length of the PPDUs to be considered in the measurement.

Auto, same type as first burst	All PPDUs using a guard interval length identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the guard interval length.
Meas only Short	Only PPDUs with a short guard interval are analyzed.
Meas only Long	Only PPDUs with a long guard interval are analyzed.
Demod all as Short	All PPDUs are analyzed as PPDUs with a short guard interval, regardless of the actual guard interval.
Demod all as Long	All PPDUs are analyzed as PPDUs with a long guard interval, regardless of the actual guard interval.

Remote: CONFigure:WLAN:GTIMe:AUTO:TYPE <PPDUType>

3.5.1.6 STBC Field

Selects the Space-Time Block Coding (STBC) field content of the PPDUs to be considered in the measurement.

Auto, same type as first burst	All PPDUs using a STBC field content identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the STBC field content.
Meas only if STBC field = 0	Only PPDUs with the specified STBC field content are analyzed.
Meas only if STBC field = 1 (+1 Stream)	Only PPDUs with the specified STBC field content are analyzed.
Meas only if STBC field = 2 (+2 Stream)	Only PPDUs with the specified STBC field content are analyzed.
Demod all as STBC field = 0	All PPDUs are analyzed as PPDUs with a STBC field = 0, regardless of the actual STBC field content.
Demod all as STBC field = 1	All PPDUs are analyzed as PPDUs with a STBC field = 1, regardless of the actual STBC field content.
Demod all as STBC field = 2	All PPDUs are analyzed as PPDUs with a STBC field = 2, regardless of the actual STBC field content.

Remote: CONFigure:WLAN:STBC:AUTO:TYPE <PPDUType>

3.5.1.7 Extension Spatial Streams (Sounding)

Selects the Ness field content of the PPDUs to be considered in the measurement.

Auto, same type as first burst All PPDUs using a Ness value identical to the first PPDU are analyzed.

Auto, individually for each burst All PPDUs are analyzed individually, regardless of the Ness field content.

Meas only if Ness = 0 Only PPDUs with the specified Ness value are analyzed.

Meas only if Ness = 1 Only PPDUs with the specified Ness value are analyzed.

Meas only if Ness = 2 Only PPDUs with the specified Ness value are analyzed.

Meas only if Ness = 3 Only PPDUs with the specified Ness value are analyzed.

Demod all as Ness = 0 All PPDUs are analyzed as PPDUs with a Ness value = 0, regardless of the actual Ness value content.

Demod all as Ness = 1 All PPDUs are analyzed as PPDUs with a Ness value = 1, regardless of the actual Ness value content.

Demod all as Ness = 2 All PPDUs are analyzed as PPDUs with a Ness value = 2, regardless of the actual Ness value content.

Demod all as Ness = 3 All PPDUs are analyzed as PPDUs with a Ness value = 3, regardless of the actual Ness value content.

Remote: CONFigure:WLAN:EXTension:AUTO:TYPE <PPDUType>

3.5.1.8 Source of Payload Length

Selects the source of the payload length used for signal analysis.

- From HT signal

  Payload length for signal analysis is taken from the signal field.

- Estimate from signal

  Payload length for signal analysis is estimated by the application.

Remote: CONFigure:WLAN:PAYLoad:LENGth:SRC <Method>

3.5.2 Synchronization

For more information see "Synchronisation Settings" on page 111.

3.6 Advanced Demod Settings (IEEE 802.11ac)

The "Advanced Demod" settings contain settings to select characteristics of the PPDUs you want to analyze. In addition, you can configure characteristics of the filter to be used.

► To select the "Advanced Demod" tab, set the focus on the tab (becomes blue) and move the cursor to the left or right.

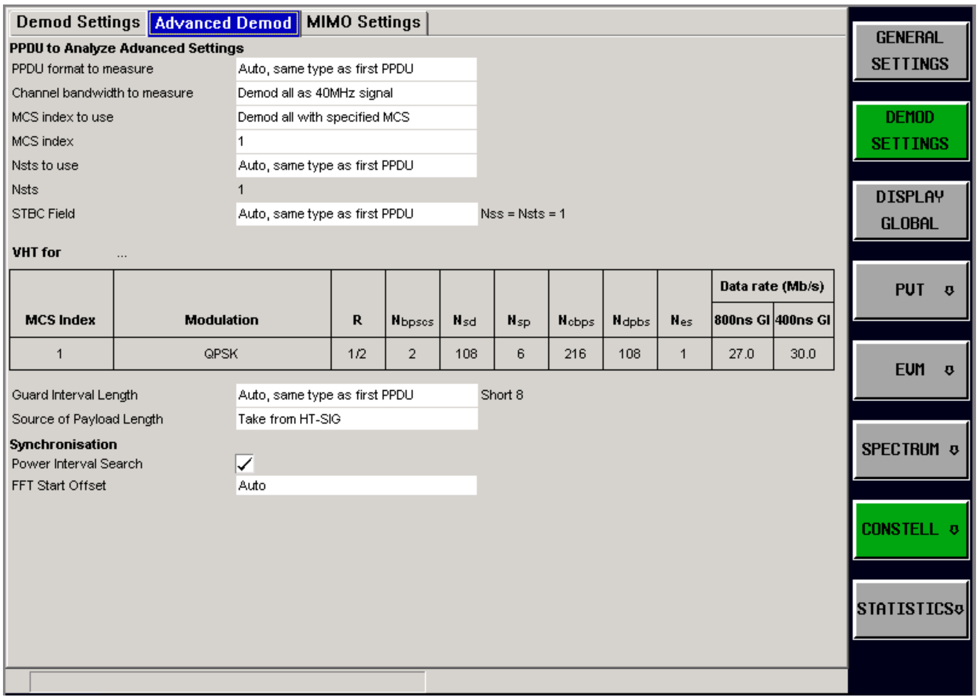


Fig. 23 Advanced Demod Settings (screenshot from IEEE 802.11ac)

3.6.1 PPDU to Analyze (Advanced)

The "PPDU to Analyze" settings contain settings to define characteristics of the PPDUs that are considered during signal analysis.

3.6.1.1 PPDU Format to Measure

Selects the PPDU types to be considered in the measurement.

Auto, same type as first PPDU	All PPDUs identical to the first PPDU are analyzed.
Auto, individual for each PPDU	All PPDUs are analyzed individually, regardless of the PPDU type.
Meas only VHT	Only very high throughput (VHT) PPDUs are analyzed.
Demod all as VHT	All PPDUs are analyzed as PPDUs with a VHT, regardless of the actual PPDU type.

Remote: [SENSe:]DEMod:FORMat:BANAlyze:BTYPe:AUTO:TYPE <PPDUType>

3.6.1.2 Channel Bandwidth to Measure

Selects the channel bandwidth of the PPDUs to be considered in the measurement.

Auto, same type as first PPDU	All PPDUs using a channel bandwidth identical to the first PPDU are analyzed.
Auto, individual for each PPDU	All PPDUs are analyzed individually, regardless of the channel bandwidth.
Meas only 20 MHz signal	Only PPDUs with a 20 MHz channel bandwidth are analyzed.
Meas only 40 MHz signal	Only PPDUs with a 40 MHz channel bandwidth are analyzed.
Meas only 80 MHz signal	Only PPDUs with a 80 MHz channel bandwidth are analyzed.
Demod all as 20 MHz signal	All PPDUs are analyzed as 20 MHz channel bandwidth PPDUs.
Demod all as 40 MHz signal	All PPDUs are analyzed as 40 MHz channel bandwidth PPDUs.
Demod all as 80 MHz signal	All PPDUs are analyzed as 80 MHz channel bandwidth PPDUs.

Remote: [SENSe:]BANDwidth:CHANnel:AUTO:TYPE <PPDUType>

3.6.1.3 MCS Index to Use

Selects the Modulation and Coding Scheme (MCS) index of the PPDUs considered in the analysis.

Auto, same type as first PPDU	All PPDUs using an MCS index identical to the first PPDU are analyzed.
Auto, individual for each PPDU	All PPDUs are analyzed individually, regardless of the MCS index.
Meas only the specified MCS	Only PPDUs with a manually selected MCS Index are analyzed.
Demod all with specified MCS	All PPDUs are analyzed as PPDUs with the manually selected MCS Index, regardless of the actual MCS Index.

Remote: [SENSe:]DEMod:FORMat:MCSindex <MCSIndex>

3.6.1.4 MCS Index

Selects the Modulation and Coding Scheme (MCS) index of the PPDUs to be considered in the measurement.

Available if you have selected "Meas Only the Specified MCS" or "Demod All with Specified MCS" as the MCS Index to Use.

The range is 0 to 76

Remote: [SENSe:]DEMod:FORMat:MCSindex <MCSIndex>

3.6.1.5 Nsts to Use

Selects the number of space time streams (NUM_STS TXVECTOR parameter) of the PPDUs to be considered in the measurement.

Auto, same type as first PPDU	All PPDUs using an Nsts value identical to the first PPDU are analyzed.
Auto, individual for each PPDU	All PPDU’s are analyzed individually, regardless of the Nsts value.
Meas only at specified Nsts	Only PPDUs with a manually selected Nsts value are analyzed.
Demod all with specified Nsts	All PPDUs are analyzed as PPDUs with the manually selected Nsts value, regardless of the actual Nsts value.

Remote: [SENSe:]DEMod:FORMat:NSTSindex:MODE <PPDUType>

3.6.1.6 Nsts

Selects the number of space time streams (NUM_STS TXVECTOR parameter) of the PPDUs to be considered in the measurement.

Available if you have selected "Meas only at specified Nsts" or "Demod all with specified Nsts" as the Nsts to Use.

The Nsts range is 1 to 8.

Remote: [SENSe:]DEMod:FORMat:NSTSindex <NSTSIndex>

3.6.1.7 STBC Field

Selects the Space-Time Block Coding (STBC TXVECTOR parameter) field content of the PPDU's to be considered in the measurement.

Auto, same type as first PPDU	All PPDUs using an STBC field content identical to the first PPDU are analyzed.
Auto, individually for each burst	All PPDUs are analyzed individually, regardless of the STBC field content.
Meas only if STBC field = 0	Only PPDUs with the specified STBC field content are analyzed.
Meas only if STBC field = 1	Only PPDUs with the specified STBC field content are analyzed.
Demod all as STBC field = 0	All PPDUs are analyzed as PPDUs with a STBC field = 0, regardless of the actual STBC field content.
Demod all as STBC field = 1	All PPDUs are analyzed as PPDUs with a STBC field = 1, regardless of the actual STBC field content.

Remote: CONFigure:WLAN:STBC:AUTO:TYPE <PPDUType>

3.6.1.8 VHT for…

The IEEE P802.11ac/D5.0, January 2013 standard defines the 802.11ac PPDU structure in section "22.5 Parameters for VHT-MCSs". Note for a given nominal channel bandwidth and number of spatial streams, the possible PPDU structures - in this case - is an unique VHT-MCS index assigned.

The table below the STBC Field displays the PPDU structure for this nominal channel bandwidth, number of spatial streams and MCS Index according to the WLAN standard.

3.6.1.9 Guard Interval Length

Selects the guard interval length of the PPDUs to be considered in the measurement.

Auto, same type as first PPDU All PPDUs using a guard interval length identical to the first PPDU are analyzed.

Auto, individually for each PPDU All PPDUs are analyzed individually, regardless of the guard interval length.

Meas only Short Only PPDUs with a short guard interval are analyzed.

Meas only Long Only PPDUs with a long guard interval are analyzed.

Demod all as Short All PPDUs are analyzed as PPDUs with a short guard interval, regardless of the actual guard interval.

Demod all as Long All PPDUs are analyzed as PPDUs with a long guard interval, regardless of the actual guard interval.

Remote: CONFigure:WLAN:GTIMe:AUTO:TYPE <PPDUType>

3.6.1.10 Source of Payload Length

For more information see Source of Payload Length.

3.6.2 Synchronization

For more information see "Synchronisation Settings" on page 111.

3.6.2.1 Power Interval Search

Turns the power interval search on and off.

When you turn the feature on, you can optimize measurement speed for signals with low duty cycles.

Turn the feature off for signals whose PPDU power levels differ significantly. In that case, some PPDUs might not be detected because of these level fluctuations.

Remote: CONFigure:WLAN:PAYLoad:LENGth:SRC <Method>

3.7 MIMO Settings (IEEE 802.11n (MIMO), ac)

The "Advanced Demod" settings contain settings to map a data stream to an antenna in MIMO measurements.

► To select the "MIMO Settings" tab, set the focus on the tab (becomes blue) and move the cursor to the left or right.

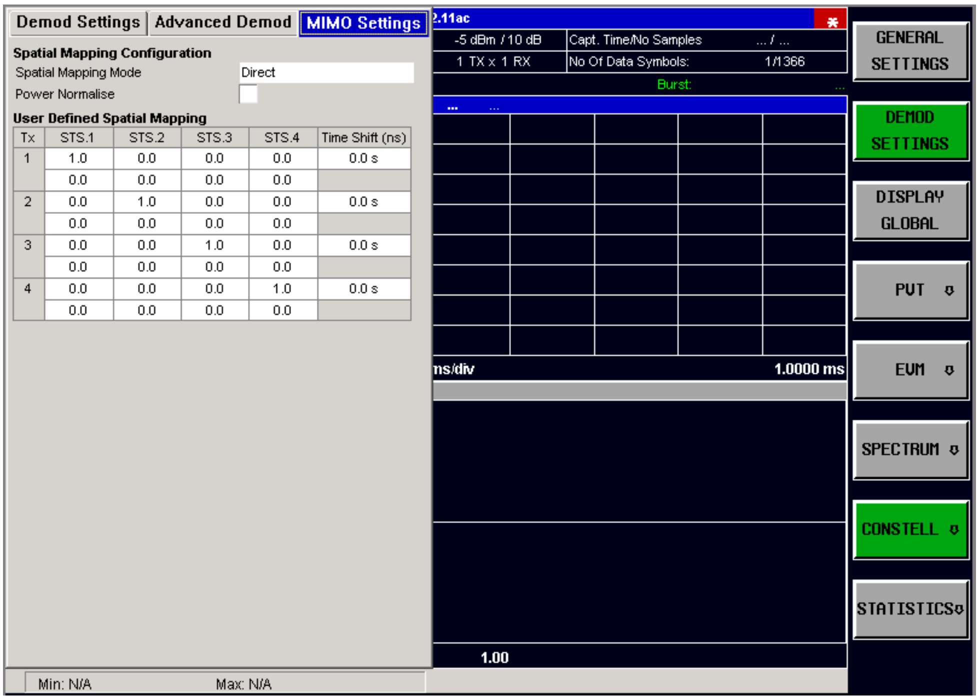


Fig. 24 MIMO Settings

3.7.1 Spatial Mapping Configuration

3.7.1.1 Spatial Mapping Mode

Selects the mapping between streams and antennas.

- Direct

  The mapping between streams and antennas is the identity matrix. See also section “20.3.11.10.1 Spatial Mapping” of the IEEE 802.11n WLAN standard.

- Spatial Expansion

  For this mode all streams contribute to all antennas. See also section “20.3.11.10.1 Spatial Mapping” of the IEEE 802.11n WLAN standard.

- User defined

  The mapping between streams and antennas is defined by the User Defined Spatial Mapping table.

Remote: CONFigure:WLAN:SMAPping:MODE <Mode>

3.7.1.2 Power Normalise

Turns amplification of the signal according to the spatial mapping matrix entries on and off.

- On

  Spatial mapping matrix is scaled by a constant factor to obtain a passive spatial mapping matrix which does not increase the total transmitted power.

- Off

  Normalization is not performed.

Remote: CONFigure:WLAN:SMAPping:NORMalise <State>

3.7.2 User Defined Spatial Mapping

User Defined Spatial Mapping

Tx	STS.1	STS.2	STS.3	STS.4	Time Shift (ns)
1	1.0	0.0	0.0	0.0	0.0 s
	0.0	0.0	0.0	0.0	
2	0.0	1.0	0.0	0.0	0.0 s
	0.0	0.0	0.0	0.0	
3	0.0	0.0	1.0	0.0	0.0 s
	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	1.0	0.0 s
	0.0	0.0	0.0	0.0	

Defines a customized spatial mapping between streams and antennas.

The spatial mapping table consists of the following items.

- Tx

  Shows the number of the antenna in the MIMO system (1 to 4).

- STS.1 to STS.4

  Complex element of each STS-Stream is defined. The upper value is the real part part of the complex element. The lower value is the imaginary part of the complex element.

- Time Shift

  Cyclic shift delay transmit diversity.

For more information see Spatial Mapping on page 147.

To edit the table, move the focus on the table header. Press ENTER or press the rotary knob to edit the table cells.

Remote:

CONFigure:WLAN:SMAPping:TX<ant>:TIMeshift <TimeShift>

CONFigure:WLAN:SMAPping:TX<ant>:STReam<stream> <STS I>,<STS Q>

3.8 Gate Settings

The gate settings define the range of captured data used to calculate results.

When you perform gated measurements, the application displays two red vertical lines in the Capture Buffer result display. These two lines represent the area of data used to calculate the results.

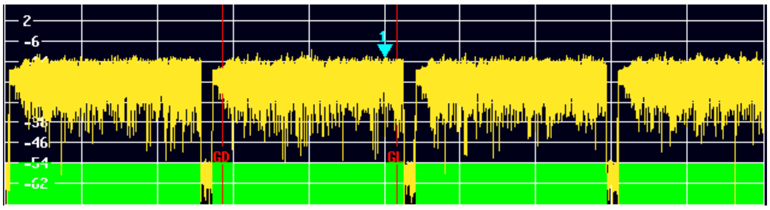


Fig. 25 Gate lines displayed in Magnitude Capture Buffer

Gated measurements are supported by the following result displays.

- PVT
- Spectrum FFT
- CCDF
- Spectrum Mask
- Spectrum ACP

► To access the gate settings, press the NEXT key in the main measurement menu.

The menu provides the following softkeys to configure gated measurements.

- Gating (On Off) on page 127
- Gate Configuration on page 128

3.8.1 Gating (On Off)

► Press the "Gating" softkey to turn gated measurements on and off.

When you turn on gated measurements, only the data inside the gate is used to calculate the measurement results. When gated measurements are turned off, the application uses all captured data in the calculation of the results.

Remote: [SENSe:]SWEep:EGATe <State>

3.8.2 Gate Configuration

► Press the "Gate Settings" softkey to open a dialog box and configure the gate.

The gate settings define the characteristics of the gate to be applied to the measurement.

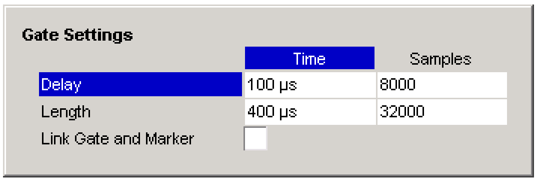
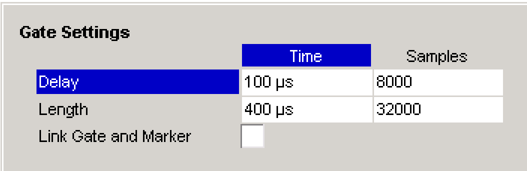


Fig. 26 Gate Settings pop-up dialog

If you open the "Gate Settings" dialog box while performing a frequency sweep measurement (Spectrum Mask or Spectrum ACP), the application automatically displays the Capture Buffer result display. This allows you to see the changes you are making to the gate.

3.8.2.1 Gate Delay



Defines the starting point of the gate in µs or samples. The gate delay is an offset from the beginning of the capture buffer (time or samples = 0).

When you change the gate delay in one unit, the application automatically updates the other unit.

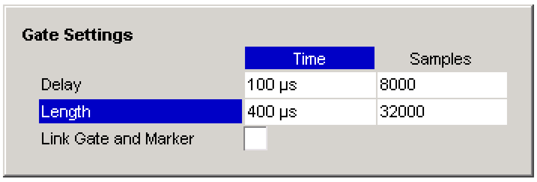
Changing the gate delay automatically moves the gate delay line in the capture buffer to a new position. The gate delay line is labeled with GD.

Remote:

[SENSe:]SWEep:EGATe:HOLDoff:SAMPle <DelayTime>

[SENSe:]SWEep:EGATe:HOLDoff[:TIMe] <DelayTime>

3.8.2.2 Gate Length



Defines the length of the gate in µs or samples. The gate length defines the amount of data used to calculate results.

When you change the gate length in one unit, the application automatically updates the other unit.

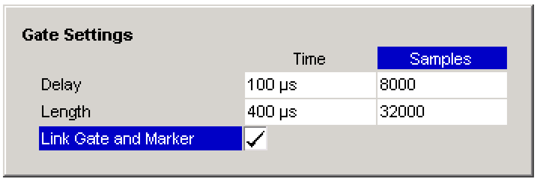
Changing the gate delay automatically moves the gate length line in the capture buffer to a new position. The gate delay line is labeled with GL.

Remote:

[SENSe:]SWEep:EGATe:LENGth:SAMPle <GateLength>

[SENSe:]SWEep:EGATe:LENGth[:TIMe] <GateLength>

3.8.2.3 Link Gate and Marker



Couples or decouples the marker position to the gate lines.

When gate and marker are linked, the marker is positioned half way between the gate start and the gate end. The marker changes its position when the gate is modified, and the gate lines move with the marker when the marker position is altered.

Remote: [SENSe:]SWEep:EGATe:LINK <State>

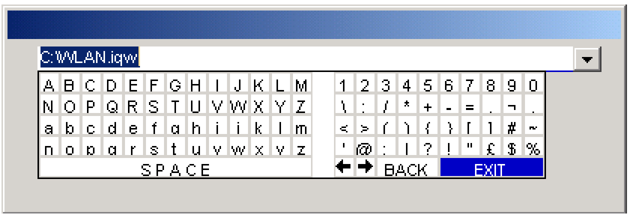
3.9 Import and Export of I/Q Data

The application allows you to import or export I/Q data to or from an external file.

► To access the import and export functionality, press the NEXT key in the main measurement menu.

Importing I/Q data

► Press the "Import" softkey to open the "Import" dialog box.



The "Import" dialog box allows you to specify the full name and path of the I/Q data file to be imported. Pressing the ENTER key causes the specified I/Q data file to be loaded and the results displayed.

If the specified file cannot be found or is not a valid I/Q data file, an error message will be displayed indicating that the I/Q data could not be imported.

Remote: MMEMory:LOAD:IQ:STATe 1,<FileName>

Exporting I/Q data

► Press the "Export" softkey to open the "Export" dialog box.

The "Export" dialog box allows you to specify the full name and path of the I/Q data file to be exported. Pressing the ENTER key causes the I/Q data to be written to the specified file.

If the specified file cannot be created or if there is no valid I/Q data to export (for example if the I/Q measurement has not been executed), an error message will be displayed indicating that the I/Q data could not be exported.

Remote: MMEMory:STORe:IQ:STATe 1,<FileName>

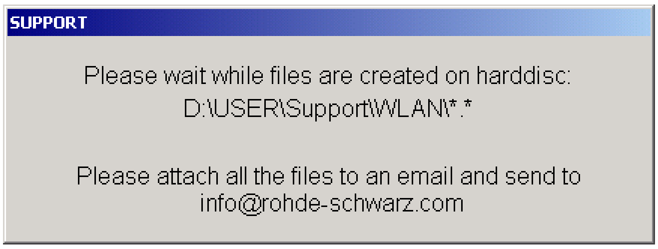
3.10 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

► To access the support functionality, press the NEXT key in the main measurement menu.

► Press the "Support" softkey.

The application opens a message box.



Availability of the support functionality

Note that the "Support" softkey is only available if no measurement is performed, i.e. RUN CONT must not be activated.

The support data is stored in the directory `D:\USER\SUPPORT` and is made up out of the following files:

- *.bin file (option settings)
- *.iqw file (I/Q-data)
- *.txt file (option and version list)
- *.bmp (screenshot)

Remote: ---

To allow for a fast and smooth processing of the request, make sure to send all four files to the Rohde & Schwarz customer support.

Attach all the files under D:\USER\SUPPORT*.* to an email and send to: info@rohde-schwarz.com.

3.11 Markers

The application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

► Press the MKR key to open the "Marker" softkey menu.

Activating Markers

You can activate the marker with the "Marker 1" softkey. When you activate the marker, the application opens the "Marker" dialog box.

After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states.

If the "Marker 1" softkey is grey, the marker is off.

After pressing the "Marker 1" softkey it turns red to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

After closing the dialog box, the "Marker 1" softkey turns green. The marker stays active.

Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "Marker Off" softkey.

Marker Zoom

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

The marker zoom is available for the following result displays.

- Magnitude Capture
- PVT
- Constellation vs Symbol
- Constellation vs Carrier

Assigning the marker to a trace

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker → Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

Positioning markers to a peak or minimum peak value

In the Spectrum Flatness measurement results graph, the marker can be assigned to the peak or minimum value for the currently allocated trace.

► Press the MKR→ hardkey to display the Marker To softkey menu.

► Press the PEAK softkey to set the marker to the peak of the allocated trace.

► Press the MIN softkey to set the marker to the minimum peak of the allocated trace.

Remote:

CALCulate<1|2>:MARKer<1>:STATe <State>

CALCulate<1|2>:MARKer<1>:X <Position>

CALCulate<1|2>:MARKer<1>:FUNCtion:ZOOM <ZoomFactor>

CALCulate<1|2>:MARKer<1>:TRACe <Trace>

CALCulate<1|2>:MARKer<1>:MAXimum

CALCulate<1|2>:MARKer<1>:MINimum

3.12 Display Settings

The layout of the display can be controlled in the display menu.

In the default state, the results are displayed in split screen mode. In split screen mode, the application displays two result displays, one in the upper area of the screen and one in lower area. The screens are labeled screen A (top) and screen B (bottom) respectively.

Frequency sweep measurements

Frequency sweep measurements (Spectrum Mask and Spectrum ACP) are always displayed in full screen mode.

Selecting a result display

► Press the SCREEN A or SCREEN B hotkey to select one of the result displays in split screen mode.

Selecting full screen or split screen mode

► Press the DISPLAY key to open the "Display" softkey menu.

The "Display" softkey menu provides functionality to view result displays in either full screen or split screen mode.

► Press the "Full Screen" softkey to view the results in full screen mode.

  In full screen mode, the application shows the selected result display over the complete screen. The other result display is hidden from view.

► Press the "Split Screen" softkey to return to the default display mode (two result displays) again.

Remote: DISPlay:FORMat <Format>

Selecting a result display for MIMO measurements

In case of MIMO measurements, the display shows the results for each antenna. You can view the results of each antenna in full screen mode when you select the corresponding measurement window.

► Press the SCREEN… hotkey to select one the result displays.

► When you have selected the required measurement window (the window title bar is highlighted blue) press the "Full Screen" softkey to display the results in full screen.

In full-screen mode, the SCREEN… hotkey also toggles which screen is displayed.

4 Measurement Basics

This section provides a more detailed explanation of the measurements provided by the WLAN application and provides help for using the WLAN application to measure the characteristics of specific types of DUT.

4.1 Signal Processing for Multicarrier Measurements (IEEE802.11a, g (OFDM))

4.1.1 Abbreviations

$a_{l,k}$	symbol at symbol l of subcarrier k
EVM_k	error vector magnitude of subcarrier k
EVM	error vector magnitude of current packet
g	signal gain
Δf	frequency deviation between Tx and Rx
l	symbol index $l = [1, Nof\_Symbols]$
$nof\_symbols$	number of symbols of payload
H_k	channel transfer function of subcarrier k
g	channel index $k = [-31, 32]$
K_{mod}	modulation-dependent normalization factor
ξ	relative clock error of reference oscillator
$r_{l,k}$	subcarrier k of symbol l

This description provides a high-level overview of IEEE 802.11a application signal processing.

A diagram of the blocks of interest is shown in Fig. 27.

First, the RF signal is downconverted to the IF frequency f_{IF} 20.4 MHz. The resulting IF signal $r_{IF}(t)$ is shown on the left-hand side of the figure. After bandpass filtering, the signal is sampled by an Analog to Digital Converter (ADC) at a sampling rate of f_{s1} = 81.6 MHz. This digital sequence is resampled to the new sampling frequency of f_{s2} = 80 MHz,which is a multiple of the Nyquist rate (20 MHz). The subsequent digital downconverter shifts the IF signal to the complex baseband. In the next step, the baseband signal is filtered by an FIR filter. To get an idea, the rough transfer function is plotted in the figure. This filter fulfills two tasks: First, it suppresses the IF image frequency; second, it attenuates the aliasing frequency bands caused by the subsequent downsampling. After filtering, the sequence is sampled down by the factor of 4. Thus, the sampling rate of the downsampled sequence $r(i)$ is the Nyquist rate of f_{s3} = 20 MHz. Up to this point, the digital part is implemented in an ASIC.

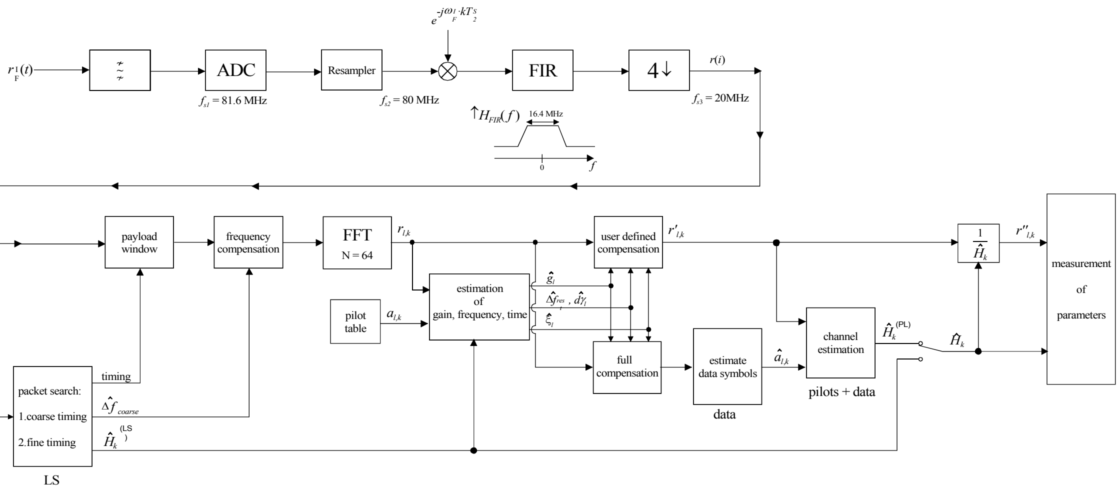


Fig. 27 Signal processing of the IEEE 802.11a application

The lower part of the figure shows the subsequent digital signal processing. In the first block, **packet search** is performed. This block detects the Long Symbol (LS) and recovers the timing. The **coarse timing** is detected first. This search is implemented in the time domain. The algorithm is based on cyclic repetition within the LS after $N = 64$ samples. Numerous treatises exist on this subject, e.g. [1]-[3]. Furthermore, a coarse estimate $\Delta\hat{f}_{coarse}$ [1] of the Rx-Tx frequency offset Δf is derived from the metric in [6]. This can easily be understood because the phase of $r(i) \cdot r^*(i+N)$ is determined by the frequency offset. As the frequency deviation Δf can exceed half a bin (distance between neighbor subcarriers), the preceding Short Symbol (SS) is also analyzed in order to detect the ambiguity.

After the coarse timing calculation, the time estimate is improved by the **fine timing calculation**. This is achieved by first estimating the coarse frequency response $\hat{H}_k^{(LS)}$, with $k = [-26,26]$ denoting the channel index of the occupied subcarriers. First, the FFT of the LS is calculated. After the FFT calculation, the known symbol information of the LS subcarriers is removed by dividing by the symbols. The result is a coarse estimate $\hat{H}_k$ of the channel transfer function. In the next step, the complex channel impulse response is computed by an IFFT. Next, the energy of the windowed impulse response (the window size is equal to the guard period) is calculated for every trial time. Afterwards, the trail time of the maximum energy is detected. This trial time is used to adjust the timing.

The position of the LS is now known and the starting point of the useful part of the first payload symbol can be derived. In the next block, this calculated time instant is used to position the **payload window**. Only the payload part is windowed. This is sufficient because the payload is the only subject of the subsequent measurements.

In the next block the windowed sequence is **compensated** by the **coarse frequency** estimate $\Delta\hat{f}_{coarse}$. This is necessary because, otherwise, interchannel interference (ICI) would occur in the frequency domain.

[1] In this paper the hat generally describes an estimate. Example: $\hat{x}$ is the estimate of x.

The transition to the frequency domain is achieved by an **FFT** of length 64. The FFT is performed symbol-wise for every of the $nof\_symbols$ symbols of the payload. The calculated FFTs are described by $r_{l,k}$ with

- the symbol index $l = [1, nof\_symbols]$ and
- the channel index $k = [-31, 32]$.

In case of an additive white Gaussian noise (AWGN) channel, the FFT is described by [4], [5]

$$r_{l,k} = K_{\text{mod}} \cdot a_{l,k} \cdot g_l \cdot H_k \cdot e^{j(phase_l^{common} + phase_{l,k}^{\text{timing}})} + n_{l,k} \qquad (1)$$

with

- the modulation-dependent normalization factor K_{mod}
- the symbol $a_{l,k}$ of subcarrier k at symbol l
- the gain g_l at the symbol l in relation to the reference gain $g = 1$ at the long symbol (LS)
- the channel frequency response H_k at the long symbol (LS)
- the common phase drift $phase_l^{common}$ of all subcarriers at symbol l (see below)
- the phase $phase_{l,k}^{\text{timing}}$ of subcarrier k at symbol l caused by the timing drift (see below)
- the independent Gaussian distributed noise samples $n_{l,k}$

The common phase drift is given by

$$phase_l^{common} = 2\pi \cdot N_s / N \cdot \Delta f_{rest} \cdot T \cdot l + d\gamma_l \qquad (2)$$

with

- $N_s = 80$ being the number of Nyquist samples of the symbol period
- $N = 64$ being the number of Nyquist samples $N = 64$ of the useful part of the symbol
- Δf_{rest} being the (not yet compensated) frequency deviation
- $d\gamma_l$ being the phase jitter at the symbol l

In general, the coarse frequency estimate $\Delta\hat{f}_{coarse}$ (see figure 1) is not error-free. Therefore the remaining frequency error Δf_{rest} represents the not yet compensated frequency deviation in $r_{l,k}$. Consequently the overall frequency deviation of the device under test (DUT) is calculated by $\Delta f = \Delta\hat{f}_{coarse} + \Delta f_{rest}$. Remark: The only motivation for dividing the common phase drift in equation (2) into two parts is to be able to calculate the overall frequency deviation of the DUT.

The reason for the phase jitter $d\gamma_l$ in equation (2) may be different. The nonlinear part of the phase jitter may be caused by the phase noise of the DUT oscillator. Another reason for nonlinear phase jitter may be the increase of the DUT amplifier temperature at the beginning of the PPDU. Please note that besides the nonlinear part, the phase jitter $d\gamma_l$ also contains a constant part. This constant part is caused by the not yet compensated frequency deviation Δf_{rest}. To understand this, keep in mind that the measurement of the phase starts at the first symbol $l = 1$ of the payload. In contrast, the channel frequency response H_k represents the channel at the long symbol of the preamble. Consequently, the not yet compensated frequency deviation Δf_{rest} produces a phase drift between the long symbol and the first symbol of the payload. Therefore, this phase drift appears as a constant value ("DC value") in $d\gamma_l$.

Referring to the IEEE 802.11a measurement standard Chapter 17.3.9.7 "Transmit modulation accuracy test" [6], the common phase drift $phase_l^{common}$ must be estimated and compensated from the pilots. Therefore, this "symbol-wise phase tracking" (Tracking Phase) is activated as the default setting of the WLAN application.

The timing drift is given by

$$phase_{l,k}^{\text{timing}} = 2\pi \cdot N_s / N \cdot \xi \cdot k \cdot l \qquad (3)$$

with ξ being the relative clock deviation of the reference oscillator. Normally a symbol-wise timing jitter is negligible and thus not modelled in equation (3). There may be situations where the timing drift has to be taken into account. This is illustrated by an example: In accordance with [6], the allowed clock deviation of the DUT is up to $\xi_{\max}$ = 20 ppm. Furthermore, a long packet with $nof\_symbols = 400$ symbols is assumed.

The resulting phase drift of the highest subcarrier $k = 26$ in the last symbol $l = nof\_symbols$ is 93 degrees. Even in the noise-free case, this would lead to symbol errors. The example shows that it is actually necessary to estimate and compensate the clock deviation, which is accomplished in the next block.

Referring to the IEEE 802.11a measurement standard [6], the timing drift $phase_{l,k}^{\text{timing}}$ is not part of the requirements. Therefore, the "time tracking" (Tracking Time) is not activated as the default setting of the WLAN application.

The time tracking option should rather be seen as a powerful analyzing option.

In addition, the tracking of the gain g_l is supported for each symbol in relation to the reference gain $g = 1$ at the time instant of the long symbol (LS). At this time, the coarse channel transfer function $\hat{H}_k^{LS}$ is calculated. This makes sense since the sequence $r'_{l,k}$ is compensated by the coarse channel transfer function $\hat{H}_k^{LS}$ before estimating the symbols. Consequently, a potential change of the gain at the symbol l (caused, for example, by the increase of the DUT amplifier temperature) may lead to symbol errors especially for a large symbol alphabet M of the MQAM transmission. In this case, the estimation and the subsequent compensation of the gain is useful.

Referring to the IEEE 802.11a measurement standard [6], the compensation of the gain g_l is not part of the requirements. Therefore, the "gain tracking" (Tracking Gain) is not activated as the default setting of the WLAN application.

How can the parameters above be calculated? In this application, the optimum maximum likelihood algorithm is used. In the first estimation step, the symbol-independent parameters Δf_{rest} and ξ are estimated. The symbol-dependent parameters can be neglected in this step, i.e. the parameters are set to $g_l = 1$ and $d\gamma_l = 0$. The log likelihood function[2].

$$L_l\left(\Delta\tilde{f}_{rest},\tilde{\xi}\right) \overset{eq(1)}{=} \sum_{l=1}^{nof\_symbols} \sum_{k=-21,-7,7,21} \left| r_{l,k} - a_{l,k} \cdot \hat{H}_k^{LS} \cdot e^{j(phase_l^{common} + phase_{l,k}^{\text{timing}})} \right|^2$$

with (4)

$$phase_l^{common} \overset{eq(2)}{=} 2\pi \cdot N_s / N \cdot \Delta\tilde{f}_{rest} T \cdot l$$

$$phase_l^{\text{timing}} \overset{eq(3)}{=} 2\pi \cdot N_s / N \cdot \tilde{\xi} \cdot k \cdot l$$

[2] In this paper, the tilde generally describes an estimate. Example: $\tilde{x}$ is the trial parameter of x.

must be calculated as a function of the trial parameters $\Delta\tilde{f}_{rest}$ and $\tilde{\xi}$. The trial parameters leading to the minimum of the log likelihood function are used as estimates $\Delta\hat{f}_{rest}$ and $\hat{\xi}$. The known pilot symbols $a_{l,k}$ are read from a table.

In the second step, the log likelihood function

$$L_2(\tilde{g}_l, d\tilde{\gamma}_l) \overset{eq(1)}{=} \sum_{k=-21,-7,7,21} \left| r_{l,k} - a_{l,k} \cdot \tilde{g}_l \cdot \hat{H}_k^{LS} \cdot e^{j(phase_l^{common} + phase_{l,k}^{\text{timing}})} \right|^2$$

with

$$phase_l^{common} \overset{eq(2)}{=} 2\pi \cdot N_s / N \cdot \Delta\tilde{f}_{rest} T \cdot l + d\tilde{\gamma}_l$$

$$phase_l^{\text{timing}} \overset{eq(3)}{=} 2\pi \cdot N_s / N \cdot \hat{\xi} \cdot k \cdot l$$

is calculated for every symbol l as a function of the trial parameters $\tilde{g}_l$ and $d\tilde{\gamma}_l$. Finally, the trial parameters leading to the minimum of the log likelihood function are used as estimates $\hat{g}_l$ and $d\hat{\gamma}_l$.

This robust algorithm works well even at low signal to noise ratios with the Cramer Rao Bound being reached.

After estimation of the parameters, the sequence $r_{l,k}$ is compensated in the **compensation blocks**.

In the upper analyzing branch, the compensation is user-defined, i.e. the user determines which of the parameters are compensated. This is useful in order to extract the influence of these parameters. The resulting output sequence is described by $r'_{l,k}$.

In the lower compensation branch, the full compensation is always performed. This separate compensation is necessary in order to avoid symbol errors. After the full compensation, the secure **estimation of the data symbols** $\hat{a}_{l,k}$ is performed. From the equations above, it is clear that first the channel transfer function H_k must be removed. This is achieved by dividing the known coarse channel estimate $\hat{H}_k^{LS}$ calculated from the LS. Usually an error-free estimation of the data symbols can be assumed.

In the next block, a better channel estimate $\hat{H}_k^{PL}$ of the data and pilot subcarriers is calculated by using all $nof\_symbols$ symbols of the payload (PL). This can be accomplished at this point because the phase is compensated and the data symbols are known. The long observation interval of $nof\_symbols$ symbols (compared to the short interval of 2 symbols for the estimation of $\hat{H}_k^{LS}$) leads to a nearly error-free channel estimate.

In the following equalizer block $r'_{l,k}$ is compensated by the channel estimate. The resulting channel-compensated sequence is described by $r''_{l,k}$. The user may either choose the coarse channel estimate $\hat{H}_k^{LS}$ (from the long symbol) or the nearly error-free channel estimate $\hat{H}_k^{LS}$ (from the payload) for equalization. In case of using the improved estimate $\hat{H}_k^{LS}$, a 2 dB reduction of the subsequent EVM measurement can be expected.

According to the IEEE 802.11a measurement standard [6], the coarse channel estimation $\hat{H}_k^{LS}$ (from the long symbol) has to be used for equalization. Therefore, the default setting of the WLAN application is equalization from the coarse channel estimate derived from the long symbol.

In the last block, the **measurement variables** are calculated. The most important variable is the error vector magnitude

$$EVM_k = \sqrt{\frac{1}{nof\_symbols} \cdot \sum_{l=1}^{nof\_symbols} \left| r''_{l,k} - K_{\mathrm{mod}} \cdot a_{l,k} \right|^2} \qquad (5)$$

of the subcarrier k of the current packet. Furthermore the packet error vector magnitude

$$EVM = \sqrt{\frac{1}{52} \cdot \sum_{\substack{k=-26 \\ (k \neq 0)}}^{26} EVM_k^2} \qquad (6)$$

is derived by averaging the squared EVM_k versus k. Finally, the average error vector magnitude

$$EVM = \sqrt{\frac{1}{nof\_packets} \sum_{counter=1}^{nof\_packets} EVM^2(counter)} \qquad (7)$$

is calculated by averaging the packet EVM of all $nof\_packets$ detected packets. This parameter is equivalent to the "RMS average of all errors $Error_{RMS}$" of the IEEE 802.11a measurement standard (see [6], Chapter 17.3.9.7).

4.1.2 Literature

[1] Speth, Classen, Meyr: "Frame synchronisation of OFDM systems in frequency selective fading channels", VTC '97, pp. 1807-1811

[2] Schmidl, Cox: "Robust Frequency and Timing Synchronization of OFDM", IEEE Trans. on Comm., Dez. 1997, pp. 1613-621

[3] Minn, Zeng, Bhargava: "On Timing Offset Estimation for OFDM", IEEE Communication Letters, July 2000, pp. 242-244

[4] Speth, Fechtel, Fock, Meyr: "Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM - Part I", IEEE Trans. On Comm. VOL. 47, NO 11, Nov. 1999

[5] Speth, Fechtel, Fock, Meyr: "Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM - Part II", IEEE Trans. On Comm. VOL. 49, NO 4, April. 2001

[6] IEEE802.11a, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications

4.2 Signal Processing for Single-Carrier Measurements (IEEE 802.11b, g (DSSS))

4.2.1 Abbreviations

ε	timing offset
Δf	frequency offset
$\Delta\phi$	phase offset
$ARG\{...\}$	calculation of the angle of a complex value
EVM	error vector magnitude
$\hat{g}_I$	estimate of the gain factor in the I branch
$\hat{g}_Q$	estimate of the gain factor in the Q branch
$\Delta\hat{g}_Q$	accurate estimate of the crosstalk factor of the Q branch in the I branch
$h_s(v)$	estimated baseband filter of the transmitter
$h_r(v)$	estimated baseband filter of the receiver
$\hat{o}_I$	estimate of the I/Q offset in the I branch
$\hat{o}_Q$	estimate of the I/Q offset in the I branch
$r(v)$	measurement signal
$\hat{s}(v)$	estimate of the reference signal
$\hat{s}_n(v)$	estimate of the power normalized and undisturbed reference signal
$REAL\{...\}$	calculation of the real part of a complex value
$IMAG\{...\}$	calculation of the imaginary part of a complex value

This description gives a rough overview of the signal processing concept of the IEEE 802.11b application.

A block diagram of the measurement application is shown in Fig. 28. The baseband signal of an IEEE 802.11b wireless LAN system transmitter is sampled with a sampling rate of 44 MHz.

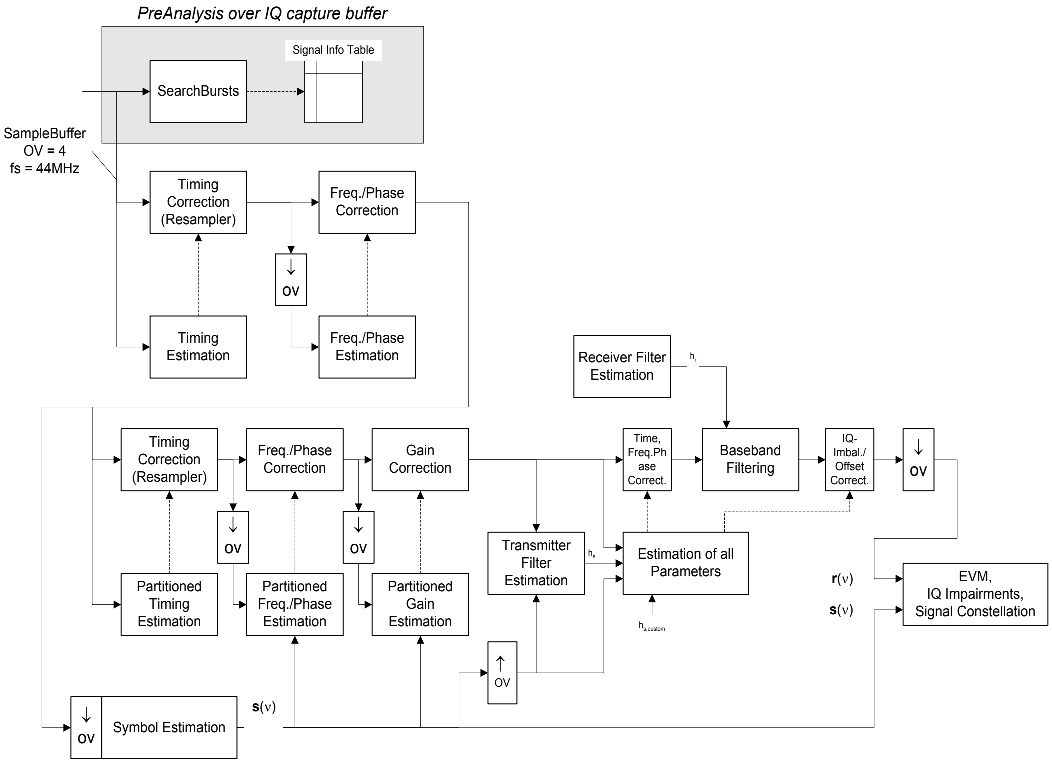


Fig. 28 Signal processing of the IEEE 802.11b application

The first task of the measurement application is to detect the position of the PPDUs within the measurement signal $r_1(v)$. The detection algorithm is able to find the positions of the begining of short and long PPDUs and can distinguish between them. The algorithm also detects the initial state of the scrambler. This is required if IEEE 802.11 signals should be analyzed, because this standard does not specify the initial state of the scrambler.

With the knowledge of the start position of the PPDU, the header of the PPDU can be demodulated. The bits transmitted in the header provide information about the length of the PPDU and the modulation type used in the PSDU.

After the start position and the PPDU length are fully known, better estimates of timing offset, timing drift, frequency offset and phase offset can be calculated using the entire data of the PPDU.

At this point of the signal processing, demodulation can be performed without decision error. After demodulation, the normalized and undisturbed reference signal $s(v)$ is available.

If the frequency offset is not constant and varies with time, the frequency offset and phase offset in several partitions of the PPDU must be estimated and corrected. Additionally, timing offset, timing drift and gain factor can be estimated and corrected in several partitions of the PPDU. These corrections can be separately switched off in the demodulation settings menu.

Knowing the normalized power and undisturbed reference signal, the transmitter baseband filter is estimated by minimizing the cost function

$$L_1 = \sum_{v=0}^{N-1} \left| r(v) \cdot e^{-j2\pi\Delta\tilde{f}v} \cdot e^{-j\Delta\tilde{\phi}} - \sum_{i=-L}^{L} \tilde{h}_s(i) \cdot \hat{s}_n(v-i) - \tilde{o}_I - j\tilde{o}_Q \right|^2$$

of a maximum-likelihood-based estimator, where $r(v)$ is the oversampled measurement signal, $\hat{s}_n(v)$ the oversampled power normalized and undisturbed reference signal, N the observation length, L the filter length, $\Delta\tilde{f}$, $\Delta\tilde{\phi}$, $\tilde{o}_I$, $\tilde{o}_Q$ and $h_s(v)$ the variation parameters of the frequency offset, the phase offset , the I/Q offset and the coefficients of the transmitter filter. The frequency offset, the phase offset and the I/Q offset are estimated jointly with the coefficients of the transmitter filter to increase the estimation quality.

Once the transmitter filter is known, all other unkown signal parameters are estimated with a maximum-likelihood-based estimation, which minimizes the cost function

$$L_2 = \sum_{v=0}^{N-1} \left| r(v-\tilde{\varepsilon}) \cdot e^{-j2\pi\Delta\tilde{f}v} \cdot e^{-j\Delta\tilde{\phi}} - \tilde{g}_I \cdot s_I(v) - j\tilde{g}_Q \cdot s_Q(v) + \Delta\tilde{g}_Q \cdot s_Q(v) - \tilde{o}_I - j\tilde{o}_Q \right|^2$$

where $\tilde{g}_I$ and $\tilde{g}_Q$ are the variation parameters of the gain used in the I and Q branches, respectively, $\Delta\tilde{g}_Q$ is the crosstalk factor of the Q branch into the I branch, and $s_I(v)$ and $s_Q(v)$ are the filtered reference signals of the I and Q branches, respectively. The unknown signal parameters are estimated in a joint estimation process to increase the accuracy of the estimates.

The accurate estimates of the frequency offset, the I/Q imbalance, the quadrature mismatch and the normalized I/Q offset are displayed by the measurement software. The I/Q imbalance

$$\text{IQ Imbalance} = \left| \frac{\hat{g}_Q + \Delta\hat{g}_Q}{\hat{g}_I} \right|$$

is the quotient of the estimates of the gain factor of the Q branch, the cosstalk factor and the gain factor of the I branch, the quadrature mismatch

$$\text{Quadrature mismatch} = ARG\{\hat{g}_Q + j \cdot \Delta\hat{g}_Q\}$$

is a measure for the crosstalk of the Q branch into the I branch. The normalized I/Q offset

$$\text{IQ Offset} = \frac{\sqrt{\hat{o}_I^2 + \hat{o}_Q^2}}{\sqrt{\hat{g}_I^2 + \hat{g}_Q^2}}$$

is defined as the magnitude of the I/Q offset normalized by the magnitude of the reference signal.

At this point in the signal processing, all unknown signal parameters such as timing offset, frequency offset, phase offset, I/Q offset and I/Q imbalance have been evaluated and the measurement signal can be corrected accordingly.

Using the corrected measurement signal $r(v)$ and the estimated reference signal $\hat{s}(v)$, the modulation quality parameters can be calculated. The mean error vector magnitude (EVM)

$$\text{EVM} = \frac{\sqrt{\sum_{v=0}^{N-1} \left| r(v) - \hat{s}(v) \right|^2}}{\sqrt{\sum_{v=0}^{N-1} \left| \hat{s}(v) \right|^2}}$$

is the quotient of the root-mean-square values of the error signal power and the reference signal power, whereas the instant error vector magnitude

$$\text{EVM(v)} = \frac{\left| r(v) - \hat{s}(v) \right|}{\sqrt{\sum_{v=0}^{N-1} \left| \hat{s}(v) \right|^2}}$$

is the momentary error signal magnitude normalized by the root mean square value of the reference signal power.

In [2], a different algorithm is proposed to calculate the error vector magnitude. In a first step, the I/Q offset in the I branch

$$\hat{o}_I = \frac{1}{N} \sum_{v=0}^{N-1} REAL\{r(v)\}$$

and the IQ offset of the Q branch

$$\hat{o}_Q = \frac{1}{N} \sum_{v=0}^{N-1} IMAG\{r(v)\}$$

are estimated separately, where $r(v)$ is the measurement signal that has been corrected with the estimates of the timing offset, frequency offset and phase offset, but not with the estimates of the I/Q imbalance and the I/Q offset. With these values, the I/Q imbalance of the I branch

$$\hat{g}_I = \frac{1}{N} \sum_{v=0}^{N-1} \left| REAL\{r(v) - \hat{o}_I\} \right|$$

and the I/Q imbalance of the Q branch

$$\hat{g}_Q = \frac{1}{N} \sum_{v=0}^{N-1} \left| IMAG\{r(v) - \hat{o}_Q\} \right|$$

are estimated in a non-linear estimation in a second step. Finally, the mean error vector magnitude

$$v_{err} = \frac{\sqrt{\frac{1}{2} \sum_{v=0}^{N-1} \left[\left| REAL\{r(v) - \hat{o}_I \right| - \hat{g}_I \right]^2 + \frac{1}{2} \sum_{v=0}^{N-1} \left[\left| IMAG\{r(v) - \hat{o}_Q \right| - \hat{g}_Q \right]^2}}{\sqrt{\frac{1}{2} \cdot (\hat{g}_I^2 + \hat{g}_Q^2)}}$$

can be calculated with a non-data-aided calculation. The instant error vector magnitude

$$v_{err} = \frac{\sqrt{\frac{1}{2}\left[\left|REAL\{r(v) - \hat{o}_I\right| - \hat{g}_I\right]^2 + \left[\left|IMAG\{r(v) - \hat{o}_Q\right| - \hat{g}_Q\right]^2}}{\sqrt{\frac{1}{2} \cdot (\hat{g}_I^2 + \hat{g}_Q^2)}}$$

is the error signal magnitude normalized by the root mean square value of the estimate of the measurement signal power. The advantage of this method is that no estimate of the reference signal is needed, but the I/Q offset and I/Q imbalance values are not estimated in a joint estimation procedure. Therefore, each estimation parameter is disturbing the estimation of the other parameter, and the accuracy of the estimates is lower than the accuracy of the estimations achieved by Eq. 4.1. If the EVM value is dominated by Gaussian noise, this method yields similar results to those of Eq. 4.2.

4.2.2 Literature

[1] Institute of Electrical and Electronic Engineers, *Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications*, IEEE Std 802.11-1999, Institute of Electrical and Electronic Engineers, Inc., 1999.

[2] Institute of Electrical and Electronic Engineers, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher-Speed Physical Layer Extensions in the 2.4 GHz Band, IEEE Std 802.11b-1999, Institute of Electrical and Electronic Engineers, Inc., 1999.

4.3 Signal Processing for MIMO Measurements

In a test setup with multiple antennas, the R&S FSQ receives a signal on each antenna that is in the setup. Each of these signals might contain a spatial stream, which contains the transmission data.

Each spatial stream has gone through a variety of transformations during transmission. The signal processing chain is displayed in the figure below, starting with the bitstream (coded bits) in the transmitting device, through the wireless transmission and ending with the merging of the spatial streams in the receiving device. This processing chain has been defined by IEEE.

The following figure shows the basic processing steps performed by the transmit antenna and the complementary blocks in reverse order applied at the receive antenna:

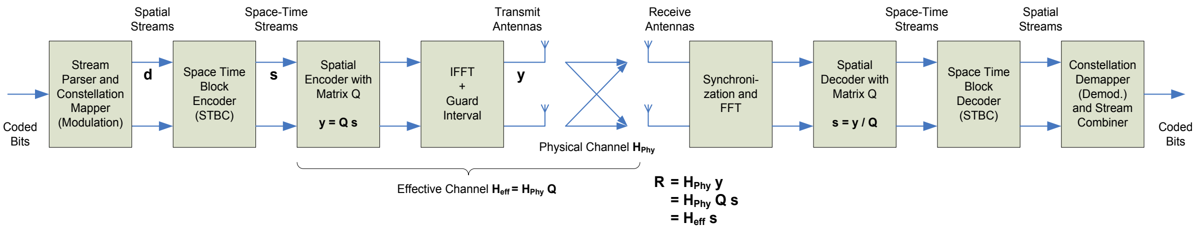


Fig. 29 Signal and data flow from the transmitter to the receiver

4.3.1 Space-Time Block Coding (STBC)

The coded bits to be transmitted are modulated to create a data stream, referred to as a spatial stream, by the stream parser in the transmitting device under test.

The Space-Time Block Encoder (STBC) implements the transmit diversity technique. It creates multiple copies of the data streams, each encoded differently, which can then be transmitted by a number of antennas.

To do so, the STBC encodes only the data carriers in the spatial stream using a matrix. Each row in the matrix represents an OFDM symbol and each column represents one antenna's transmissions over time (thus the term space-time encoder). This means each block represents the same data, but with a different coding. The resulting blocks are referred to as space-time streams (STS). Each stream is sent to a different Tx antenna. This diversity coding increases the signal-to-noise ratio at the receive antenna. The pilot carriers are inserted after the data carriers went through the STBC. Thus, only the data carriers are decoded by the analyzer to determine characteristics of the demodulated data.

In order to transmit the space-time streams, two or more antennas are required by the sender, and one or more antennas are required by the receive antenna.

4.3.2 Spatial Mapping

The Spatial Encoder is responsible for the spatial multiplexing. It defines the mapping between the streams and the transmit antennas - referred to as spatial mapping - or as a matrix: the spatial mapping matrix.

In the WLAN application, the mapping can be defined using the following methods:

- Direct mapping: one single data stream is mapped to an exclusive Tx antenna (the spatial matrix contains "1" on the diagonal and otherwise zeros.)
- Spatial Expansion: multiple (different) data streams are assigned to each antenna in a defined pattern
- User-defined mapping: the data streams are mapped to the antennas by a userdefined matrix

User-defined spatial mapping

You can define your own spatial mapping between streams and Tx antennas.

For each antenna (Tx1...4), the complex element of each STS-stream is defined. The upper value is the real part part of the complex element. The lower value is the imaginary part of the complex element.

Additionally, a "Time Shift" can be defined for cyclic delay diversity (CSD).

The stream for each antenna is calculated as:

$$\begin{pmatrix} Tx_1 - Stream \\ . \\ . \\ Tx_4 - Stream \end{pmatrix} = \begin{pmatrix} Tx_1, STS.1 & . & . & Tx_1, STS.4 \\ . & & & . \\ . & & & . \\ Tx_4, STS.1 & . & . & Tx_4, STS.4 \end{pmatrix} \begin{pmatrix} STS - Stream_1 \\ . \\ . \\ STS - Stream_4 \end{pmatrix}$$

4.3.3 Physical vs Effective Channels

The effective channel refers to the transmission path starting from the space-time stream and ending at the receive antenna. It is the product of the following components:

- the spatial mapping
- the crosstalk inside the device under test (DUT) transmission paths
- the crosstalk of the channel between the transmit antennas and the receive antennas

For each space-time stream, at least one training field (the (V)HT-LTF) is included in every PPDU preamble (see figure 4-4). Each sender antenna transmits these training fields, which are known by the receive antenna. The effective channel can be calculated from the received (and known) (V)HT-LTF symbols of the preamble, without knowledge of the spatial mapping matrix or the physical channel. Thus, the effective channel can always be calculated.

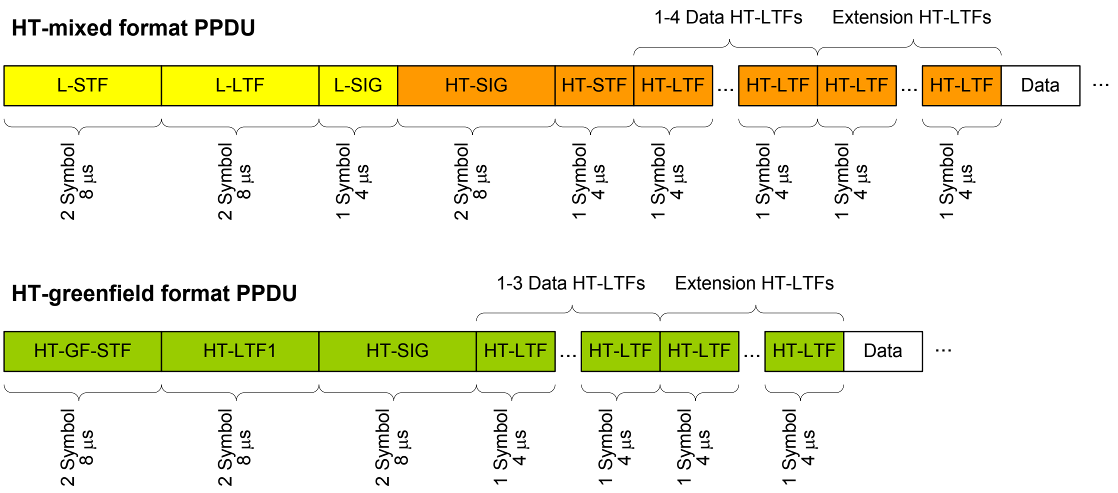


Fig. 30 Training fields (TF) in the preamble of PPDUs in IEEE 802.11n standard

The effective channel is sufficient to calculate the EVM, the constellation diagram and the bitstream results of the measured signal, so these results are always available.

The physical channel refers to the transmission path starting from the transmit antenna streams and ending at the receive antenna. It is the product of the following components:

- the crosstalk inside the device under test (DUT) transmission paths
- the crosstalk of the channel between the transmit antennas and the receive antennas

The physical channel is derived from the effective channel using the inverted spatial mapping matrix Q:

$H_{phy} = H_{eff}Q^{-1}$

Thus, if the spatial mapping matrix cannot be inverted, the physical channel cannot be calculated. This may be the case, for example, if the signal contains fewer streams than Rx antenna signals, or if the spatial matrix is close to numerical singularity.

In this case, results that are based on the transmit antenna such as I/Q offset, gain imbalance and quadrature offset are not available.

Crosstalk in estimated channels

Note that the estimated channel transfer function contains crosstalk from various ources, for example:

- from the transmission paths inside the DUT
- from the connection between the analyzer and the DUT
- from the analyzer itself

The crosstalk from the analyzer can be neglected. If the analyzer and DUT are connected by cable, this source of crosstalk can also be neglected.

4.3.4 Capturing Data from MIMO Antennas

The primary purpose of many test applications that verify design parameters, or are used in production, is to determine if the transmitted signals adhere to the relevant standards and whether the physical characteristics fall within the specified limits. In such cases there is no need to measure the various transmit paths simultaneously. Instead, they can either be tested as single antenna measurements, or sequentially (with restrictions, see also "MIMO Antenna Signal Capture", on page 85). Then only one analyzer is needed to measure parameters such as error vector magnitude (EVM), power and I/Q imbalance.

Measurements that have to be carried out for development or certification testing are significantly more extensive. In order to fully reproduce the data in transmit signals or analyze the crosstalk between the antennas, for example, measurements must be performed simultaneously on all antennas. One analyzer is still sufficient if the system is using transmit diversity (multiple input single output – MISO). However, space-division multiplexing requires two or more analyzers to calculate the precoding matrix and demodulate the signals.

The WLAN application provides the following methods to capture data from the MIMO antennas:

- Simultaneous MIMO operation

  The data streams are measured simultaneously by multiple analyzers. One of the analyzers is defined as a master, which receives the I/Q data from the other analyzers (the slaves). The IP addresses of each slave analyzer must be provided to the master. The only function of the slaves is to record the data that is then accumulated centrally by the master.

  (Note that only the MIMO master analyzer requires the R&S FSQ-K91n or ac option. The slave analyzers do not require a WLAN application.)

  The number of Tx antennas on the DUT defines the number of analyzers required for this measurement setup.

  The master calculates the measurement results based on the I/Q data captured by all analyzers (master and slaves) and displays them in the selected result displays.

- Sequential using open switch platform

  The data streams are measured sequentially by a single analyzer connected to an additional switch platform that switches between antenna signals. No manual interaction is necessary during the measurement. The WLAN application captures the I/Q data for all antennas sequentially and calculates and displays the results (individually for each data stream) in the selected result displays automatically.

  A single analyzer and the Rohde & Schwarz OSP Switch Platform is required to measure the multiple DUT Tx antennas (the switch platform must be fitted with at least one R&S®OSP-B101 option). The IP address of the OSP and the used module (configuration bank) must be defined on the analyzer; the required connections between the DUT Tx antennas, the switch box and the analyzer are indicated in the MIMO "Signal Capture" dialog box.

For important restrictions concerning sequential measurement see "MIMO Antenna Signal Capture", on page 85.

- Sequential using manual operation

  The data streams are captured sequentially by a single analyzer. The antenna signals must be connected to the single analyzer input sequentially by the user.

  In the WLAN application, individual capture buffers are provided (and displayed) for each antenna input source, so that results for the individual data streams can be calculated. The user must initiate data capturing for each antenna and result calculation for all data streams manually.

  For important restrictions concerning sequential measurement see "MIMO Antenna Signal Capture", on page 85.

- Single antenna measurement

  The data from the Tx antenna is measured and evaluated as a single antenna (SISO) measurement ("DUT MIMO configuration" = "1 Tx antenna").

Sequential MIMO Measurement

Sequential MIMO measurement allows for MIMO analysis with a single analyzer by capturing the receive antennas one after another (sequentially). However, sequential MIMO measurement requires each Tx antenna to transmit the same PPDU over time. (The PPDU content from different Tx antennas, on the other hand, may be different.) If this requirement can not be fulfilled, use the simultaneous MIMO capture method (see "Capturing Data from MIMO Antennas", on page 149).

In addition, the following PPDU attributes must be identical for ALL antennas:

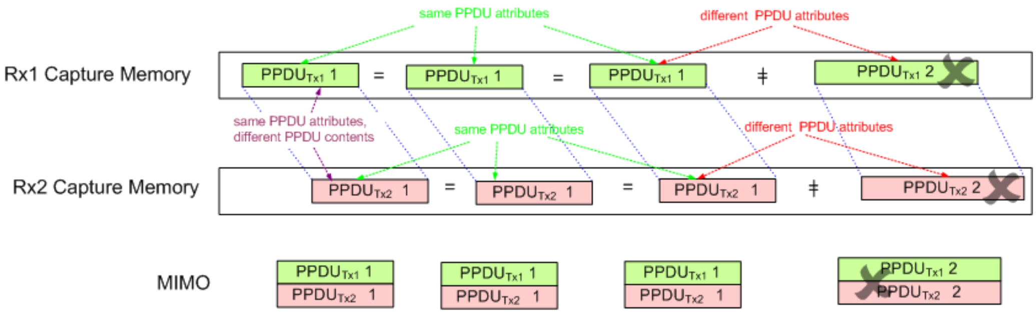
- PPDU length
- PPDU type
- Channel bandwidth
- MCS Index
- Guard Interval Length
- Number of STBC Streams
- Number of Extension Streams

Thus, for each PPDU the Signal Field bit vector has to be identical for ALL antennas!

Note that, additionally, the data contents of the sent PPDU payloads must also be the same for each Tx antenna, but this is not checked. Thus, useless results are returned if different data was sent.

To ensure that data sent by different antennas remains consistent for the measurement, the following methods can be applied:

- Send only identical PPDUs
- Use the same pseudo-random bit stream (PRBS) with the same PRBS seed (initial bit sequence)



4.3.5 Calculating Results

When you analyze a WLAN signal in a MIMO setup, the R&S FSQ acts as the receiving device. Since most measurement results have to be calculated at a particular stage in the processing chain, the WLAN application has to do the same decoding that the receive antenna does.

The following diagram takes a closer look at the processing chain and the results at its individual stages.

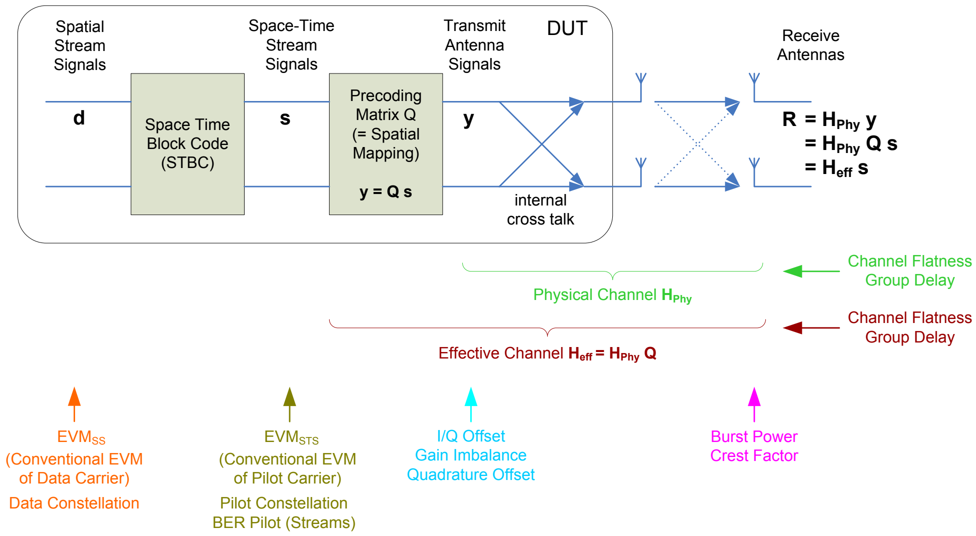


Fig. 31 Results at individual processing stages

Receive antenna results

The WLAN application can determine receive antenna results directly from the captured data at the receive antenna, namely:

- PPDU Power
- Crest factor

Demodulation is not necessary for these results. For all other results, the WLAN application has to revert the processing steps to determine the signal characteristics at those stages.

Transmit antenna results (based on the physical channel)

If the WLAN application can determine the physical channel (see "Physical vs Effective Channels", on page 147), it can evaluate the following results:

- Channel Flatness (based on the physical channel)
- Group Delay (based on the physical channel)
- I/Q Offset
- Quadrature Offset
- Gain Imbalance

Space-time stream results (based on the effective channel)

If the application knows the effective channel (see "Physical vs Effective Channels", on page 147), it can evaluate the following results:

- Channel Flatness (based on the effective channel)
- Group Delay (based on the effective channel)
- EVM of pilot carriers
- Constellation of pilot carriers
- Bitstream of pilot carriers

Spatial stream results

If space-time encoding is implemented, the demodulated data must first be decoded to determine the following results:

- EVM of data carriers
- Constellation diagram
- Bitstream

Results for data and pilot carriers with STBC

The pilot carriers are inserted directly after the data carriers went through the STBC (see "Space-Time Block Coding (STBC)", on page 146). Thus, only the data carriers need to be decoded by the analyzer to determine characteristics of the demodulated data. Because of this approach to calculate the EVM, Constellation and Bitstream results, you might get results for a different number of streams for pilots and data carriers if STBC is applied.

4.4 IEEE 802.11b RF Carrier Suppression

4.4.1 Definition

The RF carrier suppression, measured at the channel center frequency, must be at least 15 dB below the peak SIN(x)/x power spectrum. The RF carrier suppression is to be measured while transmitting a repetitive 01 data sequence with the scrambler disabled using DQPSK modulation. A 100 kHz resolution bandwidth is to be used to perform this measurement.

4.4.2 Measurement with Rohde & Schwarz Spectrum Analyzers.

The RF carrier suppression as defined in the standard is a determination of peak ratios. The unscrambled 01 data sequence provides a spectrum with distinct peaks enveloped by the transmit filter spectrum. An I/Q offset leads to an additional peak at the center frequency.

The following measurement sequence can be used in normal spectrum mode:

- Use power trigger or external trigger
- Use gated sweep with gate delay at payload start and gate length = payload length (Delay-Comp ON and RBW = 50 MHz for gate settings)
- Set RBW = 100 kHz
- Set Sweep Time = 100 ms
- Set Span = 20 MHz
- Set Detector = RMS
- Set Marker 1 to center frequency
- Use Marker 2 as Delta Marker and set it to max. peak

Fig. 32 is a screenshot of this measurement on the R&S FSQ. The delta marker directly shows the RF carrier suppression in dB (white circled value).

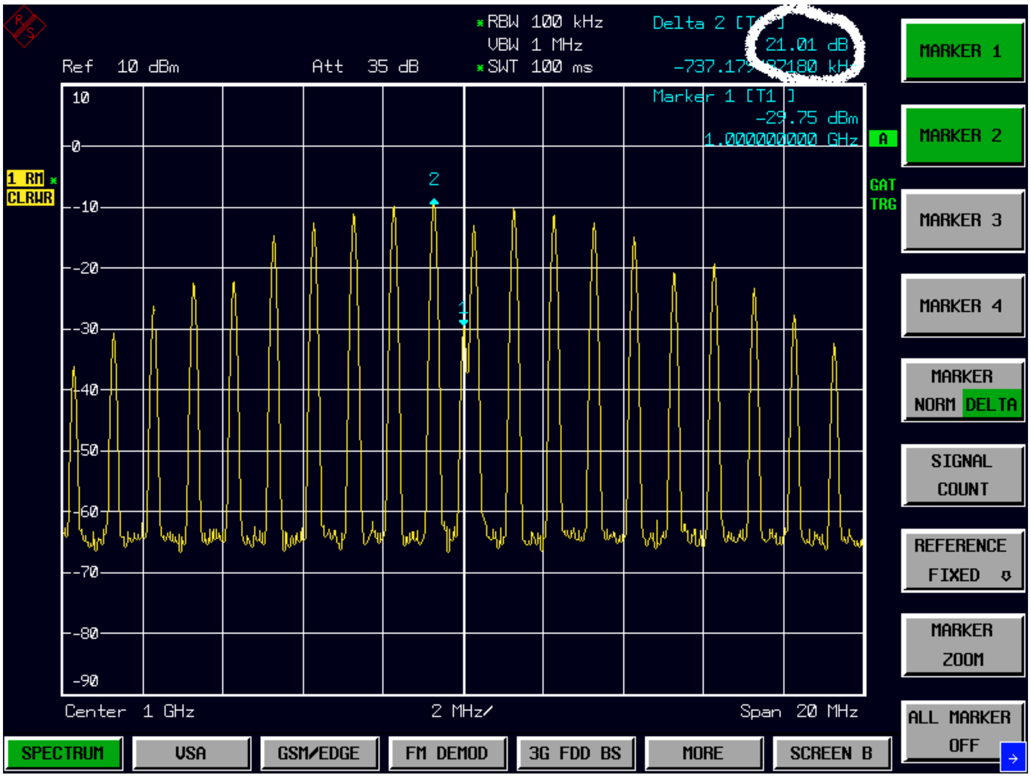


Fig. 32 RF carrier suppression measurement

4.4.3 Comparison to I/Q Offset Measurement in the WLAN List Mode

The I/Q offset measurement in the WLAN application returns the actual carrier feedthrough normalized to the mean power at the symbol timings. This measurement does not need a special test signal and is independent of the transmit filter shape.

The RF carrier suppression measured according to the standard is inversely proportional to the I/Q offset measured in the WLAN application list mode. The difference (in dB) between the two values depends on the transmit filter shape and should be determined with one reference measurement.

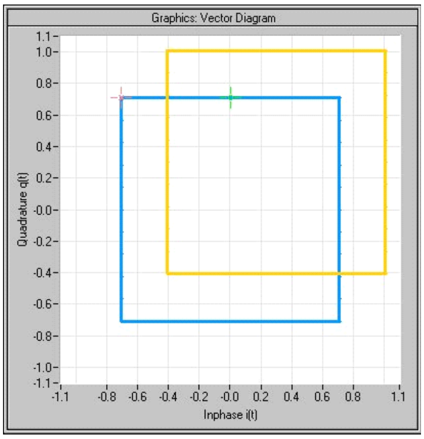
The following table lists the difference between the three transmit filter shapes (±0.5 dB):

Transmit filter	IQ_Offset [dB] - RF_Carrier_Suppression [dB]
Rectangular	11 dB
Root Raised Cosine, α = 0.22	10 dB
Gaussian, α = 0.3	9 dB

4.5 I/Q Impairments

4.5.1 I/Q Offset

An I/Q offset indicates a carrier offset with a fixed amplitude. This results in a constant shift of the I/Q axes. The offset is normalized by the mean symbol power and displayed in dB.



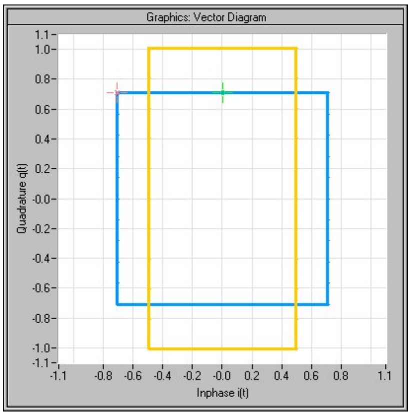
4.5.2 Gain Imbalance

An ideal I/Q modulator amplifies the I and Q signal path by exactly the same degree. The imbalance corresponds to the difference in amplification of the I and Q channel and therefore to the difference in amplitude of the signal components. In the vector diagram, the length of the I vector changes relative to the length of the Q vector.

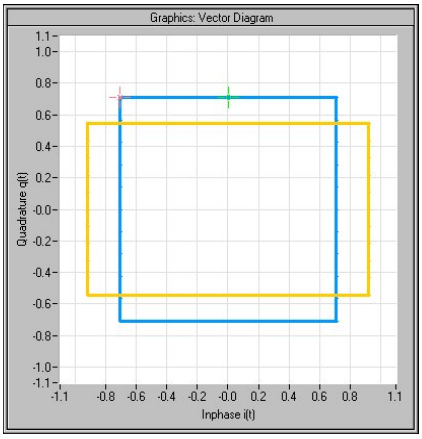
The entry is displayed in dB and %, where 1 dB offset is roughly 12% according to the following:

Imbalance [dB] = 20log (| $Gain_Q$ | / | $Gain_I$ |)

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage:



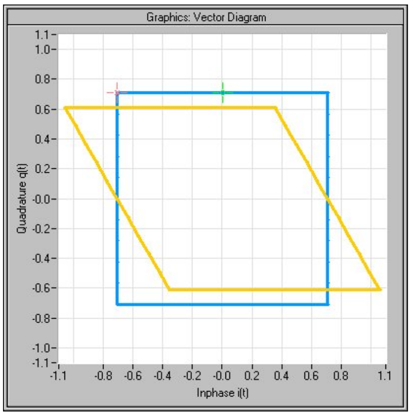
Negative values mean that the I vector is amplified more than the Q vector by the corresponding percentage:



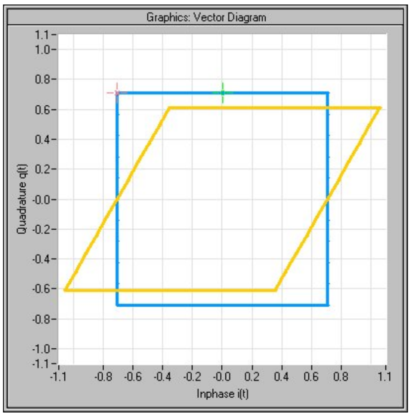
4.5.3 Quadrature Error

An ideal I/Q modulator sets the phase angle to exactly 90 degrees. With a quadrature error, the phase angle between the I and Q vector deviates from the ideal 90 degrees, and the amplitudes of both components are of the same size. In the vector diagram, the quadrature error causes the coordinate system to shift.

A positive quadrature error means a phase angle greater than 90 degrees:



A negative quadrature error means a phase angle of less than 90 degrees:



4.6 Peak EVM (IEEE)

Peak EVM (IEEE) evaluates the EVM as defined in section 18.4.7.8 "Transmit modulation accuracy" of the IEEE 802.11b standard. The measurement signal is corrected in respect of frequency error and clock deviation before EVM calculation. Additionally the specified calculation removes the dc offset of the measurement signal.

The standard does not specify a normalization factor for the error vector magnitude. To get a level independent EVM value, the WLAN application normalizes the EVM values, so that an EVM of 100% indicates that the error power on the I- or Q-channels equals the mean power on the I- or Q-channels respectively.

The Peak EVM is the maximum EVM over all chips of one PPDU. If more than one PPDU is evaluated (several analyzed PPDUs in the capture buffer or with the help of Overall Burst Count), the Min / Mean / Max columns show the minimum, mean or maximum Peak EVM of all analyzed PPDUs.

The IEEE 802.11b standard allows a Peak EVM of less than 35%. In contrary to the specification, the WLAN application does not limit the measurement to 1000 chips length, but searches the maximum over the whole PPDU.

4.7 Burst EVM (Direct)

Burst EVM (Direct) evaluates the root mean square EVM over one PPDU. That is the square root of the averaged error power normalized by the averaged reference power:

$$\mathrm{EVM} = \sqrt{\frac{\sum_{n=0}^{N-1} \left| x_{\mathrm{meas}}(n) - x_{\mathrm{ref}}(n) \right|^2}{\sum_{n=0}^{N-1} \left| x_{\mathrm{ref}}(n) \right|^2}} = \sqrt{\frac{\sum_{n=0}^{N-1} \left| e(n) \right|^2}{\sum_{n=0}^{N-1} \left| x_{\mathrm{ref}}(n) \right|^2}}$$

Before calculation of the EVM, the measurement signal is corrected in respect of frequency error, clock deviation and I/Q impairments.

If more than one PPDU is evaluated (several analyzed PPDUs in the capture buffer or with the help of Overall Burst Count), the Min / Mean / Max columns show the minimum, mean or maximum Burst EVM of all analyzed PPDUs.

Burst EVM is not part of the IEEE standard and no limit check is specified. Nevertheless this commonly used EVM calculation can give some insight in modulation quality and allows comparisons to other modulation standards.

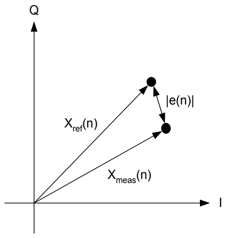


Fig. 33 IQ diagram for EVM calculation

5 Remote Control

5.1 Description of commands

This section specifies all the remote control commands specific to the WLAN application. Only those commands provided for this option are specified. For details of remote control commands provided by the host analyzer, refer to the analyzer user manual.

5.1.1 Notation

In the following sections, all commands implemented in the instrument are first listed in tables and then described in detail, arranged according to the command subsystems. The notation is adapted to the SCPI standard. The SCPI conformity information is included in the individual descriptions of the commands.

Table of Commands

Command:	In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).
Parameter:	The parameter column indicates the requested parameters together with their specified range.
Unit:	The unit column indicates the basic unit of the physical parameters.
Comment:	The comment column indicates the following:

- whether the command does not have a query form
- whether the command has only one query form
- whether the command is implemented only with a certain option of the instrument

Indentations

The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level, the further the indentation to the right. Please note that the complete notation of the command always includes the higher levels as well.

Example: `SENSe:FREQuency:CENTer` is represented in the table as follows:

`SENSe`	first level
`:FREQuency`	second level
`:CENTer`	third level

Individual description

The individual description contains the complete notation of the command. An example of each command, the *RST value and the SCPI information are included as well.

Upper-/lowercase notation

Upper-/lowercase letters are used to mark the long or short form of the key words of a command in the description (see Section 3.5.2). The instrument itself does not distinguish between uppercase and lowercase letters.

Special characters |

A selection of key words with an identical effect exists for several commands. These keywords are indicated in the same line; they are separated by a vertical stroke. Only one of these keywords needs to be included in the header of the command. The effect of the command is independent of which of the keywords is used.

Example: `SENSe:FREQuency:CW|:FIXed`

The following two commands with identical meaning can be created. They set the frequency of the fixed frequency signal to 1 kHz:

`SENSe:FREQuency:CW 1E3` = `SENSe:FREQuency:FIXed 1E3`

A vertical stroke in parameter indications marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is used.

Example: Selection of the parameters for the command

`DISPlay:FORMat FULL | SPLit`

If parameter FULL is selected, full screen is displayed; in the case of SPLit, split screen is displayed.

[ ]

Keywords in square brackets can be omitted when composing the header (see Section 3.5.2, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards. Parameters in square brackets can be incorporated optionally in the command or omitted as well.

{ }

Parameters in braces can be incorporated optionally in the command, either not at all, once or several times.

Description of parameters

Due to the standardization, the parameter section of SCPI commands always consists of the same syntactical elements. SCPI has therefore specified a series of definitions, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<...>) and will be briefly explained in the following (see also Section 3.5.5, "Parameters").

- <Boolean>

  This keyword refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword OFF or by the numeric value 0; the "on" state is indicated by ON or any numeric value other than zero. Parameter queries are always returned with the numeric value 0 or 1.

- <numeric_value>
- <num>

  These keywords mark parameters that may be entered as numeric values or be set using specific keywords (character data).The following keywords are permitted:

MINimum	This keyword sets the parameter to the smallest possible value.
MAXimum	This keyword sets the parameter to the largest possible value.
DEFault	This keyword is used to reset the parameter to its default value.
UP	This keyword increments the parameter value.
DOWN	This keyword decrements the parameter value.

  The numeric values associated with MAXimum/ MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

  Example: `SENSe:FREQuency:CENTer? MAXimum`

  returns the maximum possible numeric value of the center frequency as the result.

arbitrary block program data>

This keyword is provided for commands whose parameters consist of a binary data block.

5.2 ABORt Subsystem

List of commands

ABORt

This command aborts the measurement currently in progress.

Example

`ABOR`

Aborts the measurement.

Characteristics

*RST value: ---
SCPI: conform

5.3 CALCulate Subsystem

5.3.1 CALCulate:BURSt Subsystem

The suffix at CALCulate takes no effect in this subsystem.

List of commands

- CALCulate<1|2>:BURSt[:IMMediate] (p. 163)

CALCulate<1|2>:BURSt[:IMMediate]

This command recalculates the I/Q measurement results based on the current measurement configuration.

Example

`CALC:BURS:IMM`

'Updates the I/Q measurement results

Characteristics

*RST value: -
SCPI: device-specific

5.3.2 CALCulate:LIMit Subsystem

The suffix at CALCulate takes no effect in this subsystem.

List of commands

CALCulate<1|2>:LIMit<1>:ACPower:ACHannel?

This command queries the ACP adjacent channel limit if one has been defined.

Available for IEEE 802.11j.

Example

`CALC:LIM:ACP:ACH?`

Returns the limits of the adjacent channel.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:ACPower:ACHannel:RESult?

This command queries the result of the limit check for the lower and upper adjacent channels.

Available for IEEE 802.11j.

Return value

PASSED | FAILED

Example

`CALC:LIM:ACP:ALT:RES?`

Returns the limit check results for the adjacent channels.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:ACPower:ALTernate?

This command queries the ACP alternate channel limit if one has been defined.

Available for IEEE 802.11j.

Example

`CALC:LIM:ACP:ALT?`

Returns the IEEE 802.11j ACP alternate channel limit.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:ACPower:ALTernate:RESult?

This command queries the result of the limit check for the lower and upper alternate channels.

Available for IEEE 802.11j.

Return value

PASSED | FAILED

Example

```
CALC:LIM:ACP:ALT:RES?
```

Limit result for IEEE 802.11j alternate channel is returned.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:ALL DEFault | <Limit>,<Limit>,…

This command defines the limits for various numerical measurement results.

Parameter

DEFault
Restores the default limits for all modulation schemes as defined in the corresponding IEEE standard.

<Limit>,<Limit>,….
Defines custom limit values for various results in the following order.

<AverageFrequencyError>,<MaxFrequencyError>,<AverageSymbolError>, <MaxSymbolError>,<AverageIQOffset>,<MaximumIQOffset>, <AverageEVMAllPPDUs>,<MaxEVMAllPPDUs>,<AverageEVMDataCarriers>, <MaxEVMDataCarriers >,<AverageEVMPilots >,<MaxEVMPilots >

The limits are input (and output, if the command is used as a query) as a list of comma.separated values.

The units for the EVM results are specified with UNIT:EVM .

Example

```
CALC:LIM:BURS:ALL DEF
```

Restores the limits to their default values.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:ALL?

This command queries the limits for all numerical results.

Return value

Limits for:

<AverageFrequencyError>,<MaxFrequencyError>,<AverageSymbolError>, <MaxSymbolError>,<AverageIQOffset>,<MaximumIQOffset>, <AverageEVMAllPPDUs>,<MaxEVMAllPPDUs>,<AverageEVMDataCarriers>, <MaxEVMDataCarriers >,<AverageEVMPilots >,<MaxEVMPilots >

The results are returned as a list of comma-separated values.

Example

```
CALC:LIM:BURS:ALL?
```

Returns a list of all limits.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:ALL:RESult?

This command queries the result of the limit check for various numerical measurement results.

Return value

PASSED | FAILED

The results are returned as a list of comma-separated values in the following order.

<AverageFrequencyError>,<MaxFrequencyError>,<AverageSymbolError>, <MaxSymbolError>,<AverageIQOffset>,<MaximumIQOffset>, <AverageEVMAllPPDUs>,<MaxEVMAllPPDUs>,<AverageEVMDataCarriers>, <MaxEVMDataCarriers >,<AverageEVMPilots >,<MaxEVMPilots >

Example

```
CALC:LIM:BURS:ALL:RES?
```

Returns a list of all limit check results.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL:MAXimum <Limit>

This command defines the limit of the average and maximum for the overall EVM.

The limit applies to the EVM calculated over all carriers (pilot, data and the free carrier).

Parameter

<Limit>
EVM limit in dB.

Example

`CALC:LIM:BURS:EVM:ALL -30.0`

Defines an average EVM limit for all carriers of -30.0 dB.

Characteristics

*RST value: -25 dB (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL:MAXimum:RESult?

This command queries the average and maximum overall EVM limit check result.

The limit check applies to the EVM calculated over all carriers (pilot, data and the free carrier).

Return value

PASSED | FAILED

Example

`CALC:LIM:BURS:EVM:ALL:RES?`

Returns the result of the average EVM limit check over all carriers.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:EVM:MAXimum <Limit>

This command defines the limit of the average or maximum EVM for a PPDU.

Available for IEEE 802.11b.

Parameter

<Limit>
EVM limit of a PPDU in dB.

Example

```
CALC:LIM:BURS:EVM -20.0
```

Defines an average EVM limit of -20 dB.

Characteristics

*RST value: -25 dB (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:EVM:MAXimum:RESult?

This command queries the limit check result of the average or maximum EVM of a PPDU.

Available for IEEE 802.11b.

Return value

PASSED | FAILED

Example

```
CALC:LIM:BURS:EVM:RES?
```

Returns the result of the average EVM limit check.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA:MAXimum <Limit>

This command defines the limit for the average or maximum EVM of the data carrier.

Parameter

<Limit>
EVM limit in dB.

Example

```
CALC:LIM:BURS:EVM:DATA:AVER -30.0
```

Sets the Average EVM limit for data carriers to –30.0 dB.

Characteristics

*RST value: -25 dB (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA:MAXimum:RESult?

This command queries the limit check result for the average or maximum EVM of the data carrier.

Return value

PASSED | FAILED

Example

```
CALC:LIM:BURS:EVM:DATA:RES?
```

Returns the limit check result of the average EVM of the data carriers.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum <Limit>

This command defines the limit for the average or maximum EVM of the pilot carriers.

Parameter

<EVM>
EVM limit in dB.

Example

```
CALC:LIM:BURS:EVM:PIL -10.0
```

Defines the average EVM limit for pilot carriers to -10.0 dB.

Characteristics

*RST value: -8 dB (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum:RESult?

This command returns the limit check result of the average or maximum EVM of the pilot carriers.

Return value

PASSED | FAILED

Example

```
CALC:LIM:BURS:EVM:PIL:RES?
```

Returns the result of the average EVM limit check (pilot carriers).

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum <Limit>

This command sets the limit for the average or maximum frequency error.

Parameter

<Limit>
Frequency error limit in Hz.

Example

`CALC:LIM:BURS:FERR 10000`

Sets the average frequency error limit to 10 kHz.

Characteristics

*RST value: 265000 Hz (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum:RESult?

This command queries the limit check result of the average or maximum frequency error.

Return value

PASSED | FAILED

Example

`CALC:LIM:BURS:FERR:RES?`

Returns the result of the average frequency error limit check.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset:MAXimum <Limit>

This command defines the limit for the average or maximum I/Q offset.

Parameter

<Limit>
I/Q offset limit in dB.

Example

`CALC:LIM:BURS:IQOF -10.0`

Defines an average I/Q offset limit of -10.0 dB.

Characteristics

*RST value: -15 dB (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset:MAXimum:RESult?

This command queries the limit check result of the average or maximum I/Q offset.

Return value

PASSED | FAILED

Example

`CALC:LIM:BURS:IQOF:RES?`

Queries the limit check result of the average I/Q offset.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror:MAXimum <Limit>

This command defines the limit of the average or maximum symbol error.

Parameter

<Limit>
Symbol error limit in Hz.

Example

`CALC:LIM:BURS:SYMB 10000`

'Sets the average symbol error limit to 10 kHz.

Characteristics

*RST value: 20 ppm (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror:MAXimum:RESult?

This command queries the limit check result of the average or maximum symbol error.

Return value

PASSED | FAILED

Example

`CALC:LIM:BURS:SYMB:RES?`

Queries the limit check result of the average symbol error.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:TFALl[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:TFALl:MAXimum <Limit>

This command defines the limit of the average or maximum fall time.

Available for IEEE 802.11b.

Parameter

<Limit>
Fall time limit in seconds.

Example

```
CALC:LIM:BURS:TFAL 0.000001
```

Defines a limit for the average fall time of 1 µs.

Characteristics

*RST value: 2 µs (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:TFALl[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:TFALl:MAXimum:RESult?

This command queries the limit check result of the average or maximum fall time.

Available for IEEE 802.11b.

Return value

PASSED | FAILED

Example

```
CALC:LIM:BURS:TFAL:RES?
```

Returns the result of the average fall time limit check.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:TRISe[:AVERage] <Limit>

CALCulate<1|2>:LIMit<1>:BURSt:TRISe:MAXimum <Limit>

This command defines the limit of the average or maximum rise time.

Available for IEEE 802.11b.

Parameter

<Limit>
Rise time limit in seconds.

Example

`CALC:LIM:BURS:TRIS 0.000001`

Defines an average rise time limit of 1 µs.

Characteristics

*RST value: 2 µs (average and maximum)
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:BURSt:TRISe[:AVERage]:RESult?

CALCulate<1|2>:LIMit<1>:BURSt:TRISe:MAXimum:RESult?

This command queries the limit check result for the average or maximum rise time.

Available for IEEE 802.11b.

Return value

PASSED | FAILED

Example

`CALC:LIM:BURS:TRIS:RES?`

Queries the limit check result for the average rise time.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<x>:FAIL?

This command queries the result of the limit check result of various measurements.

It should be noted that a complete sweep must have been performed for obtaining a valid result. A synchronization with *OPC, *OPC? or *WAI should therefore be provided. The result of the limit check responds with 0 for PASS and 1 for FAIL.

Suffix

<x>
Selects the result display whose limit check is queried.

Index	Limit
1 to 2	These indexes are not used
3	ETSI Spectrum Mask limit line
4	Spectrum Flatness (Upper) limit line
5	Spectrum Flatness (Lower) limit line
6	IEEE Spectrum Mask limit line
7	PVT Rising Edge max limit
8	PVT Rising Edge mean limit
9	PVT Falling Edge max limit
10	PVT Falling Edge mean limit

Note: The suffix at CALCulate must always be 2, because limits are not evaluated in the Capture Buffer (which is displayed in screen A).

Example

`INIT;*WAI`

'Starts a new sweep and waits for its end.

`CALC2:LIM6:FAIL?`

Queries the limit check result of the IEEE Spectrum Mask limits.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:SPECtrum:MASK:CHECk:X?

This command queries the frequency at which the distance between signal level and Spectrum Mask is the greatest.

If the limit has not been violated, the command returns the frequency at which the signal level is closest to the limit line.

Return value

Frequency in Hz.

Example

`CALC:LIM:SPEC:MASK:CHEC:X?`

Queries the frequency at which the signal level exceeds the spectrum mask most.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:LIMit<1>:SPECtrum:MASK:CHECk:Y?

This command queries the maximum signal level of the SEM measurement.

Return value

Signal level in dBm.

Example

`CALC:LIM:SPEC:MASK:CHEC:Y?`

Queries the maximum power measured in the SEM measurement.

Characteristics

*RST value: -
SCPI: device-specific

5.3.3 CALCulate:MARKer Subsystem

The suffix at CALCulate takes the following effect in this subsystem.

- CALCulate1: selects screen A
- CALCulate2: selects screen B

Currently, only one marker is available per screen.

List of commands

CALCulate<1|2>:MARKer<1>:AOFF

This command turns all markers and delta markers off.

Example

```
CALC1:MARK:AOFF
```

Turns off all markers in screen A.

```
CALC2:MARK2:AOFF
```

Turns off all markers in screen B.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:BSYMbol <PPDU>,<Symbol>

This command positions the selected marker on a particular symbol of a particular PPDU.

This command is available for the following IEEE 802.11b result displays.

- Constellation vs Symbol
- EVM vs Symbol.

Parameter

<PPDU>
Number of the PPDU.

<Symbol>
Number of the symbol to place the marker on.

Example

```
CALC2:MARK1:BSYM 2,10
```

Positions the marker on symbol 10 of PPDU 2 in screen B.

Characteristics:

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:CARRier <Carrier>

This command positions the selected marker on a apricular carrier.

This command is available for the following result displays:

- Constellation vs Symbol
- Constellation vs Carrier

Parameter

<Carrier>
Number of the carrier.

Example

```
CALC2:MARK:CARR -7
```

Positions the marker on carrier -7 in screen B.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:MAXimum

This command positions the selected marker on the trace maximum.

This command is available for the following result displays:

- Spectrum Flatness

Example

`CALC2:MARK:MAX`

Positions the marker on the trace maximum in screen B.

Characteristics:

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:MINimum

This command positions the selected marker on the trace minimum.

This command is only available for the following result displays:

- Spectrum Flatness

Example

`CALC2:MARK:TRAC:MIN`

Positions the marker to the trace minimum in screen B.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:STATe <State>

This command turns a marker on and off.

Parameter

<State>
ON | OFF

Example

`CALC1:MARK1:STATE 1`

Turns on the marker in screen A.

Characteristics

*RST value: 0
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:SYMBol <Symbol>

This command positions the selected marker on a particular symbol.

This command is available for the following result displays:

- Constellation vs Symbol
- Constellation vs Carrier

Parameter

<Symbol>
Number of the symbol

Example

`CALC2:MARK:SYMB 2`

Positions the marker on symbol 2 in screen B.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:TRACe <Trace>

This command positionss the selected marker on a particular trace.

This command is available for the following result displays.

- Constellation vs Carrier
- EVM vs Symbol
- Frequency error vs Preamble
- Phase error vs Preamble
- PVT Full Burst
- PVT Rising / Falling
- Spectrum Flatness
- Spectrum Mask
- Spectrum ACP / ACPR

Example

`CALC2:MARK:TRAC 2`

'Assigns the marker to trace 2 in screen B.

Characteristics

*RST value: 1
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:X <Position>

This command positions the selected marker on a particular point of the x-axis. The unit of the x-axis depends on the result display.

The command is available for the following result displays:

- Spectrum FFT (x-axis represents the frequency)
- Spectrum Mask (x-axis represents the frequency)
- Spectrum ACPR (x-axis represents the frequency)
- Capture Buffer (x-axis represents time)
- PVT Full Burst (x-axis represents time)
- PVT Rising and PVT Falling (x-axis represents time)
- CCDF (x-axis represents power)
- EVM vs Carrier (x-axis represents subcarriers)
- Spectrum Flatness (x-axis represents subcarriers)
- EVM vs Symbol (x-axis represents symbols)

This command is a query only for the following result displays:

- Constellation vs Symbol (x-axis represents the inphase results)
- Constellation vs Carrier (x-axis represents subcarriers)

Parameter

<Position>
Marker position on the x-axis. The unit depends on the result display.

Example

```
CALC1:MARK1:X 2ms
```

Positions the marker at 2 ms in a result display that shows the time on the x-axis.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:Y?

This command queries the position of a marker on the y-axis.

This command is available for the following result displays:

- Constellation vs Symbol (y-axis represents the quadrature)
- Constellation vs Carrier (y-axis represents the magnitude of I or Q)
- EVM vs Carrier (y-axis represents the EVM)
- EVM vs Symbol (y-axis represents the EVM)
- PVT Full
- PVT Rising / Falling
- Capture Buffer
- Spectrum Mask
- Spectrum ACP / ACPR
- Spectrum FFT
- CCDF

Return value

<Position>
The unit of the return value depends on the result display.

Example

`CALC:MARK:Y?`

Returns the measured value of marker 1 in screen A.

Characteristic

*RST value: -
SCPI: device-specific

5.3.4 CALCulate:MARKer:FUNCtion Subsystem

The suffix at CALCulate takes the following effect in this subsystem.

- CALCulate1: selects screen A
- CALCulate2: selects screen B

List of commands

CALCulate<1|2>:MARKer<1>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current result values of the adjacent channel power measurement. An ACPR (adjacent channel power ratio) measurement must have previously been run in order for summary data to be available.

Return value

The command returns the results separated by commas in the following order:

1. Power of main channel
2. Power of lower adjacent channel
3. Power of upper adjacent channel
4. Power of lower alternate adjacent channel 1
5. Power of upper alternate adjacent channel 1
6. Power of lower alternate adjacent channel 2
7. Power of upper alternate adjacent channel 2

Adjacent channel power values are returned in dB.

Example

`CALC2:MARK:FUNC:POW:RES?`

Returns the results of the ACPR measurement.

Characteristics:

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:FUNCtion:POWer:RESult:MAXHold?

This command queries the maximum result values of the adjacent channel power measurement. An ACPR (adjacent channel power ratio) measurement must have previously been run with more than one sweep in order for maximum summary data to be available.

Return value

The command returns the results separated by commas in the following order:

1. Power of main channel
2. Power of lower adjacent channel
3. Power of upper adjacent channel
4. Power of lower alternate adjacent channel 1
5. Power of upper alternate adjacent channel 1
6. Power of lower alternate adjacent channel 2
7. Power of upper alternate adjacent channel 2

Adjacent channel power values are returned in dB.

Example

`CALC2:MARK:FUNC:POW:RES:MAXH?`

Returns the maximum results of the ACPR measurement.

Characteristics

*RST value: -
SCPI: device-specific

CALCulate<1|2>:MARKer<1>:FUNCtion:ZOOM <ZoomFactor>

This command defines the zoom factor around marker 1.

The default value is 1, where the full trace is shown.

This command is only available for the following result displays:

- Constellation vs Carrier
- Constellation vs Symbol
- PVT Full Burst
- PVT Rising / Falling
- Magnitude Capture Buffer

Parameter

<ZoomFactor>
Numeric value that defines the zoom factor. The range depends on the result display.

Example

`CALC:MARK:FUNC:ZOOM 2`

Magnifies the contents of screen A by 50%.

`CALC:MARK:FUNC:ZOOM 4`

Magnifies the contents of screen A by 75%.

`CALC:MARK:FUNC:ZOOM 1`

Shows the results in their default magnification.

Characteristics

*RST value: 1
SCPI: device-specific

5.4 CONFigure Subsystem

List of commands

- CONFigure:WLAN:SMAPping:TX<ant> <STS.1 I>,<STS.1 Q>,<STS.2 I>,<STS.2 Q>,<STS.3 I>,<STS.3 Q>,<STS.4 I>,<STS.4 Q>,<TimeShift> (p. 210)
- CONFigure:WLAN:SMAPping:TX<ant>:STReam<stream> <STS I>,<STS Q> (p. 211)
- CONFigure:WLAN:SMAPping:TX<ant>:TIMeshift <TimeShift> (p. 211)
- CONFigure:WLAN:STBC:AUTO:TYPE <PPDUType> (p. 212)

CONFigure:BURSt:CONStellation:CARRier:SELect <Carrier>

This command selects a particular carrier whose results are displayed in the Constellation vs Symbol result display.

Parameter

<Carrier>

ALL
Displays the results of all carriers.

PILOTS
Displays the results of the pilot carriers.

-NSR to NSR
The range (N_{SR}) depends on the WLAN standard and bandwidth.

IEEE 802.11a	20 MHz	-26 to 26
IEEE 802.11n, ac	20 MHz	-28 to 28
IEEE 802.11n, ac	40 MHz	-58 to 58
IEEE 802.11n, ac	80 MHz	-122 to 122

A SCPI error is raised if setting this parameters value outside the permitted standards data carrier index.

Example

```
CONF:BURS:CONS:CARR:SEL -26
```

Shows the results for carrier -26.

Characteristics

*RST value: ALL
SCPI: device-specific

CONFigure:BURSt:CONStellation:CCARrier[:IMMediate]

This command selects the Constellation vs Carrier result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:CONS:CCAR
INIT
```

Selects the Constellation vs Carrier result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:CONStellation:CSYMbol[:IMMediate]

This command selects the Constellation vs Symbol result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:CONS:CSYM:IMM
INIT
```

Selects the Constellation vs Symbol result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:EVM:ECARrier[:IMMediate]

This command selects the EVM vs Carrier result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:EVM:ECAR
INIT
```

Selects the EVM vs Carrier result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:EVM:ESYMbol[:IMMediate]

This command selects the EVM vs Symbol result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:EVM:ESYM
INIT
```

Selects the EVM vs Symbol result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:PREamble[:IMMediate]

This command selects the Phase or Frequency vs Preamble result display.

To select either Phase vs Preamble or Frequency vs Preamble, send the CONFigure:BURSt:PREamble:SELect <ResultType> command.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:PRE:IMM
CONF:BURS:PRE:SEL PHAS
INIT
```

Selects the Phase vs Preamble result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:PREamble:SELect <ResultType>

This command selects the result type for the Error vs Preamble result display.

Parameter

<ResultType>

FREQuency: Selects the Frequency vs Preamble result display.

PHASe: Selects the Phase vs preamble result display.

Example

```
CONF:BURS:PRE:SEL:FREQ
```

Selects the Frequency vs Preamble result display.

Characteristics

*RST value: FREQuency
SCPI: device-specific

CONFigure:BURSt:PVT:AVERage <Samples>

This command defines the number of samples used for PPDU power averaging.

This command is available for IEEE 802.11b and 11g (Single Carrier) signals.

Parameter

<Samples>
Number of samples.

Example

```
CONF:BURS:PVT:AVER 31
```

Defines a PPDU power averaging length of 31 samples.

Characteristics

*RST value: 1
SCPI: device-specific

CONFigure:BURSt:PVT[:IMMediate]

This command selects the Power vs Time result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:PVT:IMM
INIT
```

Selects the Power vs Time result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:PVT:RPOWer <ReferencePower>

This command selects the reference power for the Power vs Time result display.

This command is available for IEEE 802.11b and 11g (Single Carrier) signals.

Parameter

<ReferencePower>
MEAN | MAXimum

The reference is either the maximum or the mean PPDU power.

Example

```
CONF:BURS:PVT:RPOW MEAN
```

Selects the mean power as the reference power.

Characteristics

*RST value: MAXimum
SCPI: device-specific

CONFigure:BURSt:PVT:SELect <Method>

This command selects the method with which the application interprets Power vs Time measurement results.

Parameter

<Method>

IEEE 802.11a, j, n, ac

EDGE - configures the measurement to be rising and falling edge.

FULL - configures the measurement to be full PPDU.

IEEE 802.11b

RISE - configures the measurement to be rising edge only.

FALL - configures the measurement to be falling edge only.

EDGE - configures the measurement to be rising and falling edge

Example

```
CONF:BURS:PVT:SEL EDGE
```

Selects the display of the rising and falling edges in the PVT result display.

Characteristics

*RST value: FULL (IEEE 802.11a, j, n, ac);
EDGE (IEEE 802.11b)
SCPI: device-specific

CONFigure:BURSt:SPECtrum:ACPR[:IMMediate]

This command selects the Spectrum ACPR result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:SPEC:ACPR
INIT
```

Selects the Spectrum ACPR result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:FFT[:IMMediate]

This command selects the Spectrum FFT result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:SPEC:FFT:IMM
INIT
```

Selects the Spectrum FFT result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:FLATness:CSELect <ChannelMode>

This command selects the Spectrum Flatness measurement channel mode.

The command is available for measurements on IEEE 802.11n and ac signals.

Parameter

<ChannelMode>

EFFective: Effective channel mode

PHYsical: Physical channel mode

Example

```
CONF:BURS:SPEC:FLAT:CSEL PHY
```

Selects the Physical channel mode for the Spectrum Flatness result display.

Characteristics

*RST value: EFFective
SCPI: device-specific

CONFigure:BURSt:SPECtrum:FLATness[:IMMediate]

This command selects the Spectrum Flatness result display.

To select either Spectrum Flatness or Group Delay (IEEE 802.11n and ac), send the CONFigure:BURSt:SPECtrum:FLATness:SELect <Measurement> command.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:SPEC:FLAT:IMM
CONF:BURS:SPEC:FLAT:SEL FLAT
INIT
```

Selects the Spectrum Flatness result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:FLATness:SELect <Measurement>

This command selects the Spectrum Flatness measurement type.

This command is available for IEEE 802.11n and ac measurements.

Parameter

<Measurement>

FLATness	Spectrum Flatness results
GRDelay	Group Delay results

Example

```
CONF:BURS:SPEC:FLAT:SEL GRD
```

Selects the Group Delay result display.

Characteristics

*RST value: FLATness
SCPI: device-specific

CONFigure:BURSt:SPECtrum:MASK[:IMMediate]

This command selects the Spectrum Emission Mask result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:SPEC:MASK:IMM
INIT
```

Selects the Spectrum Emission Mask result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:MASK:SELect <Standard>

This command selects the standard the Spectrum Emission Mask evaluation is based on.

Parameter

<Standard>

IEEE	IEEE standard
ETSI	ETSI standard

The command is available for IEEE 802.11a measurements.

Example

```
CONF:BURS:SPEC:MASK:SEL ETSI
```

Selects the SEM according to the ETSI standard.

Characteristics

*RST value: IEEE
SCPI: device-specific

CONFigure:BURSt:STATistics:BSTReam[:IMMediate]

This command selects the Bit Stream result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:STAT:BSTR:IMM
INIT
```

Selects the Bit Stream result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:STATistics:CCDF[:IMMediate]

This command selects the CCDF result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:STAT:CCDF:IMM
INIT
```

Selects the CCDF result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:BURSt:STATistics:SFIeld[:IMMediate]

This command selects the Signal Field result display.

To start the measurement, send the INITiate[:IMMediate] command.

Example

```
CONF:BURS:STAT:SFI:IMM
INIT
```

Selects the Signal Field result display and runs a measurement.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:CHANnel <Channel>

This command selects the WLAN channel.

Changing the channel changes the center frequency. The new frequency is automatically calculated by the application.

Parameter

<Channel>
Channel number.

Example

```
CONF:CHAN 9
```

Selects channel number 9.

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:POWer:AUTO <State> | ONCE

This command turns automatic level detection on and off.

When you turn this feature on, the application determines the ideal reference level in a separate measurement. This measurement is performed at the start of each measurement sweep.

Parameter

ON | OFF

ONCE
Immediately performs auto leveling once, regardless of the current state (on or off).

Example

```
CONF:POW:AUTO 1
```

Turns automatic level detection on and off.

Characteristics

*RST value: 1
SCPI: device-specific

CONFigure:POWer:AUTO:MODE <Mode>

This command selects the way the auto level routine determines the reference level.

Parameter

<Mode>

LNOise	Reduces the inherent noise as much as possible.
LDIStortion	Reduces the inherent spurious products as much as possible.

Available if Auto Level is on and for frequencies above 3.6 GHz. Otherwise the setting is disabled and LNOise is selected.

Example

```
FREQ:CENT 4GHZ
CONF:POW ON
CONF:POW:AUTO:MODE LDIS
```

Selects Low Distortion leveling mode.

Characteristics

*RST value: LNOise
SCPI: device-specific

CONFigure:POWer:AUTO:SWEep:TIME <Time>

This command defines the measurement time for automatic level detection.

Parameter

<Time>
Auto level measurement time in seconds.

Example

`CONF:POW:AUTO:SWE:TIME 200MS`

Defines a measurement time of 200 ms for the auto level measurement.

Characteristics

*RST value: 100 ms
SCPI: device-specific

CONFigure:POWer:EXPected:IQ <Level>

This command defines the full scale level.

Note that the signal level corresponds to the reference level in case of IEEE 802.11b and 802.11g (Single Carrier) measurements.

For all other standards, the application automatically sets the reference level to a value 10 dB higher than the signal level. This is due to the high Crest Factor of those signals.

When you use auto leveling, the application automatically determines this value.

The command requires option R&S FSQ-B17 or R&S FSQ-B71.

Parameter

<Level>
Expected signal level in Volt.

Example

`CONF:POW:EXP:IQ 1`

Defines a full scale level of 1 Volt.

Characteristics

*RST value: 1
SCPI: device-specific

CONFigure:POWer:EXPected:RF <Level>

This command defines the expected signal level (reference level).

Note that the signal level corresponds to the reference level in case of IEEE 802.11b and 802.11g (Single Carrier) measurements.

For all other standards, the application automatically sets the reference level to a value 10 dB higher than the signal level. This is due to the high Crest Factor of those signals.

When you use auto leveling, the application automatically determines this value.

Available for the measurements on the RF input.

Parameter

<Level>
Expected signal level in dBm.

Example

`CONF:POW:EXP:RF -5`

Defines a reference level of -5 dBm.

Characteristics

*RST value: depending on standard
SCPI: device-specific

CONFigure:STANdard <Standard>

This command selects the WLAN standard.

Parameter

<Standard>

0 = IEEE 802.11a

1 = IEEE 802.11b

2 = IEEE 802.11j (10 MHz)

3 = IEEE 802.11j (20 MHz)

4 = IEEE 802.11g

5 = IEEE 802.11 Turbo Mode

6 = IEEE 802.11n

7 = IEEE 802.11n MIMO

8 = IEEE 802.11ac

Example

`CONF:STAN 0`

Selects IEEE 802.11a standard.

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:ANTMatrix:ADDRess<analyzer> <IPAddress>

This command defines the IP address for one of the analyzers in a MIMO setup.

Note that you cannot define an IP address for the master analyzer.

Suffix

<analyzer>
Selects the analyzer in a MIMO setup. The range is 1 to 4.

Parameter

<IPAddress>
String containing the IP address of the analyzer in IPV4 format.

Example

```
CONF:WLAN:ANTM:ADDR2 '192.168.114.157'
```

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:WLAN:ANTMatrix:ANTenna<analyzer> <Antenna>

This command assigns an antenna to one of the analyzers in a MIMO setup.

Suffix

<analyzer>
Selects the analyzer in a MIMO setup. The range is 1 to 4.

Parameter

<Antenna>

ANTenna1	assigns Antenna 1 to the selected analyzer.
ANTenna2	assigns Antenna 2 to the selected analyzer.
ANTenna3	assigns Antenna 3 to the selected analyzer.
ANTenna4	assigns Antenna 4 to the selected analyzer.

Example

```
CONF:WLAN:ANTM:ANT ANT1
```

Assigns antenna 1 to the receiving path.

Characteristics

*RST value: ANT1
SCPI: device-specific

CONFigure:WLAN:ANTMatrix:STATe<analyzer> <State>

This command turns an analyzer in a MIMO setup on and off.

Note that you cannot turn the master analyzer on and off.

Suffix

<analyzer>
Selects the analyzer in a MIMO setup. The range is 1 to 4.

Parameter

<State>
ON | OFF

Example

```
CONF:WLAN:ANTM:STAT2 1
```

Turns on the second analyzer.

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:DUTConfig <Antennas>

This command defines the number of antennas in a MIMO setup.

Parameter

<Antennas>

TX1 one antenna

TX2 two antennas

TX3 three antenna

TX4 four antennas

Example

```
CONF:WLAN:DUTC TX2
```

Defines a MIMO setup with two antennas.

Characteristics

*RST value: TX1
SCPI: device-specific

CONFigure:WLAN:EXTension:AUTO:TYPE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their Ness field characteristics.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same Ness value as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the Ness value.
M0	Only PPDUs with a Ness value = 0 are analyzed.
M1	Only PPDUs with a Ness value = 1 are analyzed.
M2	Only PPDUs with a Ness value = 2 are analyzed.
M3	Only PPDUs with a Ness value = 3 are analyzed.
D0	All PPDUs are demodulated as if they had a Ness value = 0.
D1	All PPDUs are demodulated as if they had a Ness value = 1.
D2	All PPDUs are demodulated as if they had a Ness value = 2.
D3	All PPDUs are demodulated as if they had a Ness value = 3.

Example

```
CONF:WLAN:EXT:AUTO:TYPE ALL
```

'Analyzes all PPDUs, regardless of the PPDU type.

Characteristics

*RST value: FBURst
SCPI: device-specific

CONFigure:WLAN:GTIMe:AUTO <State>

This command turns automatic detection of the guard interval on and off.

If you turn the feature off, you can select the guard interval manually with CONFigure:WLAN:GTIMe:SELect <GuardInterval>.

The command is available for IEEE 802.11n (SISO) measurements.

State

ON | OFF

Example

```
CONF:WLAN:AUTO 1
```

Turns on automatic guard interval detection.

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:GTIMe:AUTO:TYPE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their guard interval.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same guard interval as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the guard interval.
ML	Only PPDUs with a long guard interval are analyzed.
ML16	Only PPDUs with a 20 MHz bandwidth and a long guard interval (16 samples) are analyzed.
ML32	Only PPDUs with a 40 MHz bandwidth and a long guard interval (32 samples) are analyzed.
MN8	Only PPDUs with a 20 MHz bandwidth and short guard interval (8 samples) are analyzed.
MN16	Only PPDUs with a 40 MHz bandwidth and a short guard interval (16 samples) are analyzed.
MS	Only PPDUs with a short guard interval are analyzed.
DL	All PPDUs are demodulated as if they had a long guard interval.
DL16	All PPDUs are demodulated as if they had a 20 MHz bandwidth and a long guard interval (16 samples).
DL32	All PPDUs are demodulated as if they had a 40 MHz bandwidth and a long guard interval (32 samples).
DN8	All PPDUs are demodulated as if they had a 20 MHz bandwidth and a short guard interval (8 samples).
DN16	All PPDUs are demodulated as if they had a 40 MHz bandwidth and a short guard interval (16 samples).
DS	All PPDUs are demodulated as if they had a short guard interval.

Example

```
CONF:WLAN:GTIM:AUTO:TYPE ML32
```

Analyzes PPDUs with a long guard interval that has a 40 MHz bandwidth.

Characteristics

*RST value: FBURst
SCPI: device-specific

CONFigure:WLAN:GTIMe:SELect <GuardInterval>

This command selects the guard interval of a PPDU.

If you turn on CONFigure:WLAN:GTIMe:AUTO <State>, this command is a query only to determine the detected guard interval.

Parameter

<GuardInterval>
SHORt | NORMal

Example

`CONF:WLAN:GTIM SHOR`

Selects a short guard interval.

Characteristics

*RST value: NORM
SCPI: device-specific

CONFigure:WLAN:MIMO:CAPTure <SignalPath>

This command selects the signal path to be captured in MIMO sequential manual measurements.

Once the signal path has been selected with this command, you have to send INITiate[:IMMediate] to capture the data from the specified path.

Parameter

<SignalPath>

RX1 Sequential capture of RX1 (manual see MIMo:TYPe)

RX2 Sequential capture of RX2 (manual see MIMo:TYPe)

RX3 Sequential capture of RX3 (manual see MIMo:TYPe)

RX4 Sequential capture of RX4 (manual see MIMo:TYPe)

Example

`CONF:WLAN:DUTC TX4`

`CONF:WLAN:MIMO:CAPT:TYPE MAN`

Pause the script Connect TX1 of the DUT to the analyzer Continue the script

`CONF:WLAN:MIMO:CAPT RX1`

Select RX1 for the next capture .

`INIT:IMM`

Capture the selected channel Pause the script Connect TX2 of the DUT to the analyzer Continue the script.

`CONF:WLAN:MIMO:CAPT RX2`

Select RX2 for the next capture

`INIT:IMM`

Capture the selected channel. Pause the script. Connect TX3 of the DUT to the analyzer Continue the script

`CONF:WLAN:MIMO:CAPT RX3`

Select RX3 for the next capture

`INIT:IMM`

Capture the selected channel. Pause the script Connect TX4 of the DUT to the analyzer. Continue the script.

`CONF:WLAN:MIMO:CAPT RX4`

Select RX4 for the next capture.

`INIT:IMM`

Capture the selected channel.

`CALC:BURS:IMM`

Analyze captured data.

Characteristics:

*RST value: RX1
SCPI: device-specific

CONFigure:WLAN:MIMO:CAPTure:TYPe <Mode>

This command selects the method for analyzing MIMO signals.

Parameter

<Mode>

SIMultaneous	Simultaneous MIMO measurement with several analyzers
OSP	Sequential measurement using open switch platform
MANual	Sequential measurement with one analyzer

Example

`CONF:WLAN:MIMO:CAPT:TYP SIM`

Performs simultaneous MIMO measurements.

Characteristics

*RST value: SIMultaneous
SCPI: device-specific

CONFigure:WLAN:MIMO:OSP:ADDRess <IPAddress>

This command defines the IP address of the switch box that can be used for automated sequential MIMO measurements.

For more information see "Sequential signal capture using an R&S®OSP switch box" on page 86.

Parameter

<IPAddress>
String containing the IP address of the switch box in IPV4 format.

Example

```
CONF:WLAN:MIMO:OSP:ADDR '192.168.114.157'
```

Defines an IP address for the switch unit.

Characteristics:

*RST value: -
SCPI: device-specific

CONFigure:WLAN:MIMO:OSP:MODule <Module>

This command selects the module used in the switch box.

Parameter

<Module>
A11 | A12 | A13

Example

```
CONF:WLAN:MIMO:OSP:MOD A11
```

Selects module A11 for the measurement.

Characteristics

*RST value: A11
SCPI: device-specific

CONFigure:WLAN:PAYLoad:LENGth:SRC <Method>

This command defines the method to determine the payload length.

Parameter

<Method>

ESTimate	Estimates the payload length.
HTSignal	Acquires the payload length from the Signal Field.

Example

`CONF:WLAN:PAYL:LEN:SRC EST`

'Estimate the signal.

Characteristics

*RST value: HTSignal-
SCPI: device-specific

CONFigure:WLAN:PVERror:MRANge <Range>

This command selects the measurement range that the application uses to calculate peak vector error results.

This command is available for 802.11b and 802.11g.

Parameter

<Range>

ALL	Peak Error Vector results are calculated over the complete PPDU
PSDU	Peak Error Vector results are calculated over the PSDU only

Example

`CONF:WLAN:PVER:MRAN PSDU`

Evaluates the Peak Error Vector over the PSDU only.

Characteristics

*RST value: ALL
SCPI: device-specific

CONFigure:WLAN:RSYNc:JOINed <State>

This command turns synchronization of the Rx antennas on and off.

If on, the application tracks and synchronizes the antennas together. If off, the application tracks and synchronizes the antennas separately.

Parameter

<State>
ON | OFF

Example

`CONF:WLAN:RSYN:JOIN 0`

Turns on separate synchronization of the antennas.

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:SMAPping:MODE <Mode>

This command selects the spatial mapping mode.

Parameter

<Mode>

DIRect	direct
SEXPansion	expansion
USER	user defined

Example

`CONF:WLAN:SMAP:MODE DIR`

Selects direct mapping mode.

Characteristics

*RST value: DIRect
SCPI: device-specific

CONFigure:WLAN:SMAPping:NORMalise <State>

This command specifies whether an amplification of the signal power due to the spatial mapping is performed according to the matrix entries.

If on, the spatial mapping matrix is scaled by a constant factor to obtain a passive spatial mapping matrix which does not increase the total transmitted power.

If off, the normalization step is omitted.

Parameter

<State>
ON | OFF

Example

```
CONF:WLAN:SMAP:NORM 0
```

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:SMAPping:TX<ant> <STS.1 I>,<STS.1 Q>,<STS.2 I>,<STS.2 Q>,<STS.3 I>,<STS.3 Q>,<STS.4 I>,<STS.4 Q>,<TimeShift>

This command defines the mapping for all space-time streams.

Suffix

<ant>
Selects the antenna in a MIMO setup. The range is 1 to 4.

Parameter

<STS.n I>
Inphase part of the space-time stream n for the selected antenna.

<STS.n Q>
Quadrature part of the space-time stream n for the selected antenna.

<TimeShift>
Timeshift of the selected antenna.

Example

```
CONF:WLAN:SMAP:TX1 1.0,1.0, 2.0,2.0, 3.0,3.0, 4.0,4.0, 0
```

Characteristics

*RST value: -
SCPI: device-specific

CONFigure:WLAN:SMAPping:TX<ant>:STReam<stream> <STS I>,<STS Q>

This command defines the mapping for a specific space-time stream.

Suffix

<ant>
Selects the antenna in a MIMO setup. The range is 1 to 4.

<stream>
Selects the space time stream. The range is 1 to 4.

Parameter

<STS I>
Inphase part of a particular space-time stream and for the selected antenna.

<STS Q>
Quadrature part of a particular space-time stream and for the selected antenna.

Example

```
CONF:WLAN:SMAP:TX1:STR1 1.0, 1.0
```

Characteristics

*RST value: 1.0
SCPI: device-specific

CONFigure:WLAN:SMAPping:TX<ant>:TIMeshift <TimeShift>

This command defines the timeshift for a specific antenna.

Suffix

<ant>
Selects the antenna in a MIMO setup. The range is 1 to 4.

Parameter

<TimeShift>
Timeshift of the selected antenna.

Example

```
CONF:WLAN:SMAP:TX1:TIM 0
```

Defines a time shift of 0 seconds for antenna 1.

Characteristics

*RST value: 0
SCPI: device-specific

CONFigure:WLAN:STBC:AUTO:TYPE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their STBC field characteristics.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same STBC field as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the STBC field.
M0	Only PPDUs with a STBC field = 0 are analyzed.
M1	Only PPDUs with a STBC field = 1 are analyzed.
M2	Only PPDUs with a STBC field = 2 are analyzed.
D0	All PPDUs are demodulated as if they had an STBC field = 0.
D1	All PPDUs are demodulated as if they had an STBC field = 1.
D2	All PPDUs are demodulated as if they had an STBC field = 2.

Example

`CONF:WLAN:STBC:AUTO:TYPE ALL`

Analyzes all PPDUs, regardless of the STBC field content.

Characteristics

*RST value: FBURst
SCPI: device-specific

5.5 DISPlay Subsystem

The suffix at WINDow takes the following effect in this subsystem.

- WINDow1: selects screen A
- WINDow2: selects screen B

List of commands

DISPlay:FORMat <Format>

This command selects the screen size of the measurement windows.

Parameter

SPLit
Split screen mode (two result displays are shown)

SINGle
Full screen mode (one result display is shown)

Example

```
DISP:FORM SING
```

Selects full screen mode.

Characteristics

*RST value: SINGle
SCPI: device-specific

DISPlay[:WINDow<1|2>]:SELect

This command selects the active screen (screen A or B) via the suffix at the WINDow syntax element.

Example

```
DISP:WIND2:SEL
```

Selects screen B.

Characteristics

*RST value: -
SCPI: device-specific

DISPlay[:WINDow<1|2>]:SSELect

This command selects the active screen (screen A or B) via the suffix at the WINDow syntax element.

This is the same as DISPlay[:WINDow<1|2>]:SELect.

Example

`DISP:WIND1:SSEL`

Selects screen A.

Characteristics

*RST value: 1
SCPI: device-specific

DISPlay[:WINDow]:TABLe <State>

This command turns the numerical result display on and off.

Parameter

<State>
ON | OFF

Example

`DISP:WIND1:TABL 0`

Turns off the results table.

Characteristics

*RST value: 0
SCPI: device-specific

DISPlay[:WINDow<1|2>]:TRACe:Y[:SCALe]:AUTO <State>

This command turns automatic scaling of the y-axis on and off.

If on, the scale of the y-axis is automatically determined to yield an ideal display of the measurement results.

This command is available for the following result displays:

- EVM vs Carrier
- EVM vs Symbol
- Frequency error vs Preamble
- Phase error vs Preamble

The numeric suffix at WINDow<1|2> must be 2 as the relevant results are always displayed in screen B.

Parameter

<State>
ON | OFF

Example

`DISP:WIND2:TRAC:Y:SCAL:AUTO 1`

Turns on automatic scaling of the y-axis.

Characteristics

*RST value: 1
SCPI: conforming

DISPlay[:WINDow<1|2>]:TRACe:Y[:SCALe]:PDIVision <Size>

This command sets the size of each grid division on the y-axis.

This command is available for the following result displays:

- EVM vs Carrier
- EVM vs Symbol
- Frequency Error vs Preamble
- Phase Error vs Preamble

Note that this command has no effect if automatic scaling of the Y-axis is enabled.

The numeric suffix at WINDow<1|2> must be 2 as the relevant results are always displayed in screen B.

Parameter

<Size>
Size of the grid.

Example

`DISP:WIND2:TRAC:Y:SCAL:DPIV 2`

Sets the size of a grid division to 2.

Characteristics

*RST value: 10
SCPI: conform

DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel[:RF] <Level>

This command defines the reference level for measurements on the RF input.

Parameter

<Level>
Reference level in dBm.

Example

`DISP:WIND2:TRAC:Y:SCAL:RLEV:RF -20`

Defines a reference level of -20 dBm.

Characteristics

*RST value: -5 dB
SCPI: conform

DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel:IQ <Level>

This command defines the reference level (analog baseband) or full scale level (digital baseband).

The command requires option R&S FSQ-B17 or R&S FSQ-B71.

Parameter

<Level>
Level in dBm or Volt.

Example

```
DISP:TRAC:Y:RLEV:IQ 1
```

Defines a full scale level of 1 V on the digital baseband input.

Characteristics

*RST value: 1 V
SCPI: conform

DISPlay[:WINDow]:TRACe:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command defines the external attenuation.

Parameter

<Attenuation>
Attenuation (positive values) or gain (negative values) in dB.

Example

```
DISP:TRAC:Y:RLEV:OFFS -10
```

Defines an external attenuation of -10 dB.

Characteristics

*RST value: 0 dB
SCPI: conform

5.6 FETCh Subsystem

List of commands

FETCh:BURSt:ALL?

This command returns a list of all numerical measurement results.

Return value

List of comma-separated values in ASCII format.

IEEE 802.11a, g (OFDM), j, n, ac

<PreamblePower>,<PayloadPower>,<MinRMSPower>,<AverageRMSPower>,<MaxRMSPower>, <PeakPower>,<MinCrestFactor>,<AverageCrestFactor>,<MaxCrestFactor>,<MinFrequencyError>, <AverageFrequencyError>,<MaxFrequencyError>,<MinSymbolError>,<AverageSymbolError>, <MaxSymbolError>,<MinIQOffset>,<AverageIQOffset>,<MaximumIQOffset>,<MinGainImbalance>, <AverageGainImbalance>,<MaxGainImbalance>,<MinQuadratureOffset>,<AverageQuadratureOffset>, <MaxQuadratureOffset>,<MinEVMAllPPDUs>,<AverageEVMAllPPDUs>,<MaxEVMAllPPDUs>, <MinEVMDataCarriers>,<AverageEVMDataCarriers>,<MaxEVMDataCarriers>,<MinEVMPilots>, <AverageEVMPilots>,<MaxEVMPilots>

IEEE 802.11b, g (Single Carrier)

<MinRiseTime>,<AverageRiseTime>,<MaxRiseTime>,<MinFallTime>,<AverageFallTime>, <MaxFallTime>,<MinRMSPower>,<AverageRMSPower>,<MaxRMSPower>,<MinPeakPower>, <AveragePeakPower>,<MaxPeakPower>,<MinCrestFactor>,<AverageCrestFactor>,<MaxCrestFactor>, <MinFrequencyError>,<AverageFrequencyError>,<MaxFrequencyError>,<MinChipClockError>, <AverageChipClockError>,<MaxChipClockError>,<MinPhaseError>,<AveragePhaseError>, <MaxPhaseError>,<MinIQOffset>,<AverageIQOffset>,<MaximumIQOffset>,<MinGainImbalance>, <AverageGainImbalance>,<MaxGainImbalance>,<MinQuadratureOffset>,<AverageQuadratureOffset>, <MaxQuadratureOffset>,<MinEVM_IEEE>,<AverageEVM_IEEE>,<MaxEVM_IEEE>,<MinEVMDirect>, <AverageEVMDirect>, <MaxEVMDirect >

Note that the units for the EVM results depend on UNIT:EVM <Unit>.

Example

```
FETC:BURS:ALL?
```

Queries the measurement results.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:BERPilot:AVERage

FETCh:BURSt:BERPilot:MAXimum

FETCh:BURSt:BERPilot:MINimum

This command queries the Burst Error Rate for pilots.

The command is available for IEEE 802.11n MIMO measurements.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Burst error rate in %.

Example

`FETCh:BURS:BERP:AVER?`

Queries the average Burst Error Rate.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:COUNt?

This command queries the number of PPDUs that have been analyzed in the current sweep.

If multiple sweeps are required for the measurement (required number of PPDUs is greater than the number of PPDUs that can be captured in one sweep), the command returns the number of captured PPDUs in the current sweep.

Return value

Number of PPDUs.

Example

`FETC:BURS:COUN?`

Queries the number of analyzed PPDUs.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:COUNt:ALL?

This command queries the total number of PPDUs that have been analyzed in the current measurement.

If multiple sweeps are required for the measurement (required number of PPDUs is greater than the number of PPDUs that can be captured in one sweep), the command returns the total number of PPDUs that have been captured over all measured sweeps.

Return value

Number of PPDUs.

Example

`FETC:BURS:COUN:ALL?`

Queries the number of all captured PPDUs.

Characteristics

*RST value: –
SCPI: device-specific

FETCh:BURSt:CRESt[:AVERage]?

FETCh:BURSt:CRESt:MAXimum?

FETCh:BURSt:CRESt:MINimum?

This command queries the Crest factor.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Crest factor in dB.

The Crest factor is the ratio of the peak power to the average power.

Example

`FETC:BURS:CRES:MAX?`

Queries the maximum Crest factor.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:EVM:ALL:AVERage?

FETCh:BURSt:EVM:ALL:MAXimum?

FETCh:BURSt:EVM:ALL:MINimum?

This command queries the EVM over all PPDUs.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Error vector magnitude. The unit depends on UNIT:EVM <Unit>.

Example

`FETC:BURS:EVM:ALL:MAX?`

Queries the maximum EVM of all carriers.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:EVM:DATA:AVERage?

FETCh:BURSt:EVM:DATA:MAXimum?

FETCh:BURSt:EVM:DATA:MINimum?

This command queries the EVM over the data carriers.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Error vector magnitude. The unit depends on UNIT:EVM <Unit>.

Example

`FETC:BURS:EVM:DATA:MAX?`

Queries the maximum EVM of the data carrier.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:EVM:DIRect:AVERage?

FETCh:BURSt:EVM:DIRect:MAXimum?

FETCh:BURSt:EVM:DIRect:MINimum?

This command queries the EVM over all PPDUs after filtering has been applied.

The command is available for IEEE 802.11b.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Error vector magnitude. The unit depends on UNIT:EVM <Unit>.

Example

`FETC:BURS:EVM:DIR:MAX?`

Queries the maximum EVM after filtering.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:EVM[:IEEE]:AVERage?

FETCh:BURSt:EVM[:IEEE]:MAXimum?

FETCh:BURSt:EVM[:IEEE]:MINimum?

This command queries the EVM over all PPDUs before filtering has been applied.

The command is available for IEEE 802.11b.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Error vector magnitude. The unit depends on UNIT:EVM <Unit>.

Example

`FETC:BURS:EVM:MAX?`

Queries the maximum EVM before filtering.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:EVM:PILot:AVERage?

FETCh:BURSt:EVM:PILot:MAXimum?

FETCh:BURSt:EVM:PILot:MINimum?

This command queries the EVM over the pilot carriers.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Error vector magnitude. The unit depends on UNIT:EVM <Unit>.

Example

`FETC:BURS:EVM:PIL:MAX?`

Queries the maximum EVM of the pilot carrier.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:FERRor:AVERage?

FETCh:BURSt:FERRor:MAXimum?

FETCh:BURSt:FERRor:MINimum?

This command queries the frequency error.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Frequency error in Hz.

Example

`FETC:BURS:FERR:MAX?`

Queries the maximum frequency error.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:GIMBalance:AVERage?

FETCh:BURSt:GIMBalance:MAXimum?

FETCh:BURSt:GIMBalance:MINimum?

This command queries the I/Q imbalance.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

I/Q imbalance in dB.

Example

`FETC:BURS:GIMB:MAX?`

Queries the maximum I/Q imbalance.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:IQOFfset:AVERage?

FETCh:BURSt:IQOFfset:MAXimum?

FETCh:BURSt:IQOFfset:MINimum?

This command queries the I/Q offset.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

I/Q offset in dB.

Example

`FETC:BURS:IQOF:AVER?`

Queries the average I/Q offset.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:PAYLoad?

This command queries the power in the payload of the PPDU.

Return value

Payload power in dBm.

Example

`FETC:BURS:PAYL?`

Queries the payload power.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:PEAK?

This command queries the peak power that has been measured.

Return value

Peak power in dBm.

Example

`FETC:BURS:PEAK?`

Queries the peak power.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:PREamble?

This command queries the PPDU preamble power in the PPDU.

Return value

Preamble power in dBm.

Example

`FETC:BURS:PRE?`

Queries the preamble power.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:QUADoffset:AVERage?

FETCh:BURSt:QUADoffset:MAXimum?

FETCh:BURSt:QUADoffset:MINimum?

This command queries the quadrature error of the symbols within a PPDU.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Quadrature error.

This command queries the Quadrature Error of the symbols within a PPDU (average, minimum or maximum value).

Example

```
FETC:BURS:QUAD:MAX?
```

'Queries the maximum Quadrature Error.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:RMS[:AVERage]?

FETCh:BURSt:RMS:MAXimum?

FETCh:BURSt:RMS:MINimum?

This command queries the RMS burst power.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Burst power in dBm.

Example

```
FETC:BURS:RMS:MIN?
```

Queries the minimum RMS burst power.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:SYMBolerror:AVERage?

FETCh:BURSt:SYMBolerror:MAXimum?

FETCh:BURSt:SYMBolerror:MINimum?

This command queries the symbol error.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Symbol error in %.

The symbol error is the percentage of symbols that are outside the permissible demodulation range within a PPDU.

Example

`FETC:BURS:SYMB:MAX?`

Queries the maximum symbol error.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:TFALl:AVERage?

FETCh:BURSt:TFALl:MAXimum?

FETCh:BURSt:TFALl:MINimum?

This command queries the PPDU fall time.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Fall time in seconds.

Example

`FETC:BURS:TFAL:MAX?`

Queries the maximum fall time.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:BURSt:TRISe:AVERage?

FETCh:BURSt:TRISe:MAXimum?

FETCh:BURSt:TRISe:MINimum?

This command queries the PPDU rise time.

Depending on the last syntax element, the command returns the average, minimum or maximum value.

Return value

Rise time in seconds.

Example

`FETC:BURS:TRIS:MAX?`

Queries the maximum rise time.

Characteristics

*RST value: -
SCPI: device-specific

FETCh:SYMBol:COUNt?

This command queries the number of symbols for each analyzed PPDU.

Return value

Number of symbols as a comma separated list. Each value represents a PPDU.

Example

`FETC:SYMB:COUN?`

Queries the number of symbols in the analyzed PPDU.

Characteristics

*RST value: -
SCPI: device-specific

5.7 FORMat Subsystem

List of commands

- FORMat[:DATA] <Format> (p. 229)

FORMat[:DATA] <Format>

This command specifies the data format for the data transmitted from the instrument to the control PC.

Parameter

<Format>

ASCii
Selects ASCII data format.

REAL
Selects the real data format (32-bit IEEE 754 floating-point numbers).

UINT
Selects the UINT8 binary data format.

Example

```
FORM:DATA UINT
```

Selects the UINT8 data format.

Characteristics

*RST value: ASCii
SCPI: conform

5.8 INITiate Subsystem

List of commands

INITiate[:IMMediate]

This command initiates a new measurement sequence.

If a measurement sequence is already in progress, the command is ignored.

Example

```
INIT:IMM
```

Initiates a new measurement sequence.

Characteristics

*RST value: -
SCPI: conform

INITiate:CONTinuous <State>

This command turns continuous measurements on and off.

If off, the application performs a single measurement and then stops.

Parameter

<State>
ON | OFF

Example

```
INIT:CONT 0
```

Turns single measurements on.

Characteristics

*RST value: 0
SCPI: conform

5.9 INPut Subsystem

List of commands

INPut:ATTenuation <Attenuation>

This command defines the input attenuation.

To protect the input mixer against damage from overloads, a 0 dB attenuation is possible only by manual entry of the value.

Parameter

<Attenuation>
Attenuation in dB.

The step width is 10 dB without the electronic attenuator option, and the range is 0 dB to 70 dB. With the electronic attenuator, the step width is 5 dB between 0 dB and 75 dB.

Example

```
INP:ATT?
```

Queries the current input attenuation.

Characteristics

*RST value: 0 dB
SCPI: device-specific

INPut<1|2>:DIQ:RANGe:AUTO <State>

This command turns automatic detection of the full scale level via the LVDS interface on and off.

The command requires option R&S FSQ-B17.

Parameter

<State>
ON | OFF

Example

`INP:DIQ:RANG:AUTO 1`

Turns on automatic determination of the full scale level.

Characteristics

*RST value: 1
SCPI: conform

INPut<1|2>:DIQ:RANGe[:UPPer] <Level>

This command defines the the expected voltage of the digital baseband input signal.

The command requires option R&S FSQ-B17.

Parameter

<Level>
Level in Volt.

Example

`INP:DIQ:RANG:UPP?`

Queries the full scale level of the digital baseband input.

Characteristics

*RST value: 10 dB
SCPI: conform

INPut<1|2>:DIQ:SRATe:AUTO <State>

This command turns automatic detection of the sample rate via the LVDS interface on and off.

The command requires option R&S FSQ-B17.

Parameter

<State>
ON | OFF

Example

`INP:DIQ:SRAT:AUTO 1`

Turns on automatic detection of the input sampling rate.

Characteristics

*RST value: 1
SCPI: conform

INPut<1|2>:DIQ:SRATe <SampleRate>

This rcommand defines the sampling rate for the digital base band input.

The command requires option R&S FSQ-B17.

Parameter

<SampleRate>
Sample rate in Hz.

Example

`INP:DIQ:SRAT 10MHZ`

Defines a sampling rate of 10 MHz.

Characteristics

*RST value: 10 MHz
SCPI: conform

INPut:EATT <Attenuation>

This command defines the attenuation of the electronic attenuator.

The command requires option R&S FSQ-B25.

Parameter

<Attenuation>
Attenuation in dB.

The electronic attenuator has a step size of 5 dB in the range from 0 to 30 dB. Other entries are rounded to the next lower integer value.

Note that the electronic attenuator is switched off by default.

Example

`INP:EATT?`

Queries the current electronic attenuation.

Characteristics

*RST value: -
SCPI: device-specific

INPut:EATT:AUTO <State>

This command turns automatic determination of the electronic input attenuation on and off.

The command requires option R&S FSQ-B25.

Parameter

<State>
ON | OFF

When you turn on automatic detection of the electronic attenuation on, the application couples the electronic input attenuation to the reference level and the attenuation of the mechanical attenuator.

When it has been turned off, the attenuation is available for manual entry.

Example

```
INP:EATT:AUTO 1
```

Couples the attenuation of the electronic attenuator to the reference level.

Characteristics

*RST value: 1
SCPI: device-specific

INPut:EATT:STATe <State>

This command turns the electronic input attenuation on and off.

The command requires option R&S FSQ-B25.

Parameter

<State>
ON | OFF

Example

```
INP:EATT:STAT 1
```

Turns on the electronic attenuator.

Characteristics

*RST value: 0
SCPI: device-specific

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG filter for image frequency suppression on and off.

Parameter

<State>
ON | OFF

Example

`INP:FILT:YIG:STAT 0`

Turns off the YIG filter.

Characteristics

*RST value: 1
SCPI: device-specific

INPut:IQ:BALanced[:STATe] <State>

This command turns symmetric (or balanced) input on and off.

The command requires option R&S FSQ-B71.

Parameter

<State>
ON | OFF

Example

`INP:IQ:BAL:STAT 1`

Specifies symmetrical (balanced) I/Q inputs.

Characteristics

*RST value: 1
SCPI: device-specific

INPut:IQ:IMPedance <Impedance>

This command selects the input impedance for the baseband input.

The command requires option R&S FSQ-B71.

Parameter

<Impedance>
LOW | HIGH

Example

`INP:IQ:IMP LOW`

'Specifies low input impedance for I/Q inputs.

Characteristics

*RST value: LOW
SCPI: device-specific

INPut:IQ:TYPE <Path>

This command selects the input path for the baseband input.

The command requires option R&S FSQ-B71.

Parameter

<Path>

IQ	I + j*Q (=default)
I	I only
Q	Q only

Example

`INP:IQ:TYPE I`

Selects the I input for the baseband path.

Characteristics

*RST value: IQ
SCPI: conform

INPut:SELect <Source>

This command selects the input source.

Parameter

<Source>

AIQ	Analog baseband input (R&S FSQ-B71 only)
DIQ	Digital baseband input (R&S FSQ-B17 only)
RF	RF input

Example

`INP:SEL AIQ`

Selects the analog baseband input

Characteristics

*RST value: RF
SCPI: conform

5.10 INSTrument Subsystem

List of commands

INSTrument:SELect WLAN

This command selects the WLAN application.

Example

```
INST:SEL WLAN
```

Selects the WLAN application.

Characteristics

*RST value: SANalyzer
SCPI: device-specific

INSTrument:NSELect <ApplicationCode>

This command selects the WLAN application by specifying its associated option number.

Parameter

<ApplicationCode>
Code for the application. In case of the WLAN application, the code is "16".

Example

```
INST:NSEL 16
```

Selects the WLAN application.

Characteristics

*RST value: 1
SCPI: device-specific

5.11 MMEMory Subsystem

List of commands

MMEMory:LOAD:IQ:STATe 1,<FileName>

This command loads I/Q data from a particular .iqw file.

Parameter

<FileName>
String containing the name of the file and the path to the file.

Example

```
MMEM:LOAD:IQ:STAT 1,'D:\USER\DATA.iqw'
```

'Loads the I/Q data from the specified file.

Characteristics

*RST value: -
SCPI: device-specific

MMEMory:LOAD:SEM:STATe 1,<FileName>

This command loads a Spectrum Emission Mask configuration from an xml file.

Parameter

<FileName>
String containing the name of the file and the path to the file.

Example

```
MMEM:LOAD:SEM:STAT 1,'D:\USER\ETSI_SEM.xml'
```

Loads the SEM configuration from the specified file.

Characteristics

*RST value: -
SCPI: device-specific

MMEMory:STORe:IQ:STATe 1,<FileName>

This command stores I/Q data to a particular .iqw file.

Parameter

<FileName>
String containing the name of the file and the path to the file.

Example

`MMEM:STOR:IQ:STAT 1,'D:\USER\DATA.iqw'`

Stores I/Q data to the specified file

Characteristics

*RST value: -
SCPI: device-specific

5.12 SENSe Subsystem

List of commands

- [SENSe:]TRACking:TIME <State> (p. 264)

[SENSe:]BANDwidth:CHANnel:AUTO:TYPE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their channel bandwidth.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same channel bandwidth as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the channel bandwidth.
MB20	Only PPDUs with a channel bandwidth = 20 MHz are analyzed.
MB40	Only PPDUs with a channel bandwidth = 40 MHz are analyzed.
MB80	Only PPDUs with a channel bandwidth = 80 MHz are analyzed.
DB20	All PPDUs are demodulated as if they had a channel bandwidth of 20 MHz.
DB40	All PPDUs are demodulated as if they had a channel bandwidth of 40 MHz.
DB80	All PPDUs are demodulated as if they had a channel bandwidth of 80 MHz.

Example

```
SENS:BAND:CHAN:AUTO:TYPE MB80
```

Analyzes only PPDUs with a bandwidth of 80 MHz.

Characteristics

*RST value: FBURst
SCPI: device-specific

[SENSe:]BANDwidth:[RESolution]:FILTer <State>

This command turns the suppression of adjacent channels on and off.

Parameter

<State>
ON | OFF

Example

```
SENS:BAND:RES:FILT 0
```

Turns off adjacent channel suppression.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]BURSt:COUNt <PPDUs>

This command defines the number of PPDUs that are considered in the measurement.

The command works if [SENSe:]BURSt:COUNt:STATe <State> has been turned on.

Parameter

<PPDUs>
Number of PPDUs.

Example

`SENS:BURS:COUN 16`

Defines a number of PPDUs of 16.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]BURSt:COUNt:STATe <State>

This command turns the PPDU count on and off.

If on, you can define the number of PPDUs considered in the measurement with [SENSe:]BURSt:COUNt <PPDUs>.

Parameter

<State>
ON | OFF

Example

`SENS:BURS:COUN:STAT 1`

Turns on the PPDU count.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:CESTimation <State>

This command turns channel estimation for the payload or preamble on and off.

The effect of this is most noticeable for the EVM measurement results, where the results will be improved when this feature is enabled.

However, this functionality is not supported by the IEEE 802.11 standard and must be disabled if the results are to be strictly measured against the standard.

Parameter

<State>
ON | OFF

If on, the application performs channel estimation in the payload.

If off, the application performs channel estimation in the preamble.

Example

`SENS:DEM:CEST 1`

Performs channel estimation in the payload.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:FFT:OFFSet <StartOffset>

This command selects the FFT start offset.

Parameter

<StartOffset>

PEAK	The peak of the fine timing metric is used to determine the FFT start offset.
AUTO	The FFT start offset is automatically chosen to minimize the intersymbol interference.
GICenter	Guard Interval Center: The FFT start offset is placed to the center of the guard interval

Example

`SENS:DEM:FFT:OFFS?`

Queries the current FFT start offset.

Characteristics

*RST value: AUTO
SCPI: device-specific

[SENSe:]DEMod:FILTer:CATalog?

This command queries the names of all available filters.

Return value

The file names are returned as a comma separated list without file extension:

<filter_1>,<filter_2>, … ,<filter_n>

Example

`SENS:DEM:FILT:CAT?`

Queries all filter names.

Characteristics

*RST value: -
SCPI: device-specific

[SENSe:]DEMod:FILTer:EFLength <Chips>

This command defines the equalizer filter length.

Parameter

<Chips>
Filter length in chips.

Example

`DEM:FILT:EFL 15`

Defines 15 chips as the filter length.

Characteristics

*RST vaue: 10
SCPI: device-specific

[SENSe:]DEMod:FILTer:MODulation <TxFilter>, <RxFilter>

This command selects the Tx and Rx filters.

Parameter

<TxFilter>,<RxFilter>

The names of the filters correspond to the file names.

Available filters can be queried with [SENSe:]DEMod:FILTer:CATalog?.

Example

`SENS:DEM:FILT:MOD 'DEF_TX','DEF_RX'`

Selects "DEF_TX" as the TX filter and "DEF_RX" as the RX filter.

Characteristics

*RST value: AUTO, AUTO
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANAlyze:BTYPe:AUTO:TYPE <PPDUType>

This command selects the type of PPDUs considered in the measurement.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same characteristics as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the PPDU type.
MMIX	Only mixed mode PPDUs are analyzed.
MGRF	Only Greenfield PPDUs are analyzed.
MVHT	Only VHT PPDUs are analyzed.
DMIX	All PPDUs are demodulated as if they were mixed mode PPDUs.
DGRF	All PPDUs are demodulated as if they were Greenfield PPDUs.
DVHT	All PPDUs are demodulated as if they were VHT PPDUs.

Example

```
SENS:DEM:FOR:BTYP:AUTO:TYPE MVHT
```

Analyzes VHT PPDUs only.

Characteristics

*RST value: FBURst
SCPI: device-specific

[SENSe:]DEMod:FORMat[:BCONtent]:AUTO <State>

This command selects the type of PPDUs considered in the measurement, depending on their modulation scheme.

Parameter

<State>
ON | OFF

If on, the application determines the modulation of the first PPDU. Only PPDUs that match this modulation are considered in the measurement.

Example

```
SENS:DEM:FORM:AUTO 1
```

Turns decoding of the signal symbol field on.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:FORMat:BTRate <BitRate>

This command specifies the bit rate.

Available for IEEE 802.11b.

Parameter

<BitRate>

10	1 Mbit/s
20	2 Mbit/s
55	5.5 Mbit/s
110	11 Mbit/s

This command is the same as [SENSe:]DEMod:FORMat:BANalyze <Modulation>.

Example

```
SENS:DEM:FORM:BTR 20
```

Selects a bit rate of 2 Mbit/s.

Characteristics

*RST value: 10 (= 1 Mbit/s)
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze <Modulation>

This command selects the signal modulation type.

If the [SENSe:]DEMod:FORMat:SIGSymbol <State> is on, the command can be used to measure only certain PPDU types within a measurement sequence.

Parameter

<Modulation>
String containing the modulation scheme.

'BPSK'	Alias for BI-Phase shift keying at higher data rate for selected standard
'BPSK3'	IEEE 802.11j (10 MHz) - BI-Phase shift keying at 3 Mbps
'BPSK6'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo- BI-Phase shift keying at 6 Mbps
'BPSK9'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - BI-Phase shift keying at 9 Mbps
'BPSK45'	IEEE 802.11j (10 MHz) - BI-Phase shift keying at 4.5 Mbps
'BPSK65'	IEEE 802.11n - BI-Phase shift keying at 6.5 Mbps
'BPSK72'	IEEE 802.11n - BI-Phase shift keying at 7.2 Mbps
'CCK11'	IEEE 802.11b & g (Single Carrier) – Complementary Code Keying at 11 Mbps
'CCK55'	IEEE 802.11b & g (Single Carrier) - Complementary Code Keying at 5.5 Mbps
'DBPSK1'	IEEE 802.11b & g (Single Carrier) - Differential BI-Phase shift keying
'DQPSK2'	IEEE 802.11b & g (Single Carrier) – Differential Quadrature phase shift keying
'PBCC11'	IEEE 802.11b & g (Single Carrier) – PBCC at 11 Mbps
'PBCC22'	IEEE 802.11g (Single Carrier) – PBCC at 11 Mbps
'PBCC55'	IEEE 802.11b & g (Single Carrier) - PBCC at 5.5 Mbps
'QAM16'	Alias for Quadrature Amplitude Modulation at higher data rate for selected standard
'QAM64'	Alias for Quadrature Amplitude Modulation at higher data rate for selected standard
'QAM1612'	IEEE 802.11j (10 MHz) - Quadrature Amplitude Modulation at 12 Mbps
'QAM1618'	IEEE 802.11j (10 MHz) - Quadrature Amplitude Modulation at 18 Mbps
'QAM1624'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 24 Mbps
'QAM1626'	IEEE 802.11n Quadrature Amplitude Modulation at 26 Mbps
'QAM1636'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 36 Mbps
'QAM1639'	IEEE 802.11n Quadrature Amplitude Modulation at 39 Mbps
'QAM16289'	IEEE 802.11n Quadrature Amplitude Modulation at 28.9 Mbps
'QAM16433'	IEEE 802.11n Quadrature Amplitude Modulation at 43.3 Mbps
'QAM6424'	EEE 802.11j (10 MHz) - Quadrature Amplitude Modulation at 24 Mbps
'QAM6427'	IEEE 802.11j (10 MHz) - Quadrature Amplitude Modulation at 27 Mbps
'QAM6448'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 48 Mbps
'QAM6452'	IEEE 802.11n Quadrature Amplitude Modulation at 52 Mbps
'QAM6454'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 54 Mbps
'QAM6465'	IEEE 802.11n Quadrature Amplitude Modulation at 65 Mbps

'QAM16289'	IEEE 802.11n Quadrature Amplitude Modulation at 28.9 Mbps
'QAM16433'	IEEE 802.11n Quadrature Amplitude Modulation at 43.3 Mbps
'QAM64578'	IEEE 802.11n Quadrature Amplitude Modulation at 57.8 Mbps
'QAM64585'	IEEE 802.11n Quadrature Amplitude Modulation at 58.5 Mbps
'QAM64722'	IEEE 802.11n Quadrature Amplitude Modulation at 72.2 Mbps
'QPSK'	Alias for Quadrature phase shift keying at higher data rate for selected standard
'QPSK6'	IEEE 802.11j (10 MHz) - Quadrature phase shift keying at 6 Mbps
'QPSK9'	IEEE 802.11j (10 MHz) - Quadrature phase shift keying at 9 Mbps
'QPSK12'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature phase shift keying at 12 Mbps
'QPSK13'	IEEE 802.11n Quadrature phase shift keying at 13 Mbps
'QPSK18'	IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature phase shift keying at 18 Mbps
'QPSK144'	IEEE 802.11n Quadrature phase shift keying at 14.4 Mbps
'QPSK195'	IEEE 802.11n Quadrature phase shift keying at 19.5 Mbps
'QPSK217'	IEEE 802.11n Quadrature phase shift keying at 21.7 Mbps

For IEEE 802.11n this command is only supported for SISO. For MIMO use [SENSe:]DEMod:FORMat:MCSindex <MCSIndex>.

Example

```
SENS:DEM:FORM:BAN 'QPSK6'
```

Selects QPSK modulation at 6 Mbps.

Characteristics

*RST value: 'QAM64'
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:BTYPe <PPDUType>

This command selects the type of PPDUs considered in the measurement.

Parameter

<PPDUType>
String containing the PPDU type.

'DIRECT'	Only Direct Link PPDUs are analyzed. Available for IEEE 802.11a, g, j and Turbo Mode.
'GFM20'	Only Greenfield PPDUs are analyzed. Available for IEEE 802.11n.
'LONG'	Only Long PLCP PPDUs are analyzed. Available for IEEE 802.11b, g.
'LONG-OFDM'	Only Long DSSS OFDM PPDUs are analyzed. Available for IEEE 802.11g.
'MM20'	Only Mixed Mode PPDUs are analyzed. Available for IEEE 802.11n.
'SHORT'	Only Short PLCP PPDUs are analyzed. Available for IEEE 802.11b, g.
'SHORT-OFDM'	Only Short DSSS OFDM PPDUs are analyzed. Available for IEEE 802.11g.

Example

```
SENS:DEM:FORM:BAN:BTYP 'DIRECT'
```

Analyzes direct link PPDUs only.

Characteristics

*RST value: depending on standard'
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DBYTes:EQUal <State>

This command selects the type of PPDUs considered in the measurement, depending on their number of data bytes.

Parameter

<State>
ON | OFF

If on, the application only analyzes PPDUs with a particular number of data bytes. Define the PPDU length with [SENSe:]DEMod:FORMat:BANalyze:DBYT:MIN <DataBytes>.

Example

```
SENS:DEM:FORM:BAN:DBYT:EQU 1
```

Analyzes only PPDUs with a particular length.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DBYT:MAX <DataBytes>

This command defines the maximum number of data bytes that a PPDU may have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DBYTes:EQUal <State> is on, defining a maximum number of data bytes has no effect. In that case, only PPDUs with a fixed number of data bytes are considered.

Parameter

<DataBytes>
Number of data bytes in the PPDU.

Example

```
SENS:DEM:FORM:BAN:DBYT:EQU OFF
SENS:DEM:FORM:BAN:DBYT:MAX 1000
```

Analyzes only PPDUs that contain a maximum of 1000 data bytes.

Characteristics

*RST value: 64
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DBYT:MIN <DataBytes>

This command defines the number of data bytes that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DBYTes:EQUal <State> is on, the command defines the exact number of data bytes that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DBYTes:EQUal <State> is off, the command defines the minimum number of data bytes that a PPDU must have to be considered in the measurement.

Parameter

<DataBytes>
Number of data bytes in the PPDU.

Example

```
SENS:DEM:FORM:BAN:DBYT:EQU OFF
SENS:DEM:FORM:BAN:DBYT:MIN 16
```

Analyzes only PPDUs that contain at least 16 data bytes.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DURation:EQUal <State>

This command selects the type of PPDUs considered in the measurement.

Parameter

<State>
ON | OFF

If on, the application only analyzes PPDUs with a particular PPDUs length. Define the PPDU length with [SENSe:]DEMod:FORMat:BANalyze:DURation:MIN <Duration>.

Example

```
SENS:DEM:FORM:BAN:DUR:EQU 1
```

Analyzes only PPDUs with a particular length.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DURation:MAX <Duration>

This command defines the maximum length (in seconds) that a PPDU may have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DURation:EQUal <State> is on, defining a maximum PPDU length has no effect. In that case, only PPDUs with a fixed length are considered.

Parameter

<Duration>
Duration of the PPDU in microseconds.

Example

```
SENS:DEM:FORM:BAN:DUR:EQU OFF
SENS:DEM:FORM:BAN:DUR:MAX 1000
```

Analyzes only PPDUs with a length of at least 1000 μs.

Characteristics

*RST value: 5464
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:DURation:MIN <Duration>

This command defines the length (in seconds) that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DURation:EQUal <State> is on, the command defines the exact length that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:DURation:EQUal <State> is off, the command defines the minimum length that a PPDU must have to be considered in the measurement.

Parameter

<Duration>
Duration of the PPDU in microseconds.

Example

```
SENS:DEM:FORM:BAN:DUR:EQU ON
SENS:DEM:FORM:BAN:DUR:MIN 45
```

Analyzes only PPDUs that have a duration of 45 µs.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:EQUal <State>

This command selects the type of PPDUs considered in the measurement.

Parameter

<State>
ON | OFF

If on, the application only analyzes PPDUs with a particular number of symbols. Define the PPDU length with [SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>.

Example

```
SENS:DEM:FORM:BAN:SYM:EQU 1
```

Analyzes only PPDUs with a particular symbol number.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:MAX <Symbols>

This command defines the maximum number of symbols that a PPDU may have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:SYMbols:EQUal <State> is on, defining a maximum number of data bytes has no effect. In that case, only PPDUs with a fixed number of data bytes are considered.

Parameter

<Symbols>
Number of symbols in the PPDU.

Example

```
SENS:DEM:FORM:BAN:SYM:EQU OFF
SENS:DEM:FORM:BAN:SYM:MAX 1300
```

'Analyzes only PPDUs with a maximum of 1300 symbols.

Characteristics

*RST value: 64
SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:SYMbols:MIN <Symbols>

This command defines the number of symbols that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:SYMbols:EQUal <State> is on, the command defines the exact number of symbols that a PPDU must have to be considered in the measurement.

If [SENSe:]DEMod:FORMat:BANalyze:SYMbols:EQUal <State> is off, the command defines the minimum number of symbols that a PPDU must have to be considered in the measurement.

Parameter

<Symbols>
Number of symbols in the PPDU.

Example

```
SENS:DEM:FORM:BAN:SYM:EQU OFF
SENS:DEM:FORM:BAN:SYM:MIN 16
```

'Analyzes only PPDUs that contain at least 16 symbols.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]DEMod:FORMat:MCSindex <MCSIndex>

This command defines the MCS Index number.

The MCS Index controls the rate and modulation and streams. It is used as the offset into the available options as shown on control or MCS parameter tables (see document: IEEE P802.11n/D11.0 June 2009).

The command is available if [SENSe:]DEMod:FORMat:MCSindex:MODE has been set to MEASure or DEMod

Parameter

<MCSIndex>
MCS index code.

Example

`SENS:DEM:FORM:MCS 1`

Selects MCS index 1 (BPSK 1 spatial stream)

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]DEMod:FORMat:MCSindex:MODE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their MCS index.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same MCS Index as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the MCS Index.
MEASure	Only PPDUs with an MCS Index defined with [SENSe:]DEMod:FORMat:MCSindex <MCSIndex> are analyzed.
DEMod	All PPDUs are demodulated as if they had an MCS Index defined with [SENSe:]DEMod:FORMat:MCSindex <MCSIndex>.

Example

`SENS:DEM:FORM:MCS:MODE MEAS`

Analyzes only PPDUs with a particular MCS index.

Characteristics

*RST value: FBURst
SCPI: device-specific

[SENSe:]DEMod:FORMat:NSTSindex <NSTSIndex>

This command defines the NSTS index.

The NSTS index controls the space time stream to measure.

The command is available if [SENSe:]DEMod:FORMat:NSTSindex:MODE <PPDUType> has been set to either MEASure or DEMod.

Parameter

<NSTSIndex>
NSTS index code.

Example

```
SENS:DEM:FORM:NSTS 1
```

Selects NSTS index 1.

Characteristics

*RST value: 1
SCPI: device specific

[SENSe:]DEMod:FORMat:NSTSindex:MODE <PPDUType>

This command selects the type of PPDUs considered in the measurement, depending on their NSTS index.

Parameter

<PPDUType>

FBURst	Only PPDUs with the same NSTS Index as the first PPDU are analyzed.
ALL	All PPDUs are analyzed, regardless of the NSTS Index.
MEASure	Only PPDUs with an NSTS Index defined with [SENSe:]DEMod:FORMat:NSTSindex are analyzed.
DEMod	All PPDUs are demodulated as if they had an NSTS Index defined with [SENSe:]DEMod:FORMat:NSTSindex.

Example

```
SENS:DEM:FORM:NSTS:MODE:TYPE FBUR
```

Characteristics

*RST value: FBURst
SCPI: device-specific

[SENSe:]DEMod:FORMat:SIGSymbol <State>

This command turns signal symbol field decoding on and off.

For IEEE 802.11b, this command is a query only, because the decoding of the signal field is always performed for the IEEE 802.11b standard.

Parameter

<State>
ON | OFF

If on, the application decodes the signal symbol field to determine the details of a PPDU. Only PPDUs that match the supplied PPDU type and modulation are considered in the measurement.

Example

`SENS:DEM:FORM:SIGS 1`

Turns signal symbol field decoding on.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]DEMod:TXARea <State>

This command turns the search and subsequent analysis for power intervals on and off.

Turn the search for improved measurement speed for signals with a low duty cycle. However, valid results are only possible if the PPDUs in the signal have the same power level.

If the signal shows significant fluctuations in the power level, turn the search off.

Parameter

<State>
ON | OFF

Example

`SENS:DEM:TXAR 0`

Turns measurement speed optimization off.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency of the analyzer.

Parameter

<Frequency>
Frequency value in Hz.

Example

```
SENS:FREQ:CENT 5GHZ
```

Defines a center frequency of 5 GHz.

Characteristics

*RST value: f_{max} / 2
SCPI: conform

[SENSe:]IQ:DITHer[:STATe] <State>

Adds a noise signal into the signal path of the baseband input.

For more information see Dither on page 92.

The command requires option R&S FSQ-B71.

Parameter

<State>
ON | OFF

Example

```
SENS:IQ:DITH:STAT 1
```

Turns on the dither signal.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]IQ:LPASs[:STATe] <State>

Turns an anti-aliasing low pass filter on and off.

The command requires option R&S FSQ-B71.

Parameter

<State>
ON | OFF

Example

`SENS:IQ:LPAS:STAT 1`

Turns on the lowpass filter.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]POWer:ACHannel:MODE <Mode>

This command selects the ACP measurement mode (absolute or relative).

Available for IEEE 802.11j.

Parameter

<Mode>

ABS Absolute measurement

REL Relative measurement

Example

`SENS:POW:ACH:MODE ABS`

Selects absolute ACP measurement to mode.

Characteristics

*RST value: REL
SCPI: device-specific

[SENSe:]POWer:SEM:TRACe:REDuction <Method>

This command specifies how trace reduction is performed for the Spectrum Emission Mask (SEM) measurement.

Parameter

<Method>

PEAK	Uses peak detection to draw the complete trace.
DETector	The trace for each SEM segment is reduced according to the trace detector specified for that segment.

Example

```
SENS:POW:SEM:TRAC:RED PEAK
```

Selects SEM measurement to use peak trace reduction.

Characteristics

*RST value: PEAK
SCPI: device-specific

[SENSe:]POWer:SEM <SEMType>

This command selects the Spectrum Emission Mask (SEM) measurement type.

Parameter

<SEMType>

IEEE 802.11a, b, g, j and Turbo Mode

IEEE | ETSI | USER

IEEE 802.11n and ac

Spectrum masks described in chapter Spectrum Emission Mask on page 56 or a user defined mask are available.

Example

```
SENS:POW:SEM ETSI
```

Selects the ETSI spectrum mask.

Characteristics

*RST value: IEEE
SCPI: device-specific

[SENSe:]SWAPiq <State>

This command turns inversion of the captured I/Q pairs on and off.

Parameter

<State>
ON | OFF

Example

`SENS:SWAP 1`

Turns swapping of the I/Q pairs on.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]SWEep:COUNt <Sweeps>

This command defines the number of sweeps for Spectrum Mask and Spectrum ACPR measurements.

Parameter

<Sweeps>
Number of sweeps.

Example

`SENS:SWEep:COUN 64`

Sets the number of sweeps to 64.

Characteristics

*RST value: 1
SCPI: conform

[SENSe:]SWEep:EGATe <State>

This command switches gating on and off.

Parameter

<State>
ON | OFF

Example

`SENS:SWE:EGAT 1`

Turns on gating.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]SWEep:EGATe:HOLDoff:SAMPle <DelayTime>

This command defines the gate delay in the capture buffer.

Parameter

<DelayTime>
Delay time in samples.

The range of this value depends on the previous measurement.

Example

`SENS:SWE:EGAT:HOLD:SAMP 2500`

Defines a gate delay of 2500 samples in the capture buffer.

Characteristics

*RST value: 2000
SCPI: device-specific

[SENSe:]SWEep:EGATe:HOLDoff[:TIMe] <DelayTime>

This command defines the gate delay in the capture buffer.

Parameter

<DelayTime>
Delay time in seconds.

The range of this value depends on the previous measurement.

Example

`SENS:SWE:EGAT:HOLD 125µs`

Defines a gate delay of 125 µs in the capture buffer.

Characteristics

*RST value: 100 µs
SCPI: device-specific

[SENSe:]SWEep:EGATe:LENGth:SAMPle <GateLength>

This command defines the gate length for gated measurements.

Parameter

<GateLength>
Gate length in samples.

The range of this value depends on the previous measurement.

Example

```
SENS:SWE:EGAT:LENG:SAMP 200000
```

Defines a gate length of 200000 samples in the capture buffer.

Characteristics

*RST value: 8000
SCPI: device-specific

[SENSe:]SWEep:EGATe:LENGth[:TIMe] <GateLength>

This command defines the gate length for gated measurements.

Parameter

<GateLength>
Gate length in seconds.

The range of this value depends on the previous measurement.

Characteristics

*RST value: 400 µs
SCPI: device-specific

[SENSe:]SWEep:EGATe:LINK <State>

This command couples or decouples the marker from the gate lines.

Parameter

<State>
ON | OFF

Example

```
SENS:SWE:EGAT:LINK 1
```

Links the marker to the gate lines.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]SWEep:TIME <SweepTime>

This command defines the capture time of the measurement.

Parameter

<SweepTime>
Sweep time in seconds.

Example

```
SENS:SWEep:TIME 20ms
```

Defines a sweep acquisition period of 20 ms.

Characteristics

*RST value: 1 ms
SCPI: conform

[SENSe:]TRACking:LEVel <State>

This command turns level compensation of the measurement results on and off.

Parameter

<State>
ON | OFF

Example

```
SENS:TRAC:LEV 1
```

Turns on level compensation.

Characteristics

*RST value: 0
SCPI: device-specific

[SENSe:]TRACking:PHASe <State>

This command turns phase compensation of the measurement results on and off.

Parameter

<State>
ON | OFF

Example

```
SENS:TRAC:PHAS 1
```

Turns on phase compensation.

Characteristics

*RST value: 1
SCPI: device-specific

[SENSe:]TRACking:PILots <Method>

This command defines the method for pilot detection.

Parameter

<Method>

STANdard	Pilots selection according to the standard
DETected	Pilots detected from the signal

Example

`SENS:TRAC:PIL STAN`

Defines pilot tracking according to the standard.

Characteristics

*RST value: STAN
SCPI: conform

[SENSe:]TRACking:TIME <State>

This command turns time compensation of the measurement results on and off.

Parameter

<State>
ON | OFF

Example

`TRAC:TIME 1`

Turns on time compensation.

Characteristics

*RST value: 0
SCPI: device-specific

5.13 STATus Subsystem

The STATus subsystem contains the commands for the status reporting system (see section Status reporting registers). *RST does not influence the status registers.

List of commands

STATus:QUEStionable:ACPLimit:CONDition?

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Example

`STAT:QUES:ACPL:COND?`

Characteristics

*RST value: -
SCPI: conform

STATus:QUEStionable:ACPLimit:ENABle <SumBit>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:ACPL:ENAB 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:ACPLimit[:EVENt]?

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Example

`STAT:QUES:ACPL:EVEN?`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:ACPLimit:NTRansition <SumBit>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:ACPL:NTR 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:ACPLimit:PTRansition <SumBit>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:ACPL:PTR 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:LIMit<1|2>:CONDition?

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Example

`STAT:QUES:LIM:COND?`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:LIMit<1|2>:ENABle <SumBit>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:LIM:ENAB 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:LIMit<1|2>[:EVENt]?

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Example

`STAT:QUES:LIM1:EVEN?`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:LIMit<1|2>:NTRansition <SumBit>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:LIM:NTR 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:LIMit<1|2>:PTRansition <SumBit>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:LIMit:PTR 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:POWer:CONDition?

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Example

`STAT:QUES:POW:COND`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:POWer:ENABle <SumBit>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:POW:ENAB 65535`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:POWer[:EVENt]?

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Example

`STAT:QUES:POW:EVEN?`

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:POWer:NTRansition <SumBit>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

```
STAT:QUES:POW:NTR 65535
```

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:POWer:PTRansition <SumBit>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

```
STAT:QUES:POWer:PTR 65535
```

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:SYNC:CONDition?

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Example

```
STAT:QUES:SYNC:COND?
```

Characteristics

*RST value: -
SCPI: In compliance

STATus:QUEStionable:SYNC:ENABle <SumBit>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameter

<SumBit>
0 to 65535

Example

```
STAT:QUES:SYNC:ENAB 65535
```

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:SYNC[:EVENt]?

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Example

```
STAT:QUES:SYNC?
```

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:SYNC:NTRansition <SumBit>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

```
STAT:QUES:SYNC:NTR 65535
```

Characteristics

*RST value: -
SCPI: device-specific

STATus:QUEStionable:SYNC:PTRansition <SumBit>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameter

<SumBit>
0 to 65535

Example

`STAT:QUES:SYNC:PTR 65535`

Characteristics

*RST value: -
SCPI: device-specific

5.14 TRACe Subsystem

The TRACe subsystem controls access to the instrument's internal trace memory.

5.14.1 Using the TRACe:DATA Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values might depend on the selected WLAN standard.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example

`TRAC:DATA TRACE1`

The format of the return values is either in ASCII or binary characters and depends on the format you have set with FORMat[:DATA] <Format>.

Following this detailed description, you will find a short summary of the most important functions of the command (TRACE[:DATA] <Result>).

5.14.1.1 Bitstream

The returned values depend on the standard.

IEEE 802.11a, g (OFDM), j, n and ac

For the Bitstream result display the command returns the bitstream for each carrier and symbol that has been analyzed.

`<bitstream[sym1]>, <bitstream[sym2]>,…`

The bit pattern (binary representation) is converted to its equivalent hexadecimal value as the final measurement result.

The number of values returend for each analyzed OFDM symbol corresponds to the number of data subcarriers plus the number of pilot subcarriers.

The complete number of returned values depends on the number of symbols that have been analyzed and the number of subcarriers (and thus the selected standard and bandwidth).

Note that the DC and NULL carriers are not returned via remote control.

IEEE 802.11b, g (DSSS)

For the Bitstream result display the command returns the bitstream for each PPDU that has been analyzed.

`<bitstream[PPDU1]>, <bitstream[PPDU2]>,…`

The bitstream of each PPDU is made up of a series of bytes. The first bytes of each PPDU represent PLCP Preamble (9 bytes for a short preamble, 18 bytes for a long preamble). The following 6 bytes represent the PLCP Header. The remaining bytes in each PPDU represent the PSDU.

The bit pattern (binary representation) is converted to its equivalent hexadecimal value as the final measurement result.

5.14.1.2 CCDF

For the CCDF result display, the command returns one value for each power level.

`<number of values>,<probability>,<probability,…`

The probability values have no unit.

The maximum number of values that is returned is 201, with the first number being the number of values that follow.

The following parameters are supported.

- TRACE1

  Returns the probability values.

5.14.1.3 Constellation vs Symbol

For the Constellation vs Symbol result display, the command returns an array of interleaved I/Q data.

The contents depend on the IEEE standard.

IEEE 802.11b and g (DSSS)

Returns the I/Q data in ordered by symbols.

<I[Sym0]>,<Q[Sym0]>,<I[Sym1]>,<Q[Sym1]>,…<I[Sym(n)]>,<Q[Sym(n)>

IEEE 80211a, g (OFDM), j, n, ac

Returns the I/Q data ordered by symbols in groups of carriers.

<I[Sym1][Car1]>,<Q[Sym1][Car1]>,<I[Sym1][Car2]>,<Q[Sym1][Car2]>,<I[Sym1][Car(n)]>,<Q[Sym1][Car(n)]>
<I[Sym2][Car1]>,<Q[Sym2][Car1]>,<I[Sym2][Car2]>,<Q[Sym2][Car2]>,<I[Sym2][Car(n)]>,<Q[Sym2][Car(n)]>
…
<I[Sym(n)][Car1]>,<Q[Sym(n)][Car1]>,<I[Sym(n)][Car2]>,<Q[Sym(n)][Car2]>,<I[Sym(n)][Car(n)]>,<Q[Sym(n)][Car(n)]>

with Sym = symbol of a particular carrier (Car)

The number of returned values depends on the standard and your selection.

IEEE 802.11a, g (OFDM), j:

- "All Carriers" returns 52 pairs of I and Q values per symbol
- "Pilots Only" returns 4 pairs of I and Q values per symbol in the following order: carrier(-21), carrier(-7), carrier(7), carrier(21)
- "Single Carrier" returns one pair of I and Q values per symbol

IEEE 802.11n and ac (20 MHz bandwidth):

- "All Carriers" returns 56 pairs of I and Q values per symbol
- "Pilots Only" returns 4 pairs of I and Q values per symbol in the following order: carrier(-21), carrier(-7), carrier(7), carrier(21)
- "Single Carrier" returns one pair of I and Q values per symbol

IEEE 802.11n and ac (40 MHz bandwidth):

- "All Carriers" returns 116 pairs of I and Q values per symbol
- "Pilots Only" returns 4 pairs of I and Q values per symbol in the following order: carrier(-53), carrier(-25), carrier(-11), carrier(11), carrier(25), carrier(53)
- "Single Carrier" returns one pair of I and Q values per symbol

Supported parameters

- TRACE1

  Returns all constellation points included in the selection

5.14.1.4 Constellation vs Carrier

For the Constellation vs Carrier result display, the command returns an array of interleaved I/Q data.

Returns the I/Q data ordered by symbols in groups of carriers.

<I[Sym0][Car1]>,<Q[Sym0][Car1]>,<I[Sym0][Car2]>,<Q[Sym0][Car2]>,<I[Sym0][Car(n)]>,<Q[Sym0][Car(n)]>
<I[Sym1][Car1]>,<Q[Sym1][Car1]>,<I[Sym1][Car2]>,<Q[Sym1][Car2]>,<I[Sym1][Car(n)]>,<Q[Sym1][Car(n)]>
…
<I[Sym(n)][Car1]>,<Q[Sym(n)][Car1]>,<I[Sym(n)][Car2]>,<Q[Sym(n)][Car2]>,<I[Sym(n)][Car(n)]>,<Q[Sym(n)][Car(n)]>

with Sym = symbol of a particular subcarrier (Car)

The number of returned values depends on the standard and your selection.

- 53 subcarriers per symbol in case of IEEE 802.11a, b, g, j, incl. DC subcarrier
- 57 subcarriers per symbol in case of IEEE 802.11n ,ac (20 MHz bandwidth), incl. DC subcarrier
- 117 subcarriers per symbol in case of IEEE 802.11n ,ac (40 MHz bandwidth), incl. three DC subcarriers

Supported parameters

- TRACE1

  Returns all constellation points included in the selection

5.14.1.5 Error vs Preamble

For the Error vs Preamble result display the command returns one value for each analyzed sample in the preamble.

```
<error1>, <error1>, …
```

The unit depends on the error you are measuring.

- For the Frequency Error vs Preamble, the unit is Hz.
- For the Phase Error vs preamble, the unit is degree.

The following parameters are supported.

- TRACE1

  Returns the minimum error over all preambles.

- TRACE2

  Returns the average error over all preambles.

- TRACE3

  Returns the maximum error over all preambles.

5.14.1.6 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

`<EVM[carrier1]>, <EVM[carrier2]>,…`

The number of values depends on the standard.

The unit depends on UNIT:EVM <Unit>.

The following parameters are supported.

- TRACE1

  Returns the minimum EVM over all carriers.

- TRACE2

  Returns the average EVM over all carriers.

- TRACE3

  Returns the maximum EVM over all carriers.

5.14.1.7 EVM vs Symbol

For the EVM vs Carrier result display, the command returns one value for each symbol that has been analyzed.

`<EVM[symbol1]>, <EVM[symbol2]>,…`

The number of values depends on the number of symbol that have been measured.

The unit depends on UNIT:EVM <Unit>.

The following parameters are supported, depending on the selected standard.

IEEE 802.11a, g (OFDM), j, n and ac

- TRACE1

  Returns the minimum EVM over all carriers.

- TRACE2

  Returns the average EVM over all carriers.

- TRACE3

  Returns the maximum EVM over all carriers.

IEEE 802.11b, g (DSSS)

- TRACE1

  Returns the EVM according to IEEE.

- TRACE2

  Returns the direct EVM values.

5.14.1.8 Group Delay

For the Group Delay result display, the command returns one or more values for each subcarrier that has been analyzed.

`<GroupDelay[carrier1]>,<GroupDelay[carrier2]>,…`

The unit is ns.

The number of analyzed subcarriers depends on the selected IEEE standard.

The following parameters are supported.

- TRACE1 (IEEE 802.11n, ac)
- TRACE2 (IEEE 802.11a, g (OFDM), j and Turbo Mode)

  Returns a repeating list of group delay values for each subcarrier. The number of repeating lists corresponds to the number of fully analyzed PPDUs as displayed in the capture buffer.

  Example: if two IEEE 802.11a PPDUs have been analyzed, the command would return two series of 53 values (one for each subcarrier) each.

- TRACE2 (IEEE 802.11n, ac)
- TRACE4 (IEEE 802.11a, g (OFDM), j and Turbo Mode)

  Returns the averaged group delay value of each subcarrier (for example 53 average values in case of an IEEE 802.11a signal).

5.14.1.9 Power vs Time (Full Burst and Rising / Falling Edges)

For the Power vs Time result displays, the command returns one value for each sample in the capture buffer.

`<absolute power>, …`

The unit is always dBm.

The following parameters are supported.

Full Burst

- TRACE1

  Returns the minimum PPDU power values.

- TRACE2

  Returns the average PPDU power values.

- TRACE3

  Returns the maximum PPDU power values.

Rising and falling edges

- TRACE1

  Returns the minimum power values of the rising edge.

  Note: in case of IEEE 802.11b measurements, the parameter returns the minimum power values of the rising or falling edge, depending on which result display you have selected.

- TRACE2

  Returns the average power values of the rising edge.

  Note: in case of IEEE 802.11b measurements, the parameter returns the average power values of the rising or falling edge, depending on which result display you have selected.

- TRACE3

  Returns the maximum power values of the rising edge.

  Note: in case of IEEE 802.11b measurements, the parameter returns the maximum power values of the rising or falling edge, depending on which result display you have selected.

- TRACE4

  Returns the minimum power values of the falling edge.

- TRACE5

  Returns the average power values of the falling edge.

- TRACE6

  Returns the maximum power values of the falling edge.

5.14.1.10 Signal Field

IEEE 802.11a, j & n

Data will be returned as an array of hexidecimal values, with each hexidecimal value representing the 24 bit long signal field for a single PPDU.

IEEE 802.11b

Data will be returned as an array of hexidecimal values, with each hexidecimal value representing the 48 bit long signal field for a single PPDU.

5.14.1.11 Spectrum Flatness

For the Spectrum Flatness result display, the command returns one value for each subcarrier that has been analyzed.

`<Level[carrier1]>,<Level[carrier2]>,…`

The unit is dB.

The number of analyzed subcarriers depends on the selected IEEE standard.

The following parameters are supported.

- TRACE1 (IEEE 802.11n, ac)
- TRACE3 (IEEE 802.11a, g (OFDM), j and Turbo Mode)

  Returns the averaged power value of each subcarrier (for example 53 average values in case of an IEEE 802.11a signal).

- TRACE1 (IEEE 802.11a, g (OFDM), j and Turbo Mode)
- TRACE2 (IEEE 802.11n, ac)

  Returns a repeating list of power values for each subcarrier. The number of repeating lists corresponds to the number of fully analyzed PPDUs as displayed in the capture buffer.

  Example: if two IEEE 802.11a PPDUs have been analyzed, the command would return two series of 53 values (one for each subcarrier) each.

5.14.1.12 Spectrum FFT

For the Spectrum FFT result display, the command returns one value for each FFT point.

`<absolute power>, …`

The unit is dBm.

The number of values depends on the number of samples (2000 samples correspond to 32768 FFT points, for example).

The following parameters are supported.

- TRACE1

  Returns the FFT values for the captured data.

5.14.1.13 Spectrum Mask

For the Spectrum Mask result display the command returns one value for each pixel of the trace.

`<absolute power>, …`

The unit is dBm.

The number of values is always 625.

The following parameters are supported.

- TRACE1

  Returns the clear / write values.

- TRACE2

  Returns the maxhold values.

- LIST

  Returns the contents of the numeric results table.

  - 1st Value - Number of the table row (1 to 50)
  - 2nd Value - Start frequency band (in Hz)
  - 3rd Value - Stop frequency band (in Hz)
  - 4th Value - RBW (in Hz)
  - 5th Value - Limit fail frequency (in Hz)
  - 6th Value - Power absolute (in dBm)
  - 7th Value - Power relative (in dBc)
  - 8th Value - Limit distance (in dB)
  - 9th Value - Failure flag (1 = FAIL, 0 = PASS)

5.14.1.14 Spectrum ACPR

For the Spectrum Mask result display the command returns one value for each pixel of the trace.

`<absolute power>, …`

The unit is dBm.

The number of values is always 625.

The following parameters are supported.

- TRACE1

  Returns the ACP trace data.

TRACE[:DATA] <Result>

This command returns the trace data for the current measurement or result display.

For more information see "Using the TRACe:DATA Command" on page 273.

Parameter

<Result>

TRACE1 | … | TRACE 6
LIST

Example

`TRAC? TRACE2`

Returns the trace data.

Characteristics

*RST value: -
SCPI: conform

5.14.2 TRACe:IQ Subsystem

List of commands

TRACe:IQ:DATA:MEMory? <Offset>,<Samples>

This command queries the I/Q data currently in the capture buffer.

Parameter

<Offset>
Offset of the values to be read out related to the start of the capture buffer.

Range: 0 to <# of samples> - 1

<Samples>
Number of measurement values to be read out.

Range: 1 to <# of samples> - <offset samples>

Return value

Comma-separated list of the measured voltages in floating point format.

The results are linearily scaled in Volt, and correspond to the voltage at the RF input. The number of values is 2 * the number of samples with the first half representing the I values and the second half representing the Q values.

Example

```
TRAC:IQ:DATA:MEM? 0,2000
```

Requests the first 2000 samples.

Characteristics

*RST value: -
SCPI: device-specific.

TRACe:IQ:SRATe <SampleRate>

This command defines the sample rate for I/Q measurements.

Parameter

<SampleRate>

Example

```
TRAC:IQ:SRAT 20000
```

Defines a sample rate of 20 MHz.

Characteristics

*RST value: 20 MHz
SCPI: device-specific

TRACE:IQ:FILTer:FLATness <Filter>

This command turns the bypass of the bandwidth extension R&S FSQ-B72 on and off if you are using a wideband filter.

The signal instead passes through the normal signal path. For more information see High Dynamic.

Parameter

<Filter>
NORMal | WIDE

Example

`TRACE:IQ:FILT:FLAT WIDE`

Selects the wideband detector filter.

Characteristics

*RST value: NORMal
SCPI: device-specific

5.15 TRIGger Subsystem

List of commands

TRIGger[:SEQuence]:MODE <TriggerSource>

This command selects the trigger source.

Parameter

<TriggerSource>

IMMediate	Free run measurements (the measurement is triggered automatically at the end of the previous measurement)
EXTernal	The trigger event is provided by an external trigger source.
POWer	The trigger event is provided by a signal with a particular power level.

Example

```
TRIG:SEQ:MODE IMM
```

Selects Free Run mode.

Characteristics

*RST value: IMMediate
SCPI: device-specific

TRIGger[:SEQuence]:LEVel[:EXTernal] <Level>

This command defines the level of the external trigger source.

Parameter

<Level>
Signal level in Volt.

Example

```
TRIG:LEV 1V
```

Defines an external trigger level of 1 V.

Characteristics

*RST value: 1.4 V
SCPI: device-specific

TRIGger[:SEQuence]:LEVel:POWer <Level>

This command defines the level of the power trigger source.

Parameter

<Level>
Signal level in dBm (RF input) or Volt (baseband input).

Example

```
TRIG:SEQ:LEV:POW 10 DBM
```

Defines atrigger level of 10 dBm for RF measurement.

Characteristics

*RST value: 0
SCPI: device-specific

TRIGger[:SEQuence]:LEVel:POWer:AUTO <State>

This command turns automatic determination of the power trigger level on and off.

Available for the Power trigger source.

Parameter

<State>
ON | OFF

Example

```
TRIG:SEQ:LEV:POW:AUTO 1
```

Turns on automatic determination of the power trigger level.

Characteristics

*RST value: 0
SCPI: device-specific

TRIGger[:SEQuence]:HOLDoff <Delay>

This command defines the length of the trigger delay. A negative delay time corresponds to a pretrigger.

Parameter

<Delay>
Trigger delay time in seconds.

Example

```
TRIG:SEQ:HOLD 500us
```

Defines a trigger delay of 500 µs.

Characteristics

*RST value: -10µs
SCPI: conform

TRIGger[:SEQuence]:IFPower:HOLDoff <Holdoff>

This command defines the time that must pass before the next trigger event is recognized.

Available for the IF Power trigger.

Parameter

<Holdoff>
Trigger holdoff time in seconds.

Example

```
TRIG:SOUR IFP
TRIG:IFP:HOLD 100ns
```

Selects the IF Power trigger and defines a trigger holdoff of 100 ns.

Characteristics

*RST value: 150 ns
SCPI: conform

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis.

Available for the IF Power trigger.

Parameter

<Hysteresis>
Trigger hysteresis in dB.

Example

```
TRIG:SOUR IFP
TRIG:IFP:HYST 5
```

Selects the IF Power trigger and defines a trigger hysteresis of 5 dB.

Characteristics

*RST value: 3 dB
SCPI: conform

5.16 UNIT Subsystem

List of commands

UNIT:EVM <Unit>

This command selects the unit for EVM results.

Parameter

<Unit>

DB	EVM results returned in dB
PCT	EVM results returned in %

Example

```
UNIT:EVM PCT
```

Selects % as the unit for EVM results.

Characteristics

*RST value: DB
SCPI: device-specific

UNIT:GIMBalance <Unit>

This command selects the unit for the gain imbalance.

Parameter

<Unit>

DB	Gain imbalance is returned in dB
PCT	Gain imbalance is returned in %

Example

```
UNIT:GIMB PCT
```

Selects % as the unit for the gain imbalance.

Characteristics

*RST value: DB
SCPI: device-specific

UNIT:PREamble <Unit>

This command selects the unit for preamble error results.

Parameter

<Unit>

HZ	Preamble error is returned in Hz
PCT	Preamble error is returned in %

Example

`UNIT:PRE PCT`

Selects % as the unit for preamble results.

Characteristics

*RST value: HZ
SCPI: device-specific

5.17 Status reporting registers

The status reporting system (see Fig. 34) stores all information about the present operating state of the instrument, e.g. that the instrument is presently carrying out a calibration, and about errors that have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via the IEC bus.

The information has a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR), which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE), and registers STATus:OPERation and STATus:QUEStionable, which are defined by SCPI and contain detailed information about the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills the same function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in Fig. 4-1.

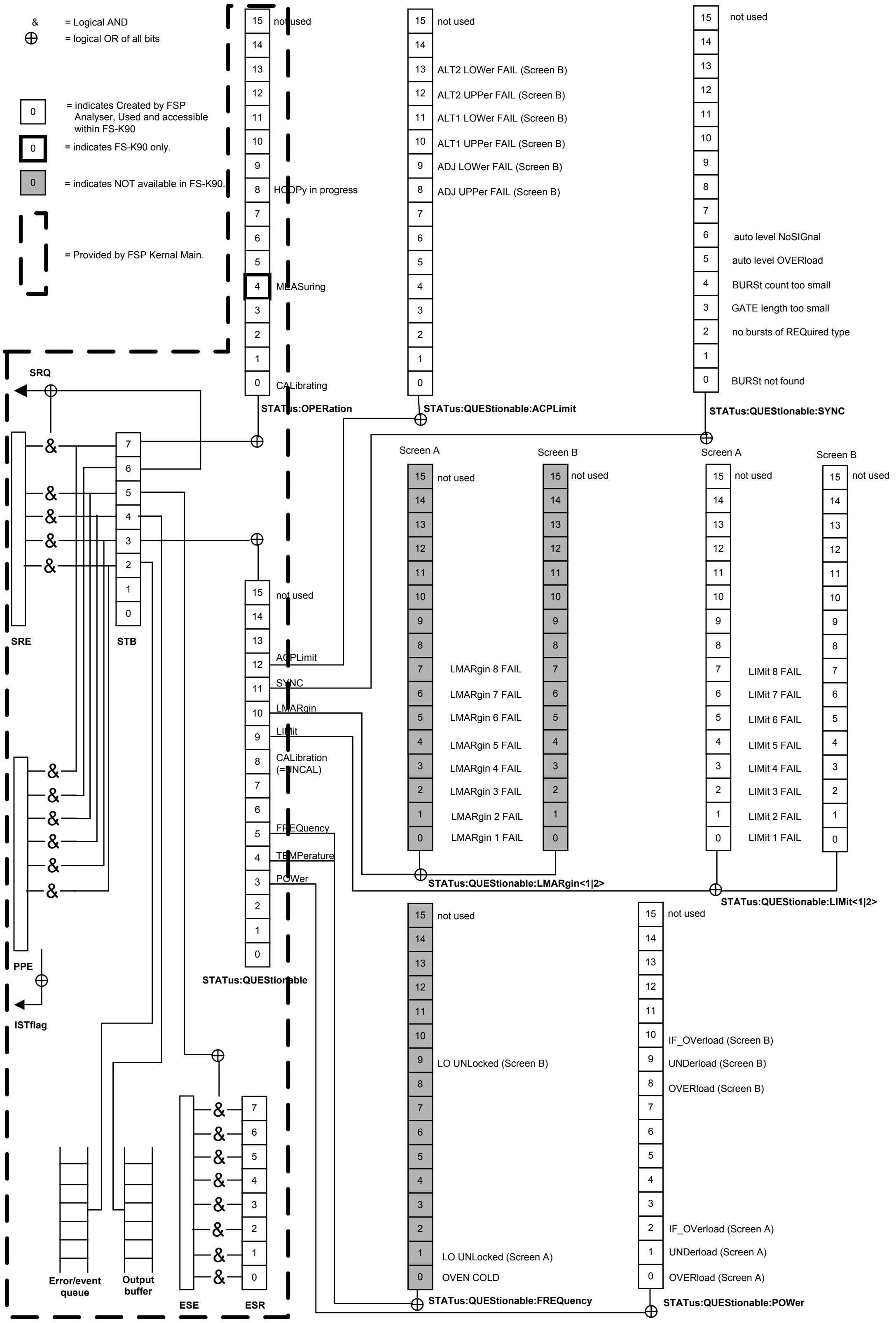


Fig. 34 Overview of the status registers

5.17.1 Description of the Status Registers

All the status registers shown in Fig. 34 are the same as those provided by the base system, with the exception of the following:

STATus:OPERation

Although this register is provided by R&S FSP Kernel main, the WLAN application makes use of bits 4 & 7 in this register which are not used within R&S FSP Kernel main.

STATus:QUEStionable:ACPLimit

This register is provided by the analyzer and is not available from the WLAN application command tree.

STATus:QUEStionable:LIMit2

This register is provided by the analyzer and is not available from the WLAN application command tree.

STATus:QUEStionable:LMARgin<1|2>

These registers are provided by the analyzer and are not available from the WLAN application command tree.

STATus:QUESTionable:FREQuency

This register is provided by the analyzer and is not available from the WLAN application command tree

The deviations from the status register structure of the base system are detailed below.

5.17.1.1 STATus:OPERation Register

In the CONDition part, this register contains information about which actions the instrument is executing or, in the EVENt part, information about which actions the instrument has executed since the last reading. It can be read using commands "`STATus:OPERation:CONDition?`" or "`STATus:OPERation[:EVENt]?`".

Bit No	Meaning
0	CALibrating This bit is set as long as the instrument is performing a calibration.
1 to 3	These bits are not used
4	MEASuring A '1' in this bit position indicates that a measurement is in progress. R&S FSQ-K91 only
5 to 7	These bits are not used
8	HardCOPy in progress This bit is set while the instrument is printing a hardcopy.
9 to 14	These bits are not used
15	This bit is always 0

5.17.1.2 STATus:QUEStionable Register

This register contains information about indefinite states that may occur if the unit is operated without meeting the specifications. It can be queried by commands "`STATus:QUEStionable:CONDition?`" and "`STATus:QUEStionable[:EVENt]?`".

Bit No	Meaning
0 to 2	These bits are not used
3	POWer This bit is set if a questionable power occurs (cf. also section "STATus:QUEStionable:POWer Register").
4	TEMPerature This bit is set if a questionable temperature occurs.
5	FREQuency The bit is set if a frequency is questionable (cf. section "STATus:QUEStionable:FREQuency Register").
6 to 7	These bits are not used
8	CALibration The bit is set if a measurement is performed uncalibrated (corresponds to label "UNCAL")
9	**LIMit** (device-specific) This bit is set if a limit value is violated (see also section STATus:QUEStionable:LIMit Register). Note: Limit register is associated with limit lines for the Spectrum Mask measurement only.
10	**LMARgin** (device-specific) This bit is set if a margin is violated (see also section STATus:QUEStionable:LMARgin Register)
11	**SYNC** (device-dependent) This bit is set if, in measurements or pre-measurements in WLAN mode, synchronization fails, no signal is detected or no PPDU is found. This bit is also set if input settings conflict with the measurement setup (see also "STATus:QUEStionable:SYNC Register").
12	**ACPLimit** This bit is set if a limit for the adjacent channel power measurement is violated (see also section "STATus:QUEStionable:ACPLimit Register").
13 to 14	These bits are not used
15	This bit is always 0

5.17.1.3 STATus:QUEStionable:LIMit Register

This register contains information about the observance of limit lines in the corresponding measurement window (LIMit 1 corresponds to Screen A, LIMit 2 to Screen B). It can be queried with commands "`STATus:QUEStionable:LIMit<1|2>: CONDition?`" and "`STATus:QUEStionable:LIMit<1|2>[:EVENt]?`".

Note that no limit lines are displayed in screen A. Thus, all bits in the LIMit1 register will always be set to 0.

Bit No	Meaning
0 to 1	These bits are not used
2	LIMit FAIL This bit is set if the ETSI Spectrum Mask limit line is violated
3	LIMit FAIL This bit is set if the Spectrum Flatness (Upper) limit line is violated
4	LIMit FAIL This bit is set if the Spectrum Flatness (Lower) limit line is violated
5	LIMit FAIL This bit is set if the IEEE Spectrum Mask limit line is violated.
6	LIMit FAIL This bit is set if the PVT Rising Edge max limit is violated.
7	LIMit FAIL This bit is set if the PVT Rising Edge mean limit is violated.
8	LIMit FAIL This bit is set if the PVT Falling Edge max limit is violated.
9	LIMit FAIL This bit is set if the PVT Falling Edge mean limit is violated.
10-14	These bits are not used
15	This bit is always 0

5.17.1.4 STATus QUEStionable:ACPLimit Register

This register contains information about the observance of limits during adjacent power measurements. It can be queried with commands "`STATus:QUEStionable:ACPLimit:CONDition?`" and "`STATus:QUEStionable:ACPLimit[:EVENt]?`".

Bit No	Meaning
0 to 7	These bits are not used
8	**ADJ UPPer FAIL (Screen B)** This bit is set if the limit is exceeded in the upper adjacent channel in screen B.
9	**ADJ LOWer FAIL (Screen B)** This bit is set if the limit is exceeded in the lower adjacent channel in screen B.
10	**ALT1 UPPer FAIL (Screen B)** This bit is set if the limit is exceeded in the upper 1st alternate channel in screen B.
11	**ALT1 LOWer FAIL (Screen B)** This bit is set if the limit is exceeded in the lower 1st alternate channel in screen B.
12	**ALT2 UPPer FAIL (Screen B)** This bit is set if the limit is exceeded in the upper 2nd alternate channel in screen B.
13	**ALT2 LOWer FAIL (Screen B)** This bit is set if the limit is exceeded in the lower 2nd alternate channel in screen B.
13-14	These bits are not used
15	This bit is always 0

5.17.1.5 STATus:QUEStionable:SYNC Register

This register contains information about sync and PPDUs that are not found, and about pre-measurement results exceeding or falling short of expected values.

The bits can be queried with commands "`STATus:QUEStionable:SYNC:CONDition?`" and "`STATus:QUEStionable:SYNC[:EVENt]?`".

Bit No	Meaning
0	BURSt not found This bit is set if an IQ measurement is performed and no PPDUs are detected
1	This bit is not used
2	no PPDUs of REQuired type This bit is set if an IQ measurement is performed and no PPDUs of the specified type are detected
3	GATE length too small This bit is set if gating is used in a measurement and the gate length is not set sufficiently large enough
4	BURSt count too small This bit is set if a PVT measurement is performed with gating active and there is not at least 1 PPDU within the gate lines
5	auto level OVERload This bit is set if a signal overload is detected when an auto-level measurement is performed
6	auto level NoSIGnal This bit is set if no signal is detected by the auto-level measurement
7 to 14	These bits are not used
15	This bit is always 0

5.18 Error Reporting

Error reporting for the WLAN application is carried out using the Service Request (SRQ) interrupt in the GPIB interface. When an error occurs, a Service Request interrupt will be generated. The master can then query the slave instrument for the error that triggered the interrupt. Errors are queried through the "SYSTem:ERRor" command.

5.19 Softkeys with assignment of IEC/IEEE bus commands

5.19.1 Key MEAS or Hotkey WLAN

GENERAL SETTINGS	:CONFigure:STANdard
	:[SENSe:]FREQuency:CENTer
	:CONFigure:CHANnel
	:CONFigure:POWer:AUTO
	:DISPlay[:WINDow<1|2>]:TRACe<1…3>:Y[:SCALe]:RLEVel:OFFSet
	:CONFigure:POWer:EXPected:RF
	:CONFigure:POWer:EXPected:IQ
	:[SENSe:]SWEep:TIME
	:[SENSe:]SWEep:COUNt
	:[SENSe:]BURSt:COUNt:STATe
	:[SENSe:]BURSt:COUNt
	:TRIGger[:SEQuence]:MODE
	:TRIGger[:SEQuence]:HOLDoff
	:TRIGger[:SEQuence]:LEVel:POWer
	:TRIGger[:SEQuence]:LEVel:POWer:AUTO
	:[SENSe:]SWAPiq
	:INPut:SELect
	:INPut:IQ:IMPedance
	:INPut:IQ:BALanced[:STATe]
	:[SENSe:]IQ:LPASs[:STATe]
	:[SENSe:]IQ:DITHer[:STATe]
DEMOD SETTINGS	:[SENSe:]DEMod:FORMat:SIGSymbol
	:[SENSe:]DEMod:FORMat:BANalyze:BTYPe
	:[SENSe:]DEMod:FORMat:AUTo
	:[SENSe:]DEMod:FORMat:BANalyze
	:[SENSe:]DEMod:BANalyze:SYMbols:EQUal
	:[SENSe:]DEMod:BANalyze:SYMbols:MIN
	:[SENSe:]DEMod:BANalyze:SYMbols:MAX
	:[SENSe:]DEMod:CESTimation
	:[SENSe:]TRACKing:PHASe
	:[SENSe:]TRACKing:TIME
	:[SENSe:]TRACKing:LEVel

DISPLAY LIST GRAPH	:DISPlay[:WINDow<1|2>]:TABLe Result query: :FETCh:BURSt:ALL? :FETCh:BURSt:PREamble? :FETCh:BURSt:PAYLoad? :FETCh:BURSt:RMS? :FETCh:BURSt:PEAK? :FETCh:BURSt:CRESt? :FETCh:BURSt:FERRor? :FETCh:BURSt:SYMBolerror? :FETCh:BURSt:IQOFfset? :FETCh:BURSt:GIMBalance? :FETCh:BURSt:QUADoffset? :FETCh:BURSt:EVM:ALL? :FETCh:BURSt:EVM:DATA? :FETCh:BURSt:EVM:PILot?
PVT	:CONFigure:BURSt:PVT[:IMMediate]
FULL BURST	:CONFigure:BURSt:PVT:SELect FULL
UP RAMP ON OFF	:CONFigure:BURSt:PVT:SELect RISE (query only - 802.11b)
RISING FALLING	:CONFigure:BURSt:PVT:SELect EDGE
DOWN RAMP ON OFF	:CONFigure:BURSt:PVT:SELect FALL (query only - 802.11b)
REF MEAS MAX MIN	:CONFigure:BURSt:PVT:RPOWer MAX | MEAN
AVERAGE LENGTH	:CONFigure:BURSt:PVT:AVERage
GATING ON OFF	:[SENSe:]SWEep:EGATe
GATE SETTINGS	:[SENSe:]SWEep:EGATe:HOLDoff[:TIMe] :[SENSe:]SWEep:EGATe:HOLDoff:SAMPle :[SENSe:]SWEep:EGATe:LENGth[:TIMe] :[SENSe:]SWEep:EGATe:LENGth:SAMPle :[SENSe:]SWEep:EGATe:LINK
EVM	

Softkey	IEC/IEEE bus command
EVM VS SYMBOL	`:CONFigure:BURSt:EVM:ESYMbol[:IMMediate]`
EVM VS CARRIER	`:CONFigure:BURSt:EVM:ECARrier[:IMMediate]`
Y AXIS DIV	`:DISPlay[:WINDow<1|2>]:TACe1:Y[:SCALe]:AUTO` `:DISPlay[:WINDow<1|2>]:TRACe1:Y[:SCALe]:PDIVision`
SPECTRUM	`:[SENSe:]POWer:ACHannel:MODE REL|ABS`
SPECTRUM FLATNESS	`:CONFigure:BURSt:SPECtrum:FLATness[:IMMediate]`
SPECTRUM ETSI	`:CONFigure:BURSt:SPECtrum:MASK:SELect IEEE | ETSI`
SPECTRUM MASK	`:CONFigure:BURSt:SPECtrum:MASK[:IMMediate]` `(query only 802.11b)`
SPECTRUM FFT	`:CONFigure:BURSt:SPECtrum:FFT[:IMMediate]`

SPECTRUM ACPR	`:CONFigure:BURSt:SPECtrum:ACPR[:IMMediate]`
	`Results:`
	`:CALCulate<1|2>:MARKer<1>:FUNCtion:POWer:RESult[:CURRent]?`
	`:CALCulate<1|2>:MARKer<1>:FUNCtion:POWer:RESult:MAXHold?`

ACP REL ABS	`:[SENSe:]POWer:ACHannel:MODE REL | ABS`
CONSTELL	
CONSTELL	`:CONFigure:BURSt:CONStellation:CSYMbol[:IMMediate]`
CONSTELL VS CARRIER	`:CONFigure:BURSt:CONStellation:CCARrier[:IMMediate]`
CARRIER SELECTION	`:CONFigure:BURSt:CONStellation:CARRier:SELect`
STATISTICS	
CCDF	
BIT STREAM	
SIGNAL FIELD	
PCLP HEADER	

5.19.2 Key DISP

FULL SCREEN	`:DISPlay:FORMat SINGle`
SPLIT SCREEN	`:DISPlay:FORMat SPLit`

5.19.3 Key MKR

MARKER 1	`:CALCulate<1|2>:MARKer<1>:STATe`
	`:CALCulate<1|2>:MARKer<1>:X`
	`:CALCulate<1|2>:MARKer<1>:Y`
	`:CALCulate<1|2>:MARKer<1>:SYMBol`
	`:CALCulate<1|2>:MARKer<1>:CARRier`

UNZOOM	`:CALCulate<1|2>:MARKer<1>:FUNCtion:ZOOM 1`
MARKER ZOOM	`:CALCulate<1|2>:MARKer<1>:FUNCtion:ZOOM <numeric value>`
MARKER OFF	`:CALCulate<1|2>:MARKer<1>:AOFF`

5.19.4 Key MKR->

SELECT MARKER	---
MKR -> TRACE	`:CALCulate<1|2>:MARKer<1>:TRACe`

5.19.5 Key LINES

```
:CALCulate<1|2>:LIMit<1>:BURSt:ALL
:CALCulate<1|2>:LIMit<1>:BURSt:ALL:RESULT
:CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage]
:CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage]:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum
:CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset[:AVERage]
:CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset[:AVERage]:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset:MAXimum
:CALCulate<1|2>:LIMit<1>:BURSt:IQOFfset:MAXimum:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERage]
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERage]:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL:MAXimum
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL:MAXimum:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA[:AVERage]
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA[:AVERage]:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA:MAXimum
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA:MAXimum:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage]
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage]:RESult
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum
:CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum:RESult
```

5.19.6 Hotkeys

SPECTRUM

```
:INSTrument:SELect SANalyzer
:INSTrument:NSELect 1
```

WLAN

AUTO LVL

```
:CONFigure:POWer:AUTO ONCE
```

RUN SGL

```
:INITiate:CONTinuous OFF; INITiate[:IMMediate]
```

RUN CONT

```
:INITiate:CONTinuous ON; INITiate[:IMMediate]
```

REFRESH

SCREEN A / B

```
:DISPlay[:WINDow<1|2>]:SELect
:DISPlay[:WINDow<1|2>]:SSELect
```

6 Remote Control - Programming Examples

The following section provides some examples of commonly performed operations whe using the WLAN application. For more general remote control examples, refer to the programming examples chapter in the instrument user manual.

6.1 Synchronization of Entry of Option

The following example shows how to synchronize the entry of the WLAN application.

```
analyzer% = 20,Instrument address
CALL IBWRT(analyzer%, "INST:SEL WLAN;*OPC?")
'waits for 1 from *OPC?
```

6.2 Selecting Measurements

Measurements are selected using the command CONFigure:BURSt:<Meas Type> where <Meas Type> is as follows

<Meas Type>	Measurement Type
PVT	Power vs Time (PVT)
PVT:SELect:EDGE	PVT rising and falling edge
PVT:SELect:FULL	PVT full PPDU (802.11a, j & n only)
PVT:SELect:RISE	PVT rising PPDU (802.11b only)
PVT:SELect:FALL	PVT falling PPDU (802.11b only)
EVM:ECARrier	EVM vs Carrier
EVM:ESYMbol	EVM vs Symbol
SPECtrum:MASK	Spectrum Mask
SPECtrum:MASK:SELect:IEEE	Spectrum Mask IEEE
SPECtrum:MASK:SELect:ETSI	Spectrum Mask ETSI
SPECtrum:FLATness	Spectrum Flatness
SPECtrum:FFT	Spectrum FFT
SPECtrum:ACPR	Spectrum ACPR
CONstellation:CCARrier	Constellation vs Carrier
CONstellation:CSYMbol	Constellation vs Symbol
STATistics:CCDF	CCDF
STATistics:BSTReam	Bit Steam
STATistics:SFIeld	Signal Field

The following example shows how to select a Spectrum Mark ETSI measurement:

```
REM select Spectrum Mask Select ETSI
CALL IBWRT(analyzer%, "SPECtrum:MASK:SELect:ETSI")
```

6.3 Running Synchronized Measurements

The following examples show how measurements can be synchronized. Synchronization is necessary to ensure that the measurement has been completed before the measurement results and markers are requested.

```
PUBLIC SUB SweepSync()
REM The command INITiate[:IMMediate] starts a single sweep if
REM the command INIT:CONT OFF was previously sent. It should be
REM ensured that the next command is executed only when the
REM entire sweep is complete.
CALL IBWRT(analyzer%, "INIT:CONT OFF")
REM ------ First possibility: Use of *WAI ---------------------
CALL IBWRT(analyzer%, "INIT:IMM; *WAI")
REM ------ Second possibility: Use of *OPC? --------------------
OpcOk$ = SPACE$(2) 'Space for *OPC? - Provide response
CALL IBWRT(analyzer%, "INIT:IMM; *OPC?")
REM ------ Here the controller can service other instrument----
CALL IBRD(analyzer%, OpcOk$) 'Wait for "1" from *OPC?
REM ------- Third possibility: Use of *OPC --------------------
REM To be able to use the service request function in
REM conjunction with a National Instruments GPIB driver, the
REM setting "Disable Auto Serial Poll" must be changed to "yes"
REM by means of IBCONF!
//Permit service request for ESR
CALL IBWRT(analyzer%, "*SRE 32")
//Set event-enable bit for operation-complete bit
CALL IBWRT(analyzer%, "*ESE 1")
//Start sweep and synchronize with OPC
CALL IBWRT(analyzer%, "INIT:IMM; *OPC")
//Wait for service request
CALL WaitSRQ(boardID%,result%)
REM ------- Fourth possibility: Use of INIT:IMM --------------
REM To be able to use the service request function in
REM conjunction with a National Instruments GPIB driver, the
REM setting "Disable Auto Serial Poll" must be changed to "yes"
REM by means of IBCONF!
//Permit service request for ESR
CALL IBWRT(analyzer%, "*SRE 128")
//Set event-enable bit for operation-complete bit
CALL IBWRT(analyzer%, "*ESE 0")
//Enable bit 4 of status'operation 'register
CALL IBWRT(analyzer%, "STATus:OPERation:ENABle 16")
//Set negative transition to 1
CALL IBWRT(analyzer%, "STAT:OPERation:NTRansition 16")
//Set positive transition to 0
CALL IBWRT(analyzer%, "STATus:OPERation:PTRansition 0")
//Start sweep and synchronize with OPC
CALL IBWRT(analyzer%, "INIT:IMM")
//Wait for service request
REM Continue main program here
CALL WaitSRQ(boardID%,result%)
END SUB
REM ********************************************************
```

7 Warnings & Error Messages

The list of possible warning & error messages are shown below:

Status Bar Message	**Description**
Gate length too small - must be greater than 1	This message is only displayed for the FFT measurement. This message indicates that there are no samples contained within the gating lines. Increase the Gate length and then press the *REFRESH* hotkey to remove this error.
No valid analyzed PPDUs within gating lines	This message is only displayed for the PVT measurement. This message indicates that there are no complete & valid PPDUs contained within the gating lines. Increase the Gate length and then press the *REFRESH* hotkey to remove this error.
No PPDUs found	This message is displayed if no valid PPDU was detected in the input data. To correct this problem, check the following: The connections between the DUT and analyzer are correct. The input signal is of a sufficient level. The capture time is long enough to capture at least one complete PPDU. If running with a Free Run trigger, the capture time must be greater than the PPDU length (ideally at least twice the PPDU length) to ensure that a complete PPDU is recorded. Check that the demod settings are correct.
No PPDUs of desired type to analyze	This message is displayed if PPDUs are found, but none of the desired type to analyse. Verify that the setting for Burst Type is correct.
No signal found	This message is displayed when an automatic level detection measurement is performed and the measured signal level is lower the permitted minimum value.
No power trigger for Spectrum Mask ETSI	This message is displayed when the Spectrum Mask ETSI measurement is selected whilst the trigger is set to power. No action is required as the trigger is automatically set to Free Run in this case.
Signal overload detected	This message is displayed when the OVLD enhancement label is displayed and indicates that the input mixer is overloaded. If this message is displayed, try increasing the setting for the Signal Level parameter (or settings Auto Level). If this does not clear the problem, an external attenuation may need to be applied.

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