



ROHDE & SCHWARZ

Test and Measurement
Division

Software Manual

WLAN 802.11A, B, G & J TX Tests

Application Firmware R&S FSQ-K90/91

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1 General Information

The Rohde & Schwarz FSQ-K90/91 application extends the functionality of the R&S FSQ spectrum analyzer to enable wireless LAN TX measurements in accordance with IEEE standards 802.11a (FSQ-K90) and IEEE 802.11 a b,g & j (FSQ-K91).

This manual describes how to use R&S FSQ-K90/91. It aids in the preparation, execution and evaluation of a measurement and provides many helpful hints and examples.

For quick instructions on using R&S FSQ-K90/91, refer to the Quick Start Guide section below. It provides step-by-step descriptions of a typical measurement. The remainder of this section describes all basic information about how the FSQ-K90/91 application works, without covering measurements in detail. A detailed description of all measurement modes, settings and results can be found in section 2. Section 4 covers remote control operation of R&S FSQ-K90/91.

This section covers the following topics:

Introduction to R&S FSQ-K91 & wireless LAN measurements

- Installation
- Starting the application
- Exiting the application
- Quick Start Guide – for quickly getting the application up-and-running
- Navigation
- Save/recall – saving & recalling user settings & measurement results
- Printing

Introduction to R&S FSQ-K90/91 & Wireless LAN Measurements

The use of an R&S FSQ spectrum analyzer with its high sensitivity enables the accurate and reproducible TX measurement of a wireless LAN device under test (DUT) in accordance with the standards specified for the device:

- Modulation formats:
 - IEEE 802.11a, j & g (OFDM)
 - BPSK
 - QPSK
 - 16QAM
 - 64QAM
 - IEEE 802.11b & g (single carrier mode)
 - DBPSK
 - DQPSK
 - CCK (5.5 Mbps & 11 Mbps)
 - PBCC (5.5 Mbps, 11 Mbps & 22 Mbps)
- 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 bursts
- Freq/Phase Err vs. Preamble

Installation

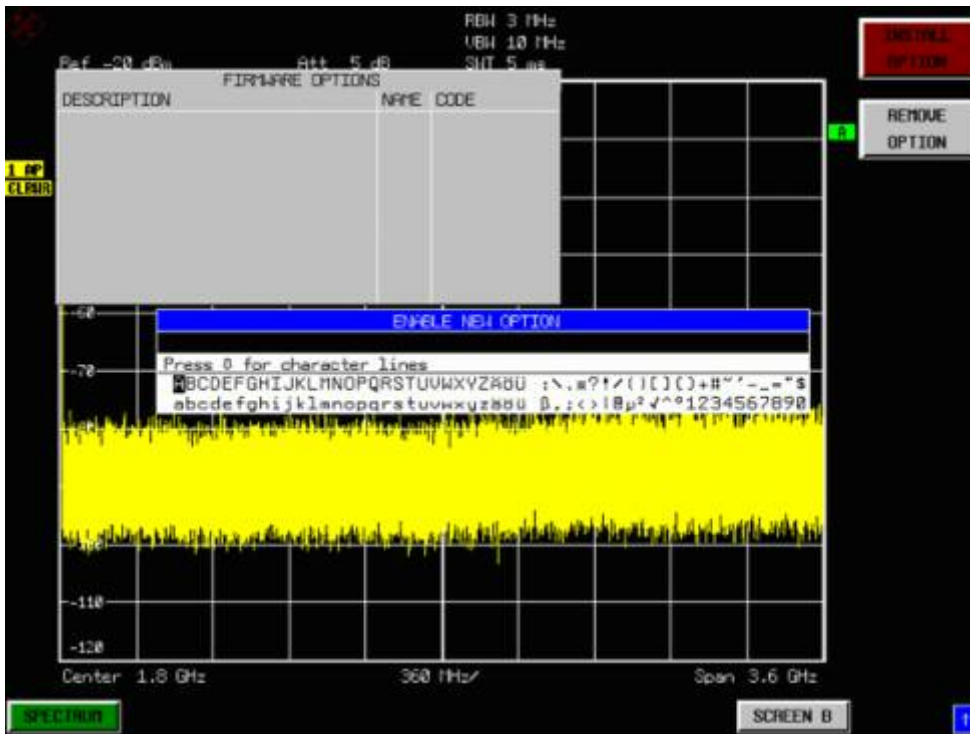
From the analyzer, select firmware update.

- Press the **SETUP** hardkey followed by **NEXT**, **FIRMWARE UPDATE** and finally the **FIRMWARE UPDATE** softkey. Follow the instructions displayed.

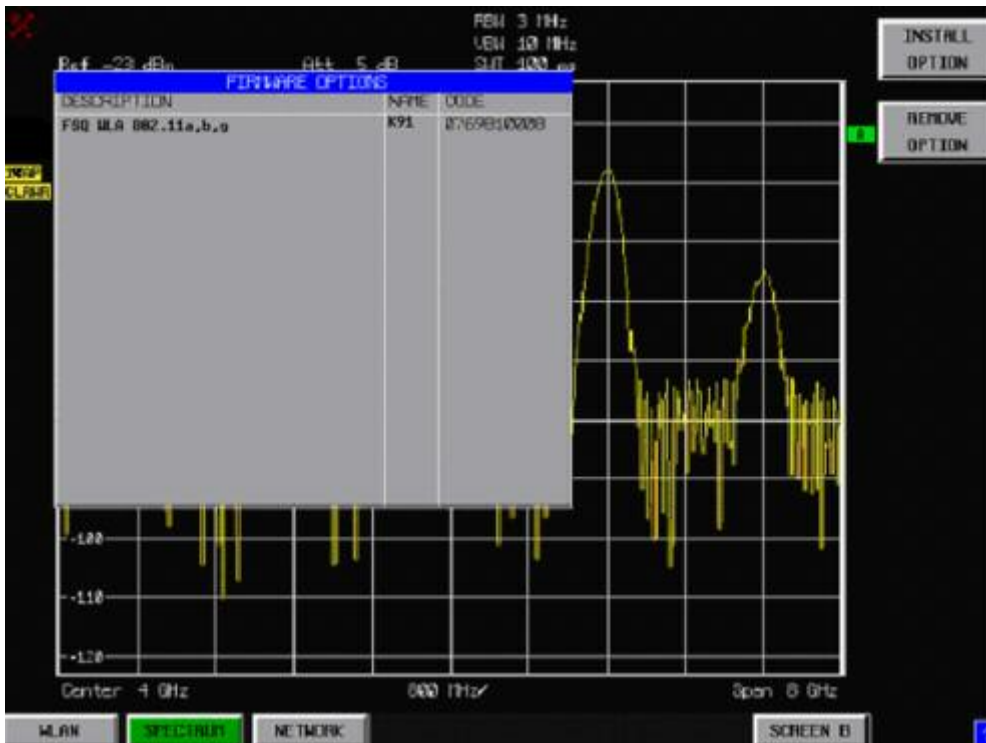
Once the installation has been completed, the analyzer will reboot.

Once the option has been installed, it needs to be activated:

- Start up the analyzer.
- Press the **SETUP** hardkey, followed by the **GENERAL SETUP** softkey and then the **OPTIONS** softkey. A list of the options currently activated is displayed.
- Press the **INSTALL OPTION** softkey. A dialog is displayed allowing the option key to be entered.



- Enter the option key supplied with the R&S FSQ-K90/91 software. If upgrading from FSQ-K90 to FSQ-K91, the upgrade key needs to be entered in addition to the original FSQ-K90 option key.
- When a valid option key has been supplied, a dialog will be displayed explaining that a reboot is required to complete this operation. Select OK in this dialog and the instrument will be rebooted.
- When the analyzer starts after the reboot, a new hotkey will be displayed at the bottom of the display labeled *WLAN*. In addition, an entry for the R&S FSQ-K90/91 option will be displayed in the *FIRMWARE OPTIONS* dialog.



Starting the application

Power up the R&S FSQ spectrum analyzer. When R&S FSQ-K90/91 is correctly installed, a hotkey labeled *WLAN* will appear at the bottom of the screen. Press the *WLAN* hotkey to start R&S FSQ-K90/91.

If only standard 802.11a is available please check the memory amount (SETUP/SYSTEM INFO/STATISTICS Memory Size).

System Memory Requirements

For FSQ-K90 Wireless LAN Application Firmware, an installed system memory of 512MByte is recommended. For FSQ-K91 Wireless LAN Application Firmware, an installed system memory of 512MByte is essential. The FSQ-K90/K1 will generate an error message during activation, if available system memory does not meet the requirements. This may happen for FS-K90, if FS-K30 or FSQ-K70 was active before starting WLAN.



For instruments, shipped with 256MByte system memory, a memory extension FSQ-B512, order number 1157.1590.02, is available.

A reboot of the instrument after using NOISE (FS-K30) or VSA (FSQ-K70), will allow FSQ-K90 to be activated without memory extension.

The system memory size can be easily checked by pressing SETUP – SYSTEM INFO – STATISTICS, item "Memory size". This item is available since version 3.25 of the base system firmware.

If the spectrum analyzer is powered down while R&S FSQ-K90/91 is active, the spectrum analyzer will start up in the R&S FSQ-K90/91 application when it is powered up again.

Exiting the application

To exit the R&S FSQ-K90/91 application, press the *SPECTRUM* hotkey at the bottom of the screen. This will cause the option to exit and the spectrum analyzer to be activated with the same settings as were set when the R&S FSQ-K90/91 option was activated.

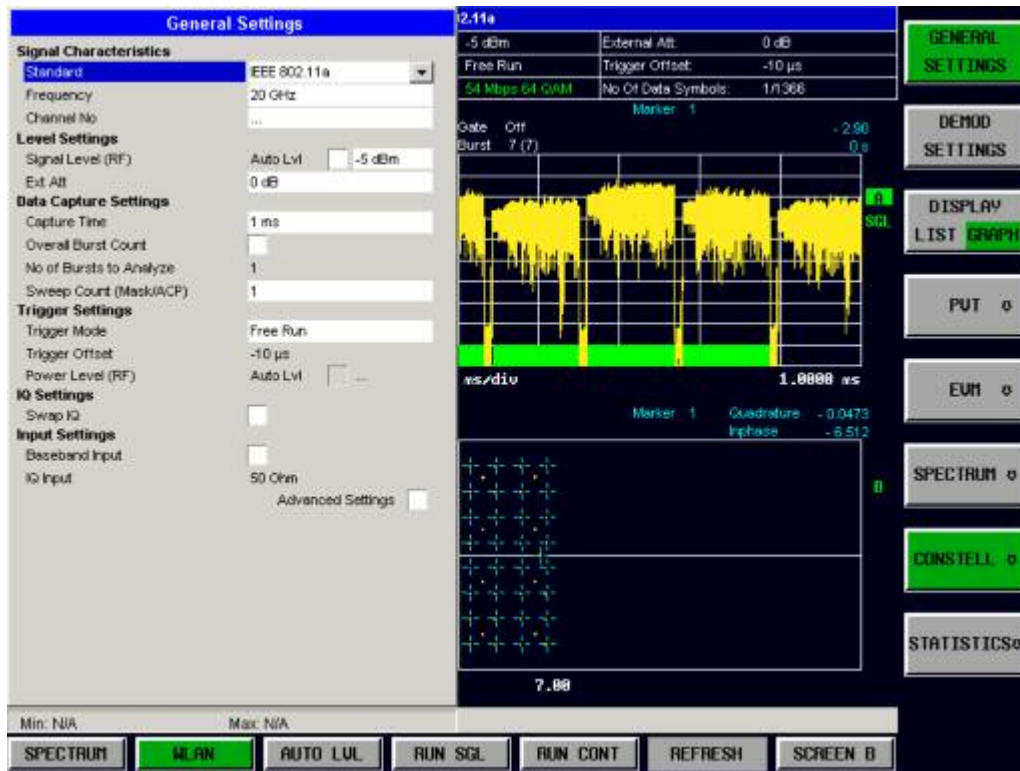
Quick Start Guide

This section helps the user to quickly become familiar with R&S FSQ-K90/91 by working step-by-step through an typical measurement. (Refer to section 2 for a detailed reference guide.)

This example will use a DUT based on IEEE 802.11a. The DUT will be connected to the analyzer using the RF input of the analyzer. The DUT will generate a signal modulated using 16QAM

Setting up the measurement

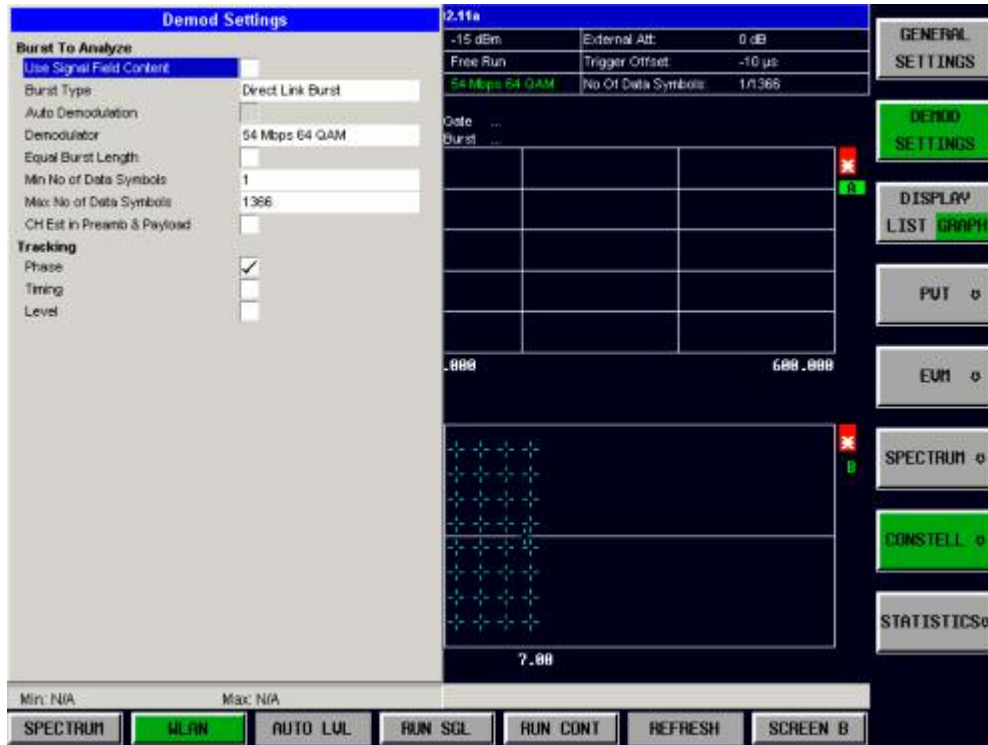
- Start the R&S FSQ-K91 application.
- Press the *GENERAL SETTINGS* softkey to open the General Settings view.



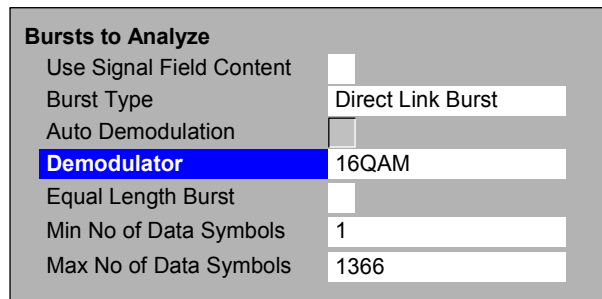
- Select the *Frequency* field and enter the desired frequency to measure. Note that the *Channel No* field updates when a valid frequency is entered.
- Switch off the *Auto Level* field. In this example, the level detection measurement will be executed manually.

All other settings in this view are sufficient for this example.

➤ Press the *DEMODO SETTINGS* softkey to open the Demod Settings view



➤ Enter the modulation scheme used in the *Demodulator* field.



Close the Demod Settings by pressing the *WLAN* hotkey.

Performing Level Detection

- Connect the DUT to the RF input of the spectrum analyzer (see Fig. 1-1).

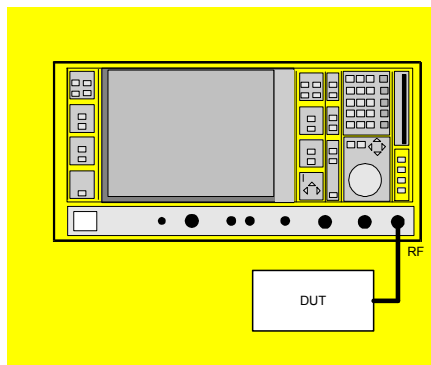


Fig. 1-1 Preparation for level detection

- Start the level detection measurement by pressing the *AUTO LVL* hotkey.
- During the level detection measurement, the text "*Running ...*" is displayed in the status bar at the bottom of the screen.
- After successful level detection, the status bar will display "*Measurement Complete*", the signal level field for the selected input will be updated to show the detected signal level and the magnitude capture buffer (screen A) will be updated to show the zero span trace obtained during the measurement sequence.
- Details, when using manual leveling schapter Automatic Level Detection

Performing the Main Measurement

After level detection has been successfully completed, the main measurement can be started. The setup for the main measurement is the same as that for the level detection measurement.

- Start the measurement by pressing the *RUN SGL* hotkey.
- 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 points by pressing the *DISPLAY* softkey

Navigation

This section deals with navigation within the option. Navigation here 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

Hotkeys

Hotkeys are allocated to the seven keys at the bottom edge of the screen. On initial startup of the K90/91 option, the hotkeys provided are shown in Fig. 1-2. These hotkeys are present at all times once the option has been started.

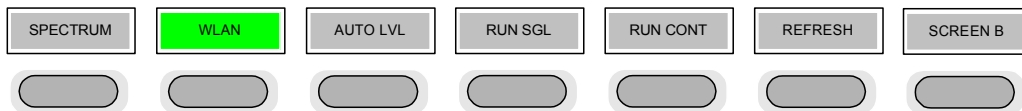
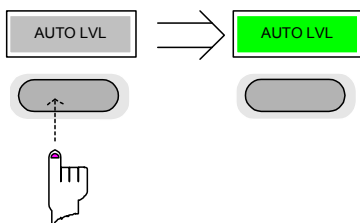


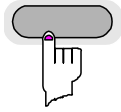
Fig. 1-2 Initial hotkey menu

A keystroke activates the associated hotkey. An activated hotkey changes color to green, as shown.



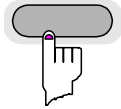
These hotkeys perform the following operations:

SPECTRUM



The *SPECTRUM* hotkey exits the R&S FSQ-K90/91 option and returns to the spectrum analyzer with all previous settings restored.

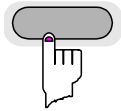
WLAN



The *WLAN* hotkey returns the user to the main measurement menu of R&S FSQ-K91, where measurement results can be seen. All settings, views and dialogs are removed from the display, and the default softkey menu is displayed

The *WLAN* hotkey remains green whenever R&S FSQ-K90/91 is active

AUTO LVL

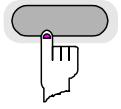


The *AUTO LVL* hotkey starts an automatic level detection measurement.

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

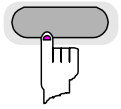


The *RUN SGL* hotkey starts the selected measurement in single sweep mode.

If another measurement is running, such as a continuous sweep measurement, the running measurement will be aborted before the single sweep measurement is started.

Pressing the *RUN SGL* hotkey while a single frequency range measurement is running causes the measurement to be stopped immediately.

RUN CONT

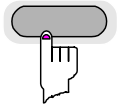


The *RUN CONT* hotkey starts the selected measurement in continuous sweep mode

If another measurement is running, the running measurement will be aborted before the continuous sweep measurement is started.

Pressing the *RUN CONT* hotkey while a continuous sweep measurement is running causes the measurement to be stopped immediately.

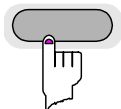
REFRESH



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

The *REFRESH* hotkey is only available for measurement results that are affected by the gate settings (spectrum FFT, PVT and CCDF). The *REFRESH* hotkey becomes available only when the gate settings are modified after a measurement result has been obtained.

SCREEN [A|B]



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

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

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

Softkeys

Softkey Settings

The softkeys are assigned to the nine keys on the right-hand side of the display. These enable quick access to all parameter settings and measurement screens of the K90/91 option. When each of the top two softkeys is pressed, it brings up a settings view for a group of parameters. These softkeys are always available (except when using Save/Recall and Print manager or controlling markers) and are as follows:

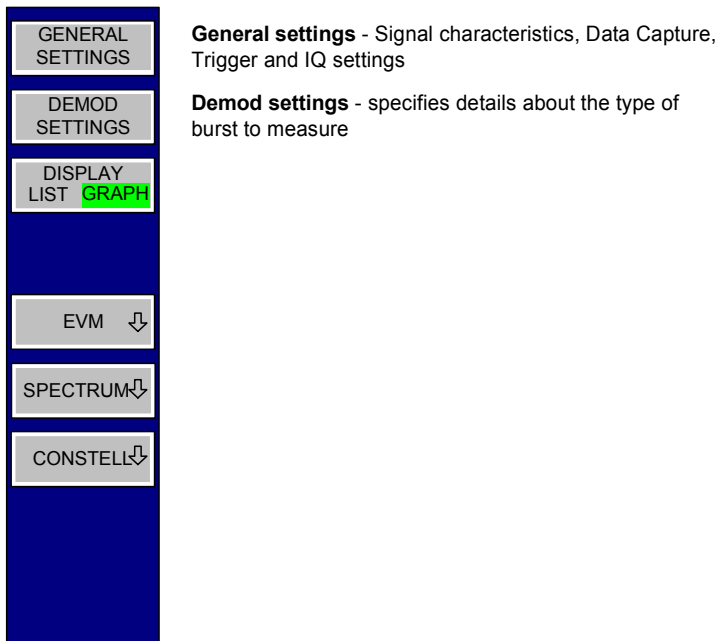


Fig. 1-3 Main softkeys

Each of these groups of settings is described in detail in the Measurements & Settings section of this manual.

Other Softkeys

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

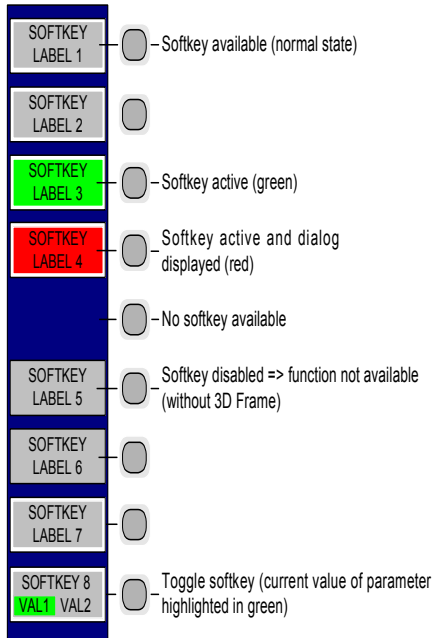


Fig. 1-4 Setup of the softkey area

A softkey in its normal state, i.e. its function is available, is coloured grey with a 3D border.

A softkey that is disabled, i.e. its function is not available, is coloured grey without a 3D border. Softkeys may become disabled because of the state of the instrument or because other settings disable the function associated with the softkey.

An active softkey (highlighted in green) is used when the softkey selects an item or view. For example, the *GATE SETTINGS* softkey will be highlighted green when the Gate Settings pop-up dialog is displayed.

A toggle softkey is used to change the value of a parameter that has only two states. Each press of the softkey toggles the value of the parameter. The current parameter value is highlighted in green in the lower half of the softkey label. For example, in the measurement results view, the *DISPLAY* softkey will have either *LIST* or *GRAPH* highlighted in green depending on whether the results are currently displayed as a list of measurement points or graphical trace(s).

When no function is assigned to a softkey, no softkey label will be shown.

Hardkeys

Hardkeys allow quick access to the desired parameter and various functions. The hardkeys supported by the K90/91 option are as follows (other hardkeys have no function):

FREQ Hardkey	When the <i>FREQ</i> hardkey is pressed, the General Settings view is displayed (if it is not already being displayed) and the <i>Frequency</i> parameter is selected.
AMPT Hardkey	When the AMPT hardkey is pressed, the General Settings view is displayed (if it is not already being displayed) and the relevant <i>Signal Level</i> parameter for the selected signal input is selected.
MKR Hardkey	When the MKR hardkey is pressed, the main Marker softkey menu is displayed (if it is not already being displayed).
MKR-> Hardkey	When the MKR-> hardkey is pressed, the Marker extension softkey menu is displayed (if it is not already being displayed).
SWEEP Hardkey	When the SWEEP hardkey is pressed, the General Settings view is displayed (if it is not already being displayed) and the <i>Capture Time</i> parameter is selected.
MEAS Hardkey	When the MEAS hardkey is pressed, the Main softkey menu is displayed (if it is not already being displayed).
TRACE Hardkey	When the TRACE hardkey is pressed, the General Settings view is displayed (if it is not already being displayed) and the <i>Burst Count</i> parameter is selected.
LINES Hardkey	When the LINES hardkey is pressed, the Limit Lines softkey menu is displayed (if it is not already being displayed) and the first limit in the results summary is selected. Note: This hardkey only functions when the results summary is displayed.
DISP Hardkey	When the DISP hardkey is pressed, the Display softkey menu is displayed (if it is not already being displayed).
FILE Hardkey	When the FILE hardkey is pressed, the Save & Recall softkey menu is displayed, allowing settings and/or measurement results of the K90 option to be saved and recalled.
PRESET Hardkey	When the PRESET hardkey is pressed, the K90 option is exited and a preset will be performed. Note that all options (including R&S FSP-K90) will also be preset.
HCOPY Hardkey	When the HCOPY hardkey is pressed, the print manager softkey menu is displayed, allowing the items to be printed to be selected.

External Keyboard

The external keyboard is optional. The keys on the external keyboard that can be used to interact with the K90/91 option are as follows:

Number keys 0 to 9

Decimal point (“.”) Inserts a decimal point “.” at the cursor position.

Minus key (“-“) Changes the sign of the mantissa or exponent of a numeric parameter. A “-“ is inserted at the cursor position in the case of an alphanumeric parameter.

ESC key Aborts the entry before it has been terminated. The previous value is restored.
Closes the entry field after termination of input.
Closes pop-up dialogs.

ENTER key Terminates the input of dimension quantities. The new value is set.
Invokes the input of parameters or immediately sets the new value.
Selects the highlighted item in drop-down menus.

Left and Right Cursor Keys are used to: Navigate between individual parameters within the setting views and some of the pop-up dialogs.
Navigate between the individual items within drop-down menus.
Move the cursor left & right inside the entry window to reach a particular position in the string during alphanumeric entry.

Up and Down Cursor keys are used to: Navigate between individual parameters within the setting views and some of the pop-up dialogs.
Navigate between the individual items within drop-down menus.
Increment or decrement the value of a parameter during numeric entry.

CTRL keys Used to activate hotkeys. Each of the seven hotkeys is allocated a different function (F) key. To access these hotkeys, press CTRL and the corresponding F key together (see Fig. 1-5):

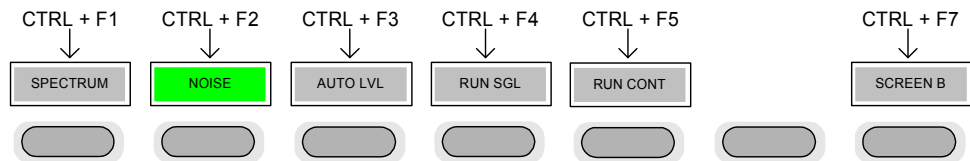


Fig. 1-5 Quick Access to Hotkeys

Function Keys Used to activate softkeys. Each of the nine softkeys is allocated a different function (F) key. To access these softkeys, press the corresponding F key, as shown below:

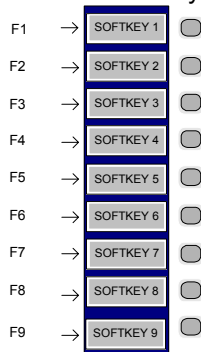


Fig. 1-6 Quick access to softkeys

Mouse

The mouse can be used to select individual parameters within the setting views or data entry dialogs and to activate hotkeys and softkeys. It can also be used to select values from a drop-down list.

Selecting & Editing Parameters

Parameters are set either by numeric or alphanumeric entry or by simple selection from a list of possible values (a drop-down list is used to select an “enumerated” value) or by using checkboxes to turn a parameter setting on and off.

In all cases, the parameter has to be selected by placing focus on it either by selecting it with the mouse or by navigating to it with the cursor or rotary key. Editing then has to be enabled before its value can be changed.

The rotary knob and cursor keys on the front panel are provided for navigation and selection of parameters.

The numeric keypad, rotary knob and cursor keys on the front panel and an external keyboard (optional) are provided for the entering parameter values.

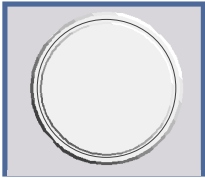
Numeric Keypad



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

- **Number keys 0 to 9**
Starts editing of the selected parameter. This enables a new value to be entered for a parameter directly without having to press *ENTER* first. The digit will be displayed as the first digit of the newly entered value. Inserts a digit at the cursor position when editing an alphanumeric parameter.
- **Decimal point**
Inserts a decimal point “.” at the cursor position.
- **Sign key (“-“)**
Changes the sign of the mantissa or exponent of a numeric parameter. A “-“ is inserted at the cursor position when editing an alphanumeric parameter.
- **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 with alphanumeric entry.
- **ESC/CANCEL key**
Aborts the entry of a new parameter value. The previous value is restored. Closes pop-up dialogs.
- **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.

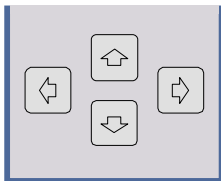
Rotary Knob





The rotary knob has various functions:



- In a settings view, the rotary knob can be used to navigate between individual parameters (the parameter selected being highlighted).
- In drop-down menus, the rotary knob can be used to navigate between the individual values for the parameter.
- During numeric entry, the parameter is incremented (by turning clockwise) or decremented (by turning counterclockwise) at a defined step size (depending on the parameter).
- In setting views and data entry dialogs, pressing the rotary knob invokes the input of parameters or immediately sets the new value, i.e. pressing the rotary knob is like pressing the *ENTER* key.
- In drop-down menus, pressing the rotary knob selects the relevant item.

Cursor Keys



The keys  and  are used to:

- Navigate between individual parameters within the setting views and some of the pop-up dialogs.
- Navigate between the individual values within drop-down menus.
- Move the cursor left & right inside the entry window to reach a particular position in the string during alphanumeric entry.

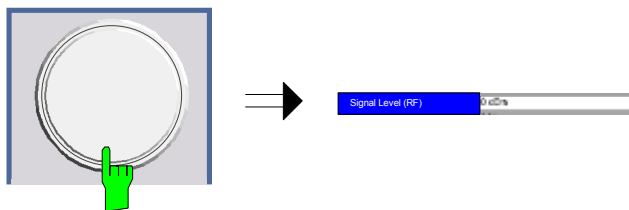
The keys  and  are used to:

- Navigate between individual parameters within the setting views and some of the pop-up dialogs.
- Navigate between the individual items within drop-down menus.
- Increment or decrement the value of a parameter during numeric entry.

Selection of a parameter within a settings view

- Selection using rotary knob** ➤ Press *GENERAL SETTINGS* softkey for example (General settings view is displayed).
- Rotate the rotary knob until the required parameter is reached. Turning the rotary knob clockwise selects parameters in the upward direction; turning it counterclockwise selects parameters in the downward direction.





Example: Selecting *Signal Level* (General settings)



Note: When the *Signal Level* parameter is selected, its label is highlighted blue.

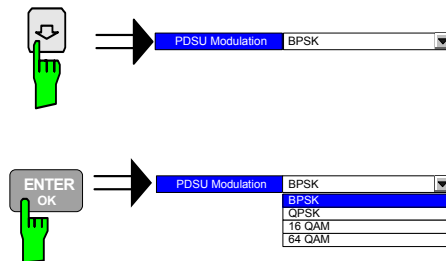
When the desired parameter is reached, press the rotary knob to edit the parameter.

Selection using cursor keys

Cursor , ,  or  until the required parameter is obtained. Within a list of parameters, the *Down* and *Right* keys both move to the next item (down) in the list, and the *Up* and *Left* keys both move to the previous item (up) in the list. Within a table of parameters, the cursor keys move the cursor in the direction indicated.

To start editing the parameter, either press the *ENTER* key on the numeric keypad, or press the rotary knob.

For numeric parameters, editing can also be started by entering the new value directly from the numeric keypad without pressing the *ENTER* key first.

Example: Selecting PDSU Modulation

Note: When *ENTER* is pressed, a drop-down menu is displayed that contains all available settings to which the Demodulator parameter can be set.

Selection using mouse

- Use the mouse to move the cursor to the parameter and press the left mouse button to select the parameter.
- To start editing the parameter, either press the *ENTER* key on the numeric keypad, or press the rotary knob.

For numeric parameters, editing can also be started by entering the new value directly from the numeric keypad without pressing the *ENTER* key first.

Selection using external keyboard

- Select parameter using the cursor keys (in the same way as using the cursor keys on the front panel).
- To start editing the parameter, either press the *ENTER* key on the numeric keypad, or press the rotary knob.

For numeric parameters, editing can also be started by entering the new value directly from the numeric keypad without pressing the *ENTER* key first.

Entry of a numeric value

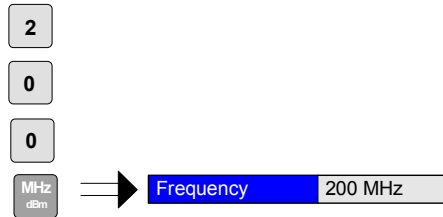
Once a parameter has been selected (see above), a new value for a numeric parameter can be entered in a number of ways. In addition to entering a value via the number keys, you can start editing the parameter either by pressing the *ENTER* key on the numeric keypad, or by pressing the rotary knob before following the instructions below.

If an error occurs (for example, the entered value is out of range), the new value will not be accepted for the parameter setting.

Entry using number keys (numeric keypad)

- Enter required value using the number keys.



Example: To enter 200 MHz



Note: *The parameter is not set to the new value until either one of the unit keys on the numeric keypad, the *ENTER* or the rotary knob is pressed.*

If the new value is not valid, a message box is displayed and the entered value will be replaced with a valid value. For example, when a value above the maximum allowed value is entered, the maximum allowed value will be shown in the entry box. The parameter will still be ready for editing so that another value can be entered if desired.

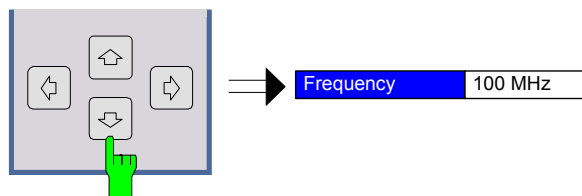
Entry using cursor keys

- Cursor  or  until the required value is obtained.

The application prevents the minimum and maximum values of the parameter from being exceeded and displays an “Out of range” message box if attempted.

Note: The cursor keys increment/decrement a parameter value in large steps.

Example: Cursor down to 100 MHz



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

Entry using rotary knob

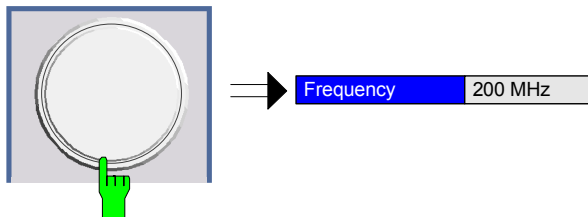
- Rotate the rotary knob until the required value is reached.

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.

Note: The rotary knobs increment/decrement a parameter value in small steps

Example: Rotate to 200 MHz



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

Entry using external keyboard

- Enter value using number keys 0 – 9 in the same way as for using the number keys on the numeric keypad (see above).

Terminating the entry

- Press one of the unit keys on the numeric keypad.

The unit is entered in the parameter’s edit box and the new parameter value is set immediately.



- Press the *ENTER* key (on numeric keypad or external keyboard) or press the rotary knob.

The new parameter value is set immediately.

Note: *Pop-up dialogs, where used, do not close automatically. They can be closed by pressing the ESC key.*

In both cases, if the new value is not valid, a message box is displayed and the entered value will be replaced with a valid value. For example, when a value above the maximum allowed value is entered, the maximum allowed value will be shown in the entry box. The parameter will still be ready for editing so that another value can be entered if desired.

Correcting the entry

- Position the cursor to the right of the digit which is to be deleted using the cursor keys  or .
- Press the BACK key. The digit to the left of the cursor is deleted.
- Enter new digits. Each digit is inserted to the left of the cursor; the other digits are shifted to the right.

Aborting the entry

- Press the *ESC* key during parameter editing.

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

- If a pop-up dialog is displayed, press the *ESC* key again.



The entry window is closed, and the original value remains active.

Entry of an enumerated value

Once a parameter has been selected (see above), a new value for an enumerated parameter can be entered in a number of ways. To start editing the parameter, either press the *ENTER* key on the numeric keypad, press the rotary knob or left-click with the mouse on the drop-down button before following the instructions below.

Note: *When the rotary knob or ENTER is pressed, a drop-down menu is displayed that contains all available settings that may be selected for the parameter.*

Selection of setting using cursor keys

- Cursor  or  until the required setting is obtained.
- Press *ENTER* on external keyboard or numeric keypad, or press rotary knob to select the desired setting of parameter.

Note: *The currently selected setting of the parameter is highlighted blue.
Pressing ENTER sets the new setting of the parameter immediately.*

Selection of setting using rotary knob

- Rotate the rotary knob until the required setting is reached.
- Press rotary knob to select setting.

Example: Select *Mode* parameter.

Note: *The currently selected setting of the parameter is highlighted blue.
Pressing the rotary knob sets the new setting of the parameter immediately.*

Selection of setting using mouse

- When the parameter is selected and ready for editing, select a new setting using the mouse by left-clicking the new setting from the drop-down list. The new setting of the parameter is set immediately.

Selection of setting using external keyboard

- Select setting using cursor keys.
- Press *ENTER* to set the parameter to the new value.

Entry of a checkbox

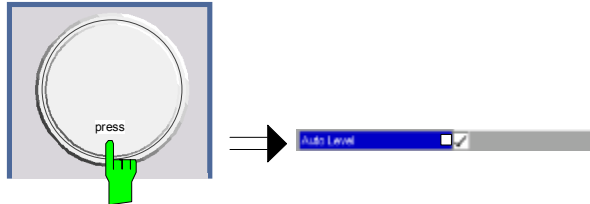
A checkbox is used for parameter settings that are either On or Off (Boolean settings). A checkmark (✓) appears in the box when the setting is On; the checkbox is empty when the setting is Off.

Once a parameter has been selected (see above), a new value for a Boolean parameter can be entered in a number of ways. Because Boolean parameters are very simple, it is not necessary to press the *ENTER* key on the numeric keypad or to press the rotary knob in order to edit them.

Toggle between the two states of a checkbox using rotary knob

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

Example: Turn *Auto Level* setting to Off



Note: The checkbox is empty when the settings is Off

Toggle between the two states of a checkbox using numeric keypad

- Press the *ENTER* key to toggle between the two states.

Example: Turn *Auto Level* setting to On



Toggle between the two states of a checkbox using a mouse

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

Toggle between the two states of a checkbox using external keyboard

- Press *ENTER* to toggle between the two states.

Status Bar & Title Bar

Title Bar

The title bar is visible at the very top of the display when R&S FSQ-K90/91 is active and no setting views are displayed.



Fig. 1-7 Title Bar

The center of the title bar shows the wireless LAN standard applicable to the current measurement. 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.

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. 1-8).

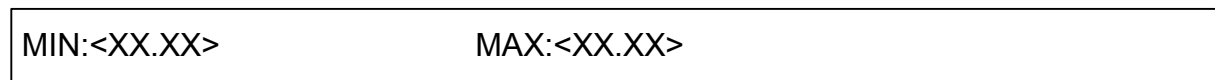


Fig. 1-8 Status Bar

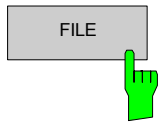
When a parameter whose value is enumerated or Boolean in type is selected in any dialog, the status bar will show “N/A” for the minimum and maximum, since the minimum and maximum values are “Not Applicable.”

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 Section 6 for a list of warning and error messages.

Save/Recall

This section of the user manual describes the Save/Recall facility of the option.



The *FILE* hardkey brings up the Save/Recall softkey menu. Any setting views on display when the save/recall softkey menu is displayed will be closed.

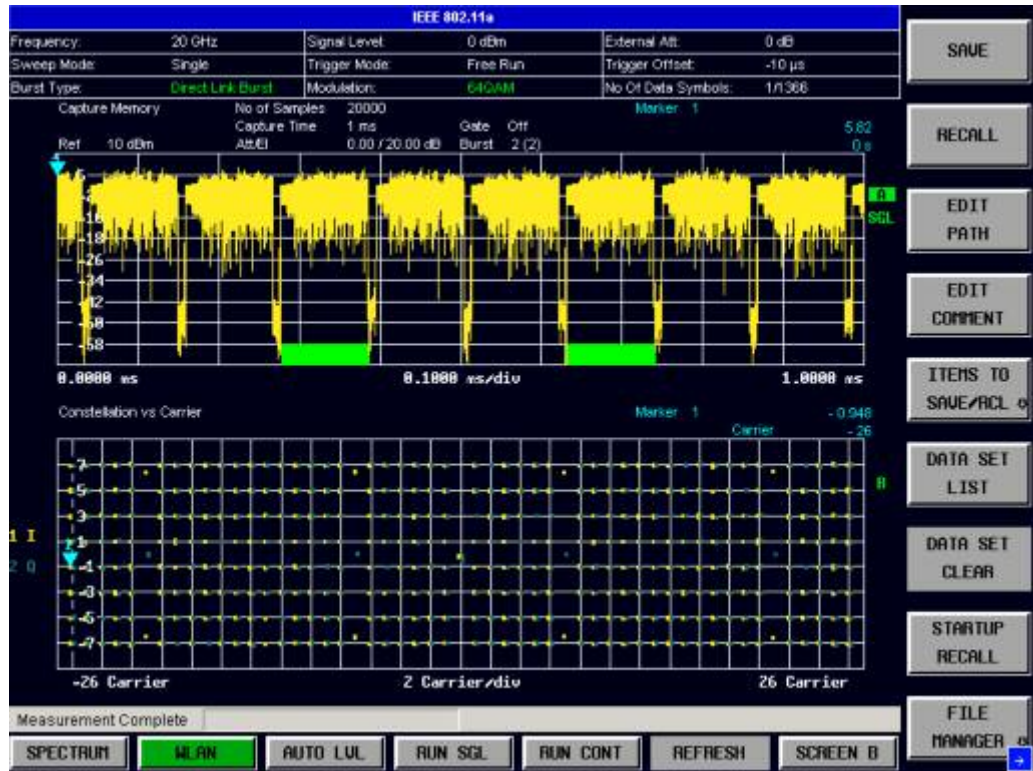


Fig. 1-9 Save/Recall softkey menu

The save/recall facility provided by R&S FSQ-K90/91 is exactly the same as that provided by the host analyzer. Refer to the user manual for the spectrum analyzer for details about the save/recall facility operation.

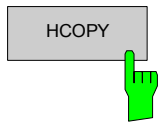
The save/recall facility in R&S FSQ-K90/91 provides the following items that can be saved and/or recalled:

Current Settings	All user settings provided by R&S FSQ-K90/91.
WLAN Results	All current trace and table results.
User Limits	All limit lines and table limit values.
IQ Data	Allows the raw IQ trace results to be stored. When recalled, the data is reprocessed to generate results. Note: IQ data can also be saved/recalled using the Import/Export feature for .iqw format files (see section <i>Import/Export of IQ Data</i>)

To close the save/recall softkey menu and return to the main R&S FSQ-K90/91 softkey menu, press the *WLAN* hotkey.

Printing

This section of the user manual describes print facility of the option.



The *HCOPY* hardkey brings up the print softkey menu. Any setting views on display when the print softkey menu is displayed will be closed.

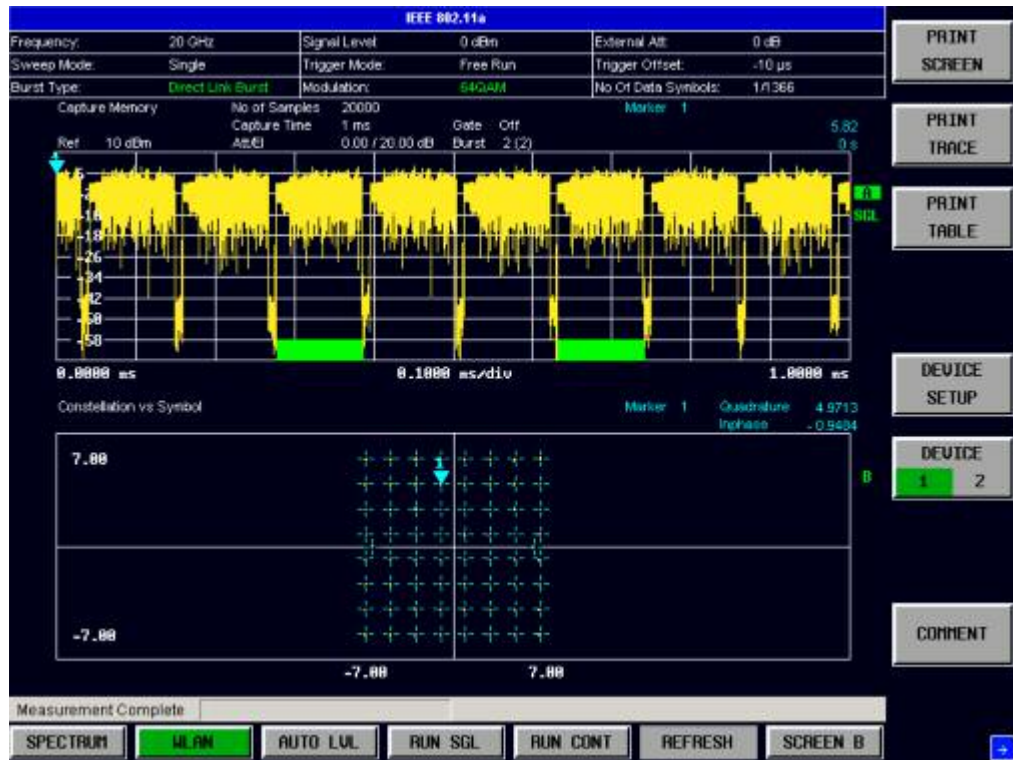


Fig. 1-10 Print softkey menu

The print facility provided by R&S FSQ-K90/91 is exactly the same as that provided by the host analyzer. Refer to the user manual for the spectrum analyzer for details about the print facility operation.

To close the print softkey menu and return to the main R&S FSQ-K90/91 softkey menu, press the *WLAN* hotkey.

2 Measurements & Settings

This section contains a detailed description of all measurement modes, settings & results. It covers the following subjects:

- Measurement modes
- Running measurements
- Measurement results
- General settings
- Demodulation settings
- Gate settings
- Marker settings
- General hints about measurements

Measurements

R&S FSQ-K90/91 provides two main measurement types:

- IQ Measurements
- Frequency Sweep Measurements

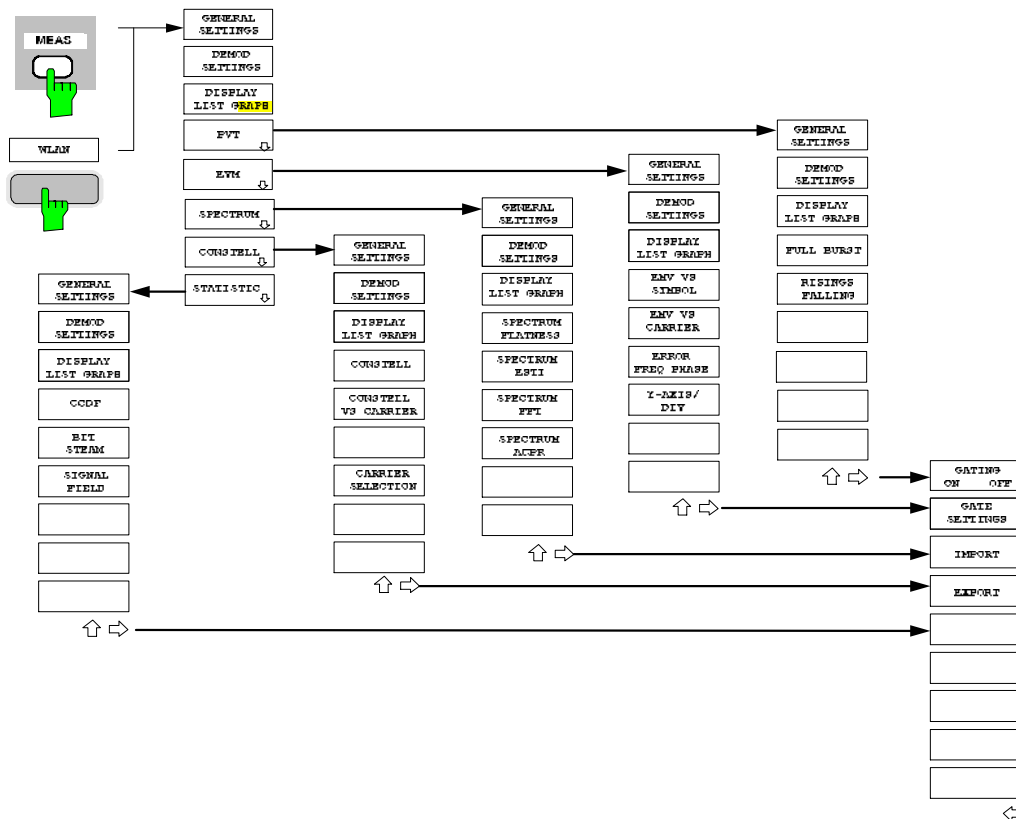


Fig. 2-1 IEEE 802.11a, g (OFDM) & Turbo Mode

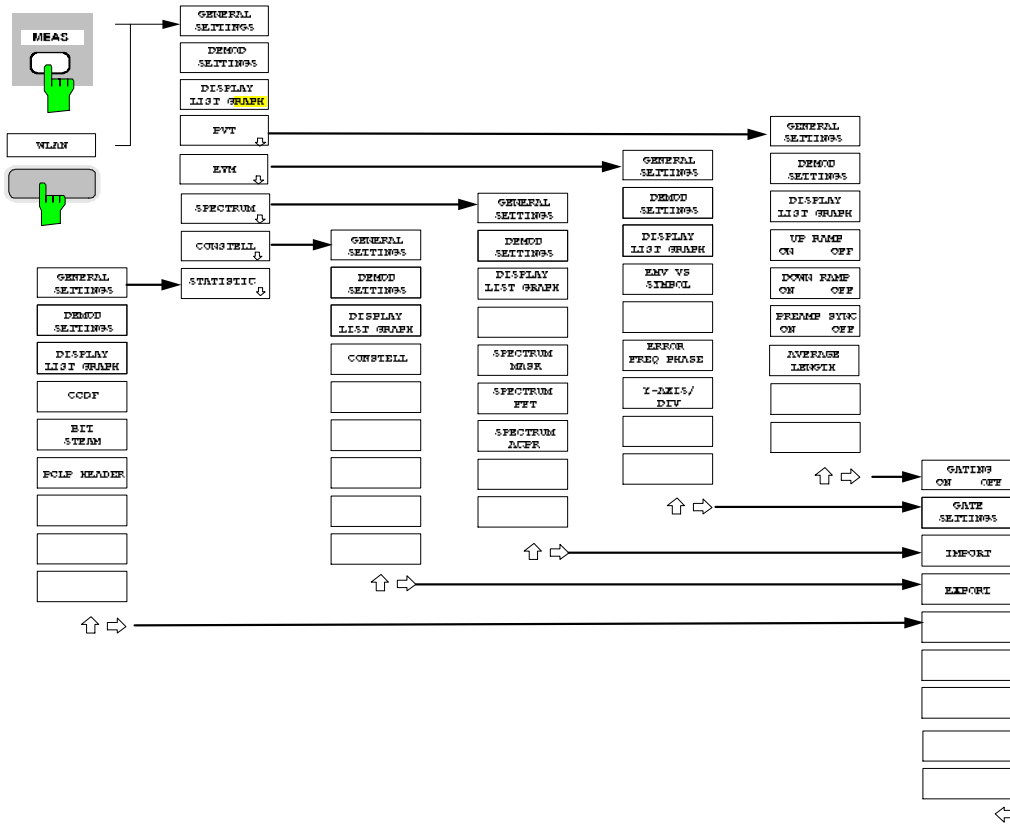


Fig. 2-2 IEEE 802.11b & g (Single Carrier)

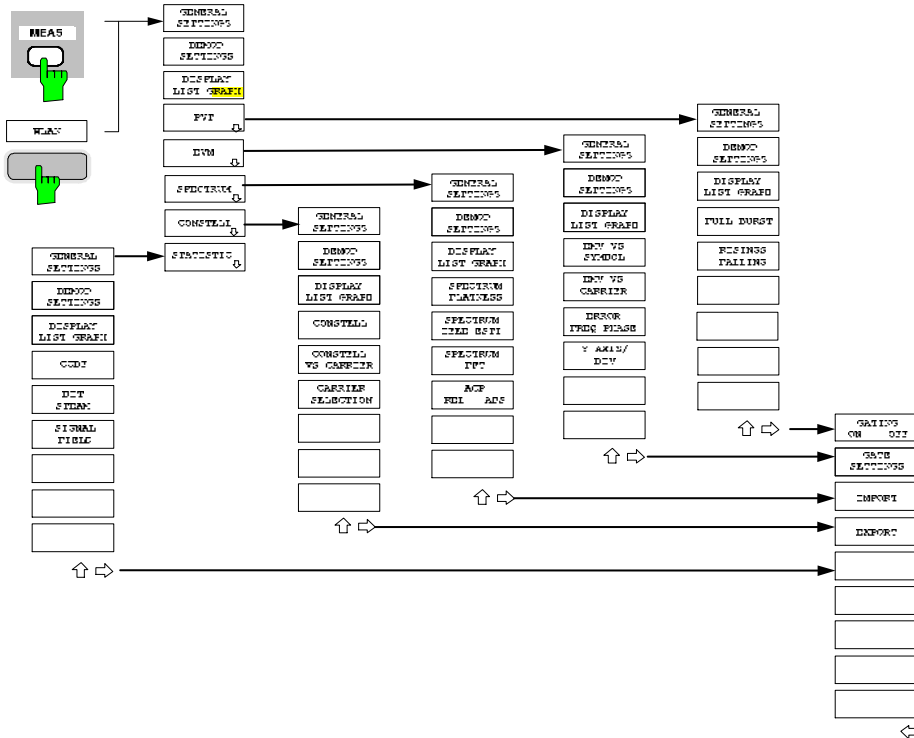


Fig. 2-3 IEEE 802.11j (10 or 20 MHz)

IQ measurements

The following measurement results are obtained in IQ measurement mode:

- Power Vs Time (PVT)
- EVM Vs Symbol
- EVM Vs Carrier
- Phase Vs Preamble
- Frequency Vs Preamble
- Spectrum Flatness
- Spectrum FFT
- Constellation Vs Symbol
- Constellation Vs Carrier
- Conditional Cumulative Distribution Function (CCDF)
- Bit Stream
- Signal Field

For each of the above results, the Magnitude Capture Buffer display is available.

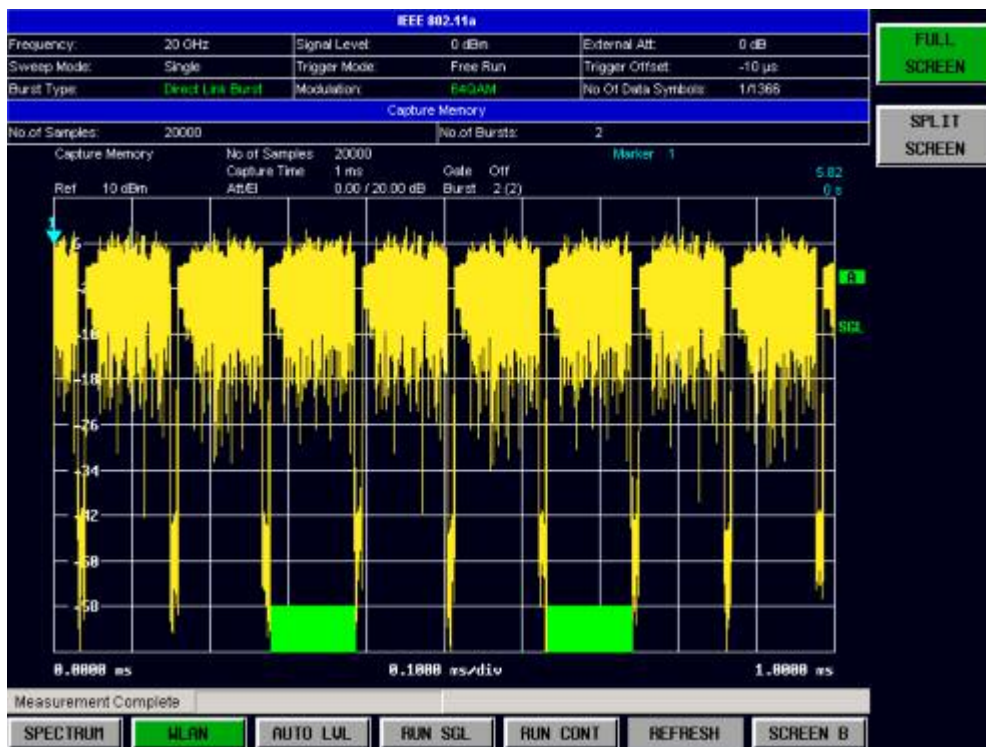


Fig. 2-4 Magnitude Capture Buffer results

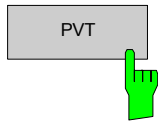
The Magnitude Capture Buffer shows the complete range of captured data for the last sweep. All analyzed bursts are identified with a green bar at the bottom of the Magnitude Capture Buffer. When the *Use Signal Field Content* parameter is selected in the Demod Settings view, only bursts that matched the required criteria are marked with a green bar. When the selected standard is IEEE 802.11b, the *Use Signal Field Content* parameter is replaced by *Use PLCP Header Content* parameter, which is always selected.

All IQ measurements process the same signal data and, thus, all IQ measurement results are available after a single IQ measurement.

IQ measurements can be run in split-screen mode (allowing both the Magnitude Capture Buffer Display and the selected IQ measurement results to be displayed simultaneously) or in full-screen mode (with either the Magnitude Capture Buffer Display or the selected IQ measurement results displayed).

IQ measurements may be performed for RF or baseband input.

Power Vs Time(PVT)



The PVT measurement results are selected by pressing the *PVT* softkey in the main measurement softkey menu.

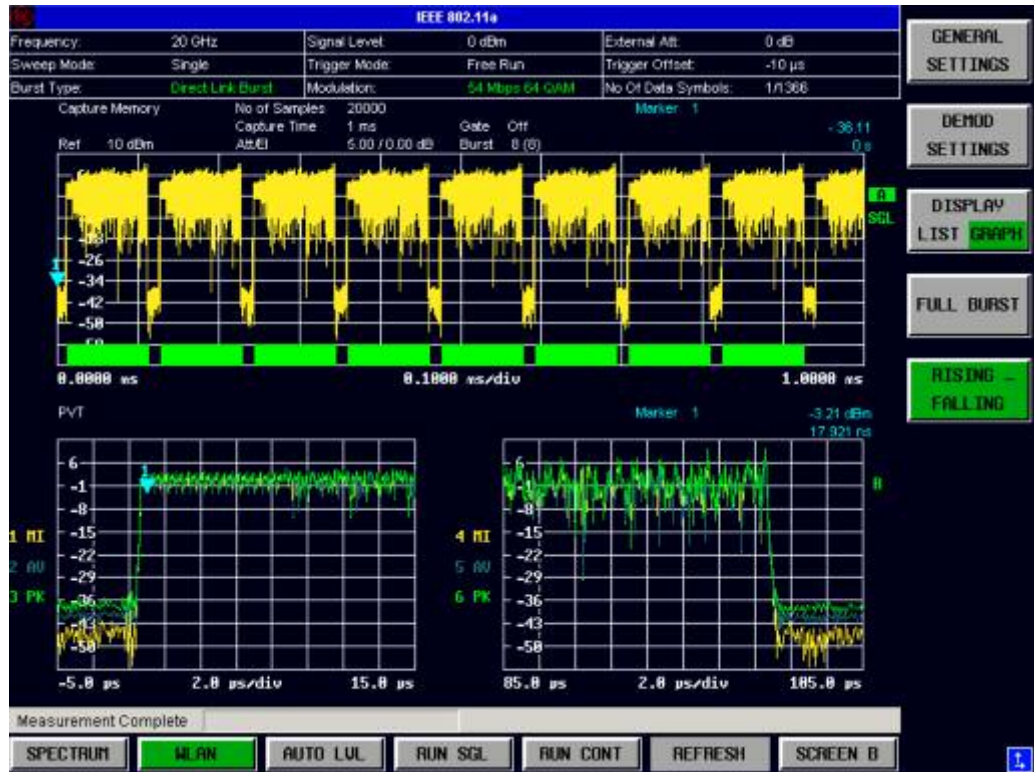
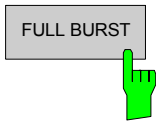


Fig. 2-5 PVT Results – Full Burst

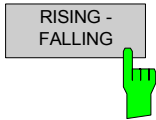
The PVT results display shows the minimum, average and maximum levels measured over the full range of the measured input data, or over complete bursts displayed within the gating lines if gating is switched on. The results are displayed as a single burst. If the gate start or gate length is altered, the results can be updated to reflect these changes by pressing the *REFRESH* hotkey.

Using screen B in full-screen mode provides additional power information during this measurement.

IEEE 802.11a, j & g (OFDM)



Pressing the *FULL BURST* softkey displays the results in a single graph with all burst data being displayed.



Pressing the *RISING FALLING* softkey displays the results in two separate graphs, the left-hand side showing the rising edge and the right-hand side the falling edge.

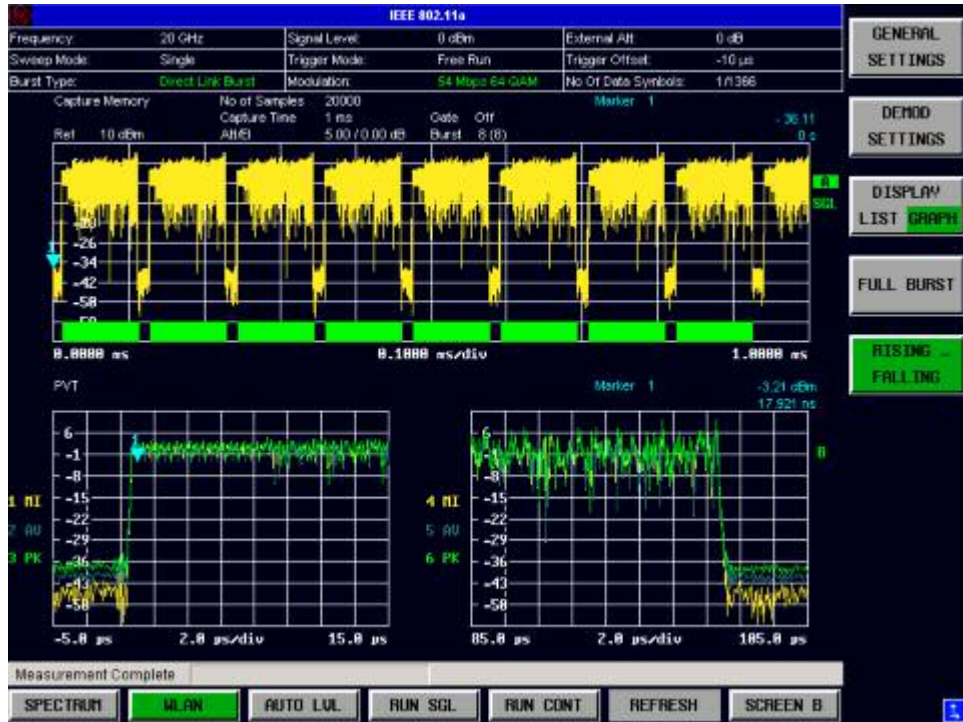
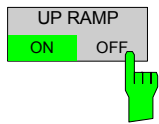
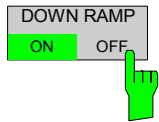


Fig. 2-6 PVT Results – Rising Falling Edge

IEEE 802.11b & g (Single Carrier)



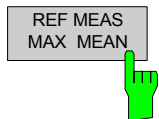
Pressing the *UP RAMP* softkey toggles the display of the rising edge graph on and off.



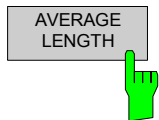
Pressing the *DOWN RAMP* softkey toggles the display of the falling edge graph on and off.



Fig. 2-7 PVT Results – Up Ramp and Down Ramp Switched On



Pressing the *REF MEAS* softkey toggles the reference for the trace between the max and mean burst power.



Pressing the *AVERAGE LENGTH* softkey displays a pop-up dialog which allows the length of the smoothing filter to be adjusted.

For IEEE 802.11b and g (single carrier), the PVT results are displayed as percentage values of the reference power. The reference can be set to either the max or mean power of the burst. 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 for the rising and falling edges.

Rise / Fall Time Definition

The rise/fall time is calculated according to the following algorithm:

1. Apply a moving average filter across the burst power (adjustable average length)
2. If "REF POW" = 'MAX':
Search for maximum power P_{\max} across the entire burst. Set $P_{\text{ref}} = P_{\max}$
If "REF POW" = 'MEAN':
Calculate mean power P_{mean} of the entire burst. Set $P_{\text{ref}} = P_{\text{mean}}$
3. Rise Time
 - Search for the first crossing of $0.5 \cdot P_{\text{ref}}$ from the left. From there,
 - search backward for the 10% crossing $0.1 \cdot P_{\text{ref}}$ and note t_{10} .
 - Search forward for the 90% crossing $0.9 \cdot P_{\text{ref}}$ and note t_{90} .
 - Return $T_{\text{rise}} = t_{90} - t_{10}$.
4. Fall Time
 - Search for the first crossing of $0.5 \cdot P_{\text{ref}}$ from the right. From there,
 - search forward for the 10% crossing $0.1 \cdot P_{\text{ref}}$ and note t_{10} .
 - Search backward for the 90% crossing $0.9 \cdot P_{\text{ref}}$ and note t_{90} .
 - Return $T_{\text{fall}} = t_{10} - t_{90}$.

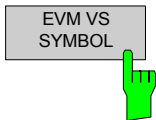
Dealing with Modulated Signals

Since the single carrier modes of 802.11b/g use linear modulation formats such as BPSK or QPSK, the transmit signal power varies between symbol sampling times. These power variations are determined by the transmit filter, which is not defined in the standard. The R&S FSQ-K91 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 burst power or the mean burst power can be chosen as reference power. Using the mean burst power reduces the effect of power peaks within the burst on the rise and fall times.

The moving average filter smooths the power trace and thus eliminates the modulation. While a long average length leads to more stable measurement results, it naturally increases the rise/fall times compared to no averaging.

EVM Vs Symbol



The EVM Vs Symbol measurement results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *EVM Vs SYMBOL* softkey

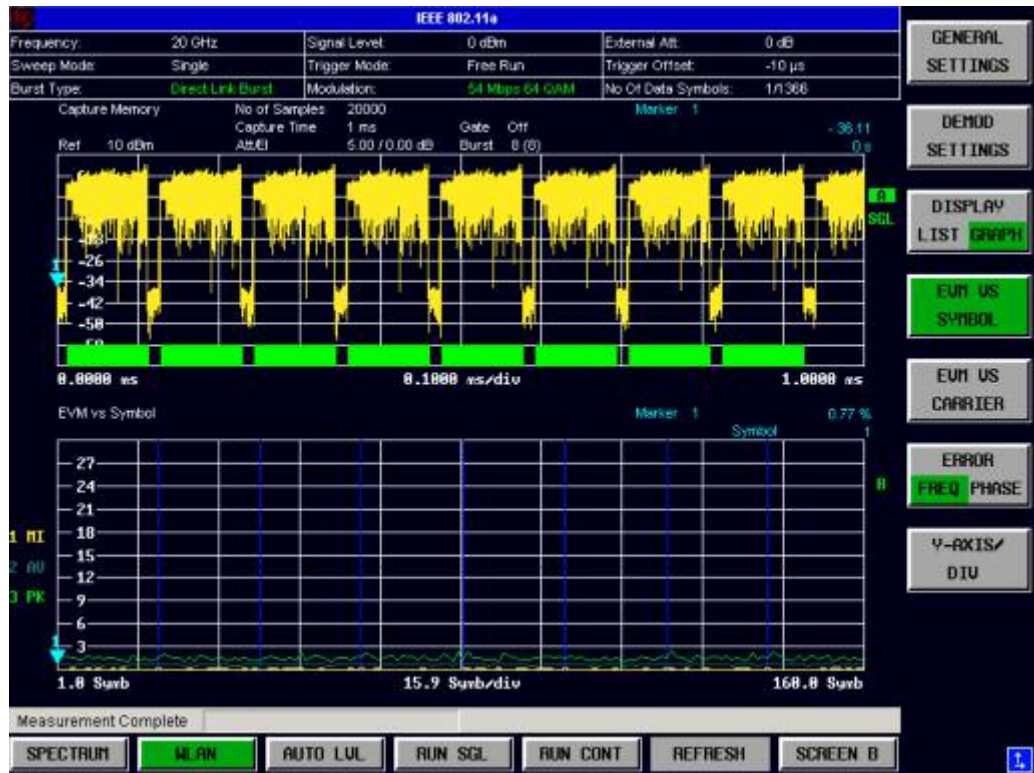
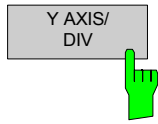


Fig. 2-8 EVM Vs Symbol

The EVM Vs Symbol results display shows the EVM measured over the full range of the measured input data. The results are displayed on a per-symbol basis, with blue vertical lines marking the boundaries of each burst. Note that burst boundary lines are only displayed if the number of analyzed bursts is less than 250. For IEEE 802.11a, j & g (OFDM), the minimum, average and maximum traces are displayed.

For IEEE 802.11b & g (Single Carrier), two EVM traces are displayed. The trace labeled with VEC ERR IEEE shows the error vector magnitude as defined in the IEEE 802.11b & g standards. For the trace labeled with 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 3.



Pressing the Y AXIS/ DIV softkey displays a pop-up dialog which allows the settings of the Y-axis to be controlled.

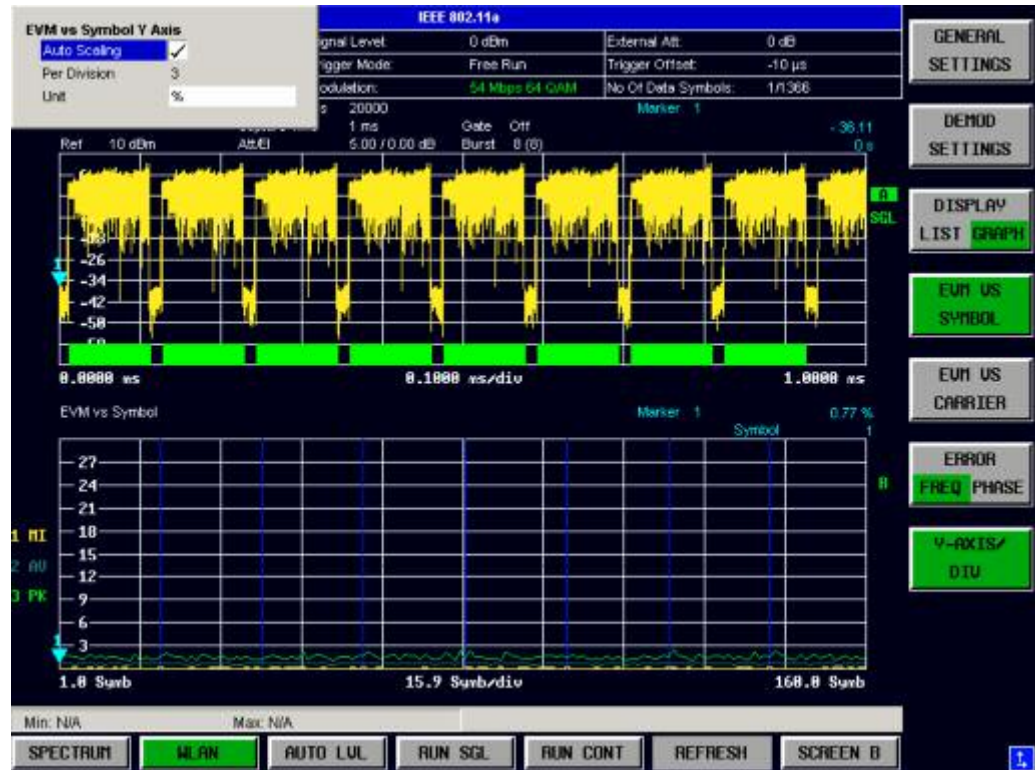


Fig. 2-9 EVM Vs Symbol - Y-axis Scaling

EVM Vs Symbol Y Axis

Auto Scaling

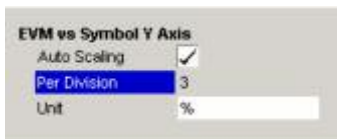


Auto Scaling specifies whether the Y-axis scale should be calculated manually or automatically.

When the *Auto Scaling* parameter is switched OFF, the setting of the *Per Division* setting is used to calculate the Y-axis scale.

Auto Scaling is always enabled when the Unit setting is dB

Per Division



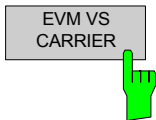
Per Division specifies the scaling to be used when *Auto Scaling* is switched OFF.

Unit



Unit allows the Y-axis unit to be specified.

EVM Vs Carrier



The EVM Vs Carrier measurement results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *EVM Vs CARRIER* softkey.

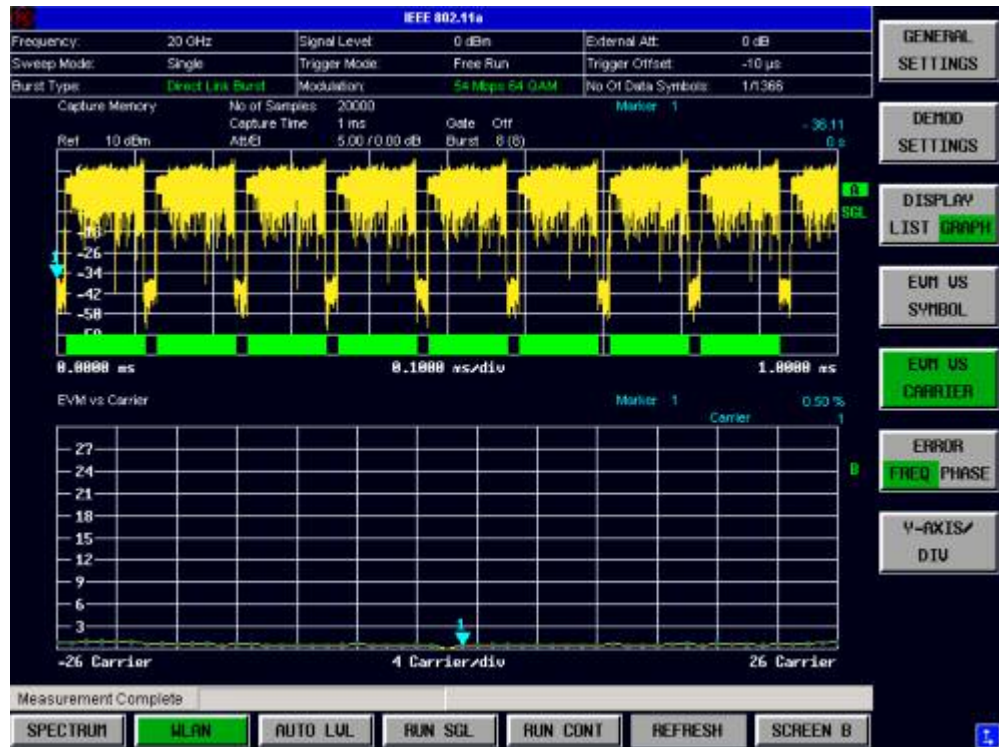
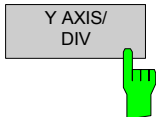


Fig. 2-10 EVM Vs Carrier Results

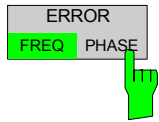
The EVM Vs Carrier results display shows all EVM values recorded on a per-carrier basis over the full set of measured data. An average trace is also displayed. This measurement is not available when the IEEE 802.11b or g (Single Carrier) standards are selected.

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



Pressing the *Y AXIS/ DIV* softkey displays a pop-up dialog which allows the settings of the Y-axis to be controlled. The settings provided are the same as for the EVM Vs Symbol measurement screen.

Error Vs Preamble



The Error Vs Preamble results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *ERROR FREQ/PHASE* softkey. Subsequent presses of the *ERROR FREQ/PHASE* softkey toggle the error measurement between Frequency Error Vs Preamble and Phase Error Vs Preamble.

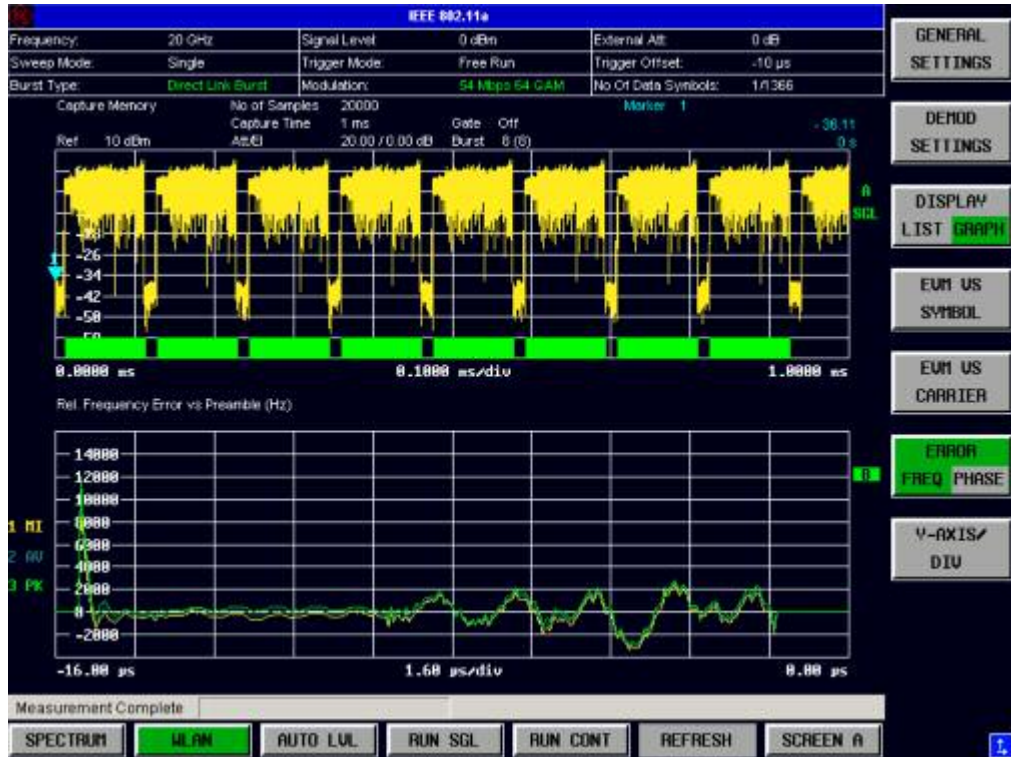
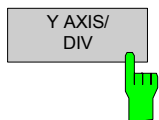


Fig. 2-11 Error Vs Preamble Results

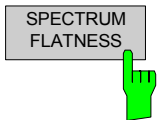
The Error Vs Preamble results display shows the error values recorded over the preamble part of the burst. A minimum, average and maximum trace are displayed. The results display either relative frequency error or phase error.

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



Pressing the *Y AXIS/ DIV* softkey displays a pop-up dialog which allows the settings of the Y-axis to be controlled. The settings provided are the same as for the *EVM Vs Symbol* measurement screen.

Spectrum Flatness



The Spectrum Flatness measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM FLATNESS* softkey.

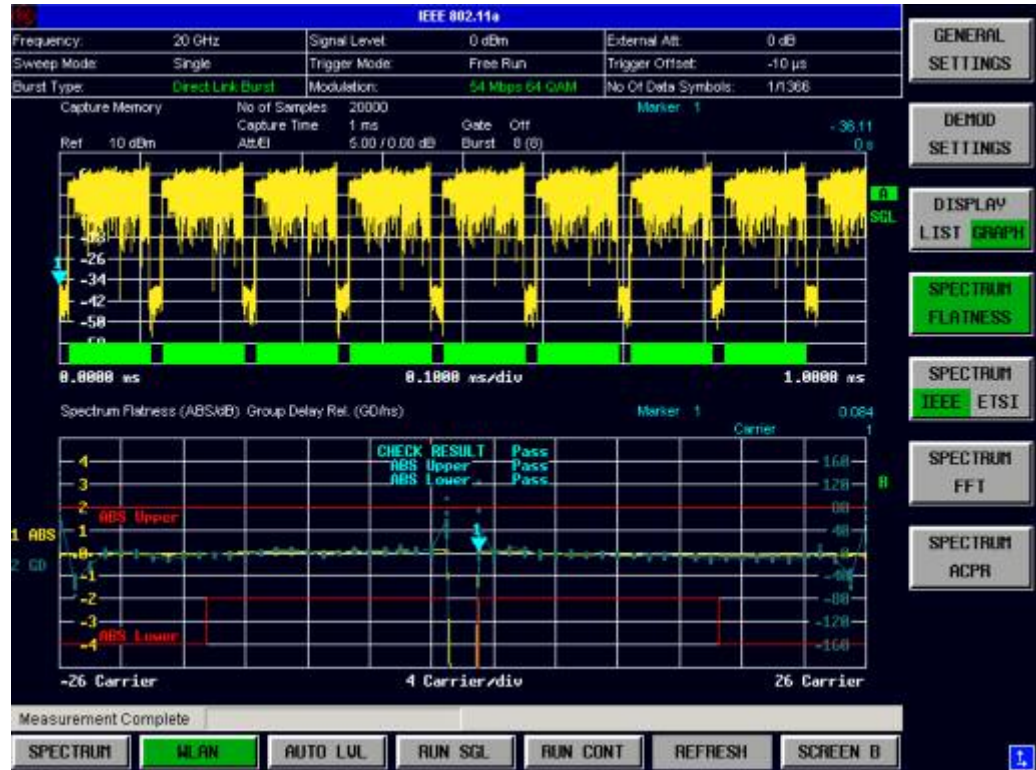
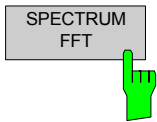


Fig. 2-12 Spectrum Flatness Results

The Spectrum Flatness results display shows the Spectrum Flatness and Group Delay values recorded on a per-carrier basis over the full set of measured data. An average trace is also displayed for each of the result types. An upper and lower limit line representing the limits specified for the selected standard are displayed and an overall pass/fail status is displayed for the obtained (average) results against these limit lines. This measurement is not available when the IEEE 802.11b or g (Single Carrier) standards are selected.

Group Delay is "zero mean" adjusted (every result is reduced by the mean Group Delay over all carriers).

Spectrum FFT



The Spectrum FFT measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM FFT* softkey.

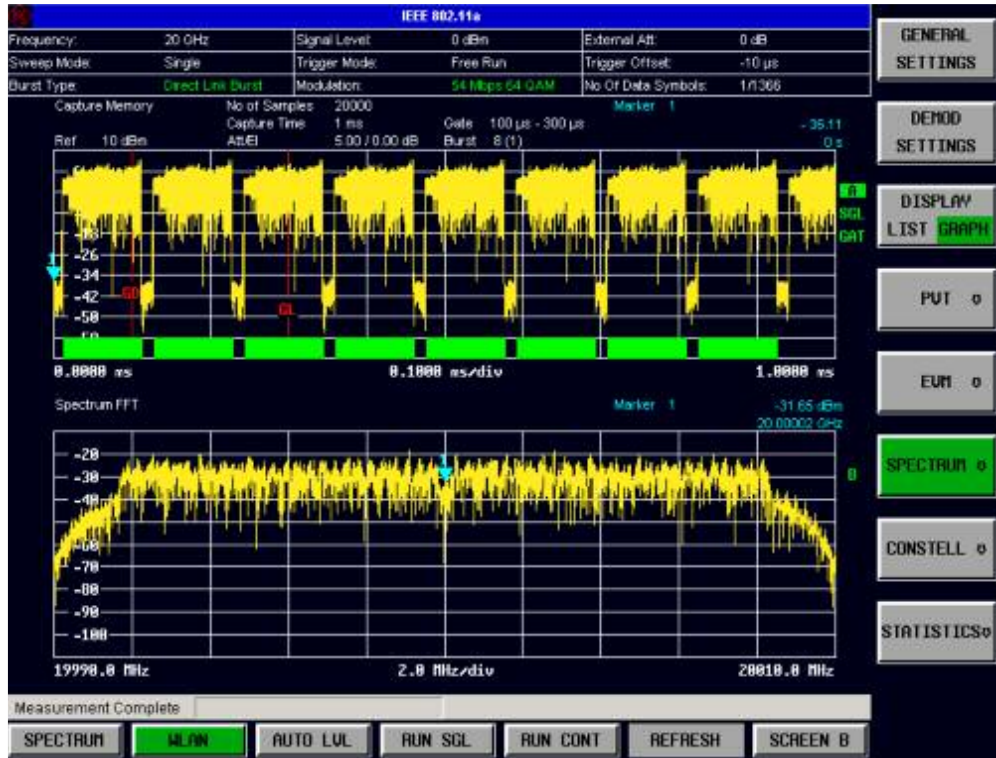
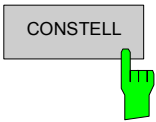


Fig. 2-13 Spectrum FFT Results

The Spectrum FFT results display shows the Power Vs Frequency results obtained from a FFT performed over the range of data in the Magnitude 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

Constellation Vs Symbol



The Constellation diagram is selected by pressing the *CONSTELL* softkey in the main measurement softkey menu followed by the *CONSTELL* softkey,

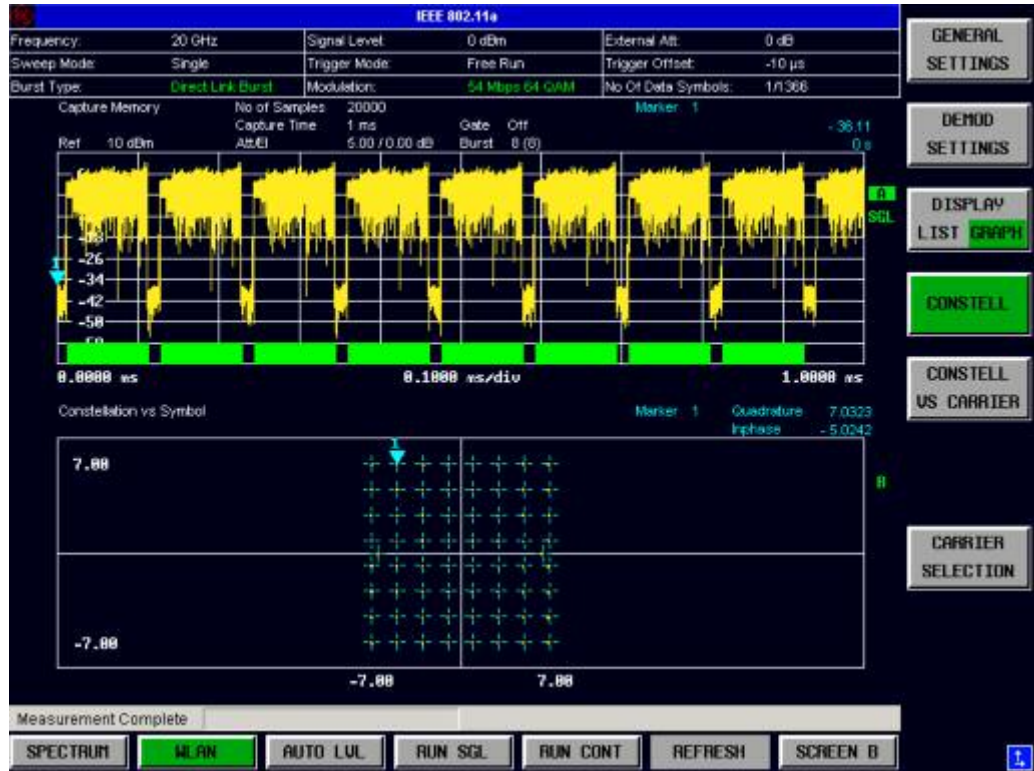
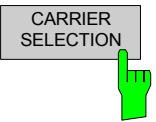


Fig. 2-14 Constellation Vs Symbol Results

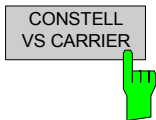
The Constellation display shows the Inphase and Quadrature phase results over the full range of the measured input data. The ideal points for the selected modulation scheme are displayed for reference purposes.

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.



Pressing the *CARRIER SELECTION* softkey displays a pop-up dialog which allows the carrier for data display to be selected. Either a specific carrier number or pilots only can be selected. Selecting All Carriers allows all the results to be displayed. This facility is not available when the IEEE 802.11b or g (Single Carrier) standards are selected.

Constellation Vs Carrier



The Constellation Vs Carrier measurement results are selected by pressing the *CONSTELL* softkey in the main measurement softkey menu followed by the *CONSTELL VS CARRIER* softkey,

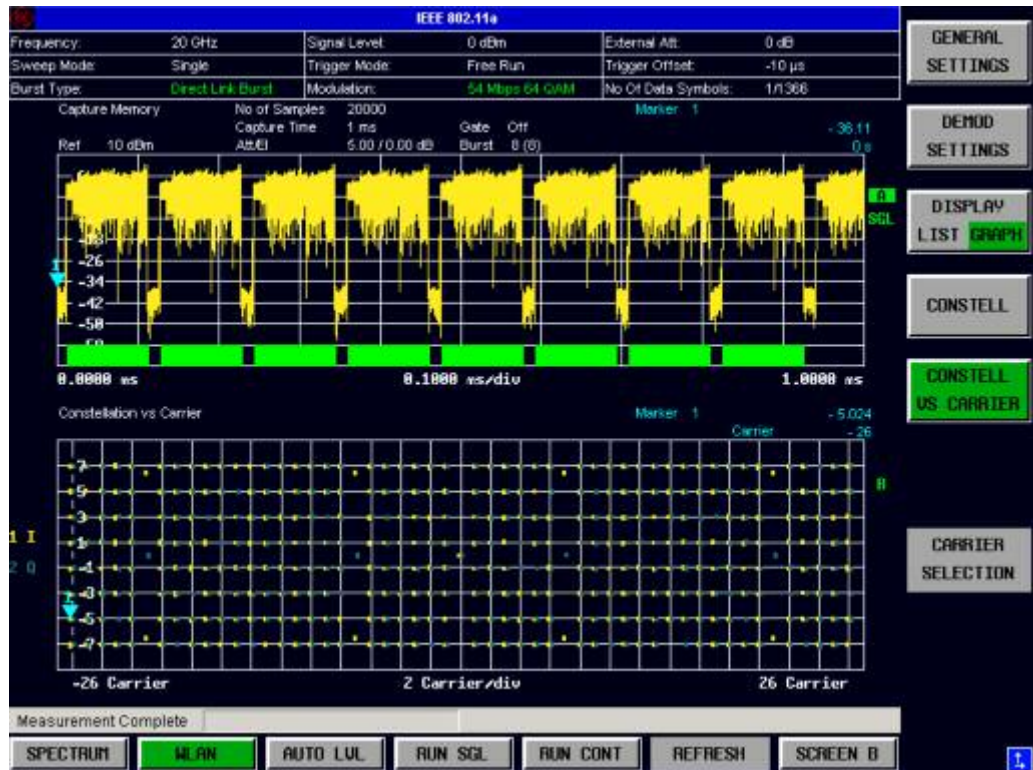
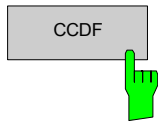


Fig. 2-15 Constellation Vs Carrier Results

The Constellation Vs Carrier results 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-> trace 1, Q-> trace 2). This measurement is not available when the IEEE 802.11b or g (Single Carrier) standards are selected

Conditional Cumulative Distribution Function (CCDF)



The CCDF measurement results are selected by pressing the *STATISTICS* softkey in the main measurement softkey menu followed by the *CCDF* softkey,

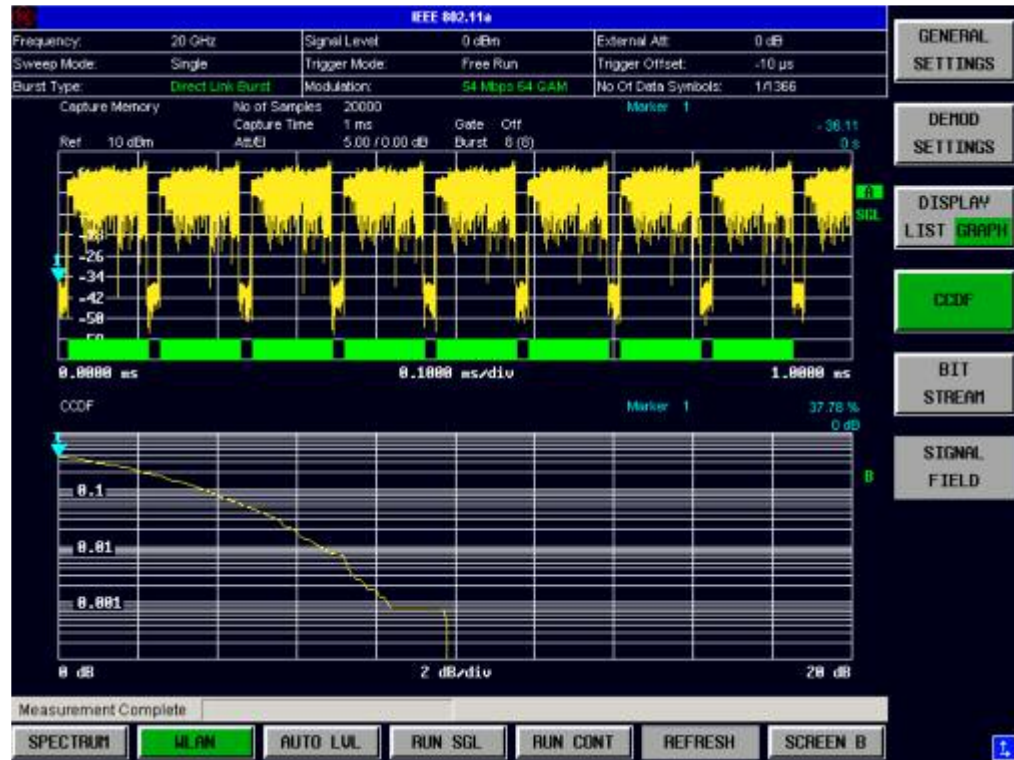
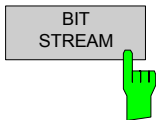


Fig. 2-16 CCDF Results

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

Bit Stream



The Bit Stream measurement results are selected by pressing the *STATISTICS* softkey in the main measurement softkey menu followed by the *BIT STREAM* softkey.

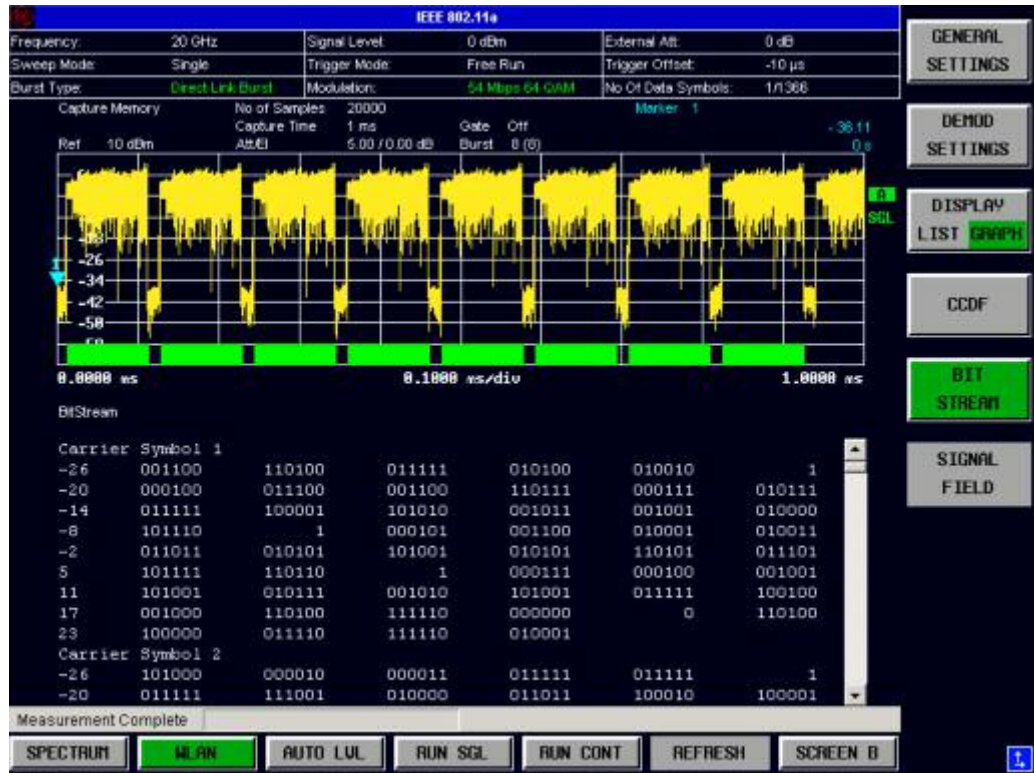


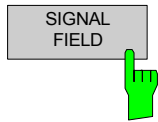
Fig. 2-17 IEEE 802.11a , j, g (OFDM) and Turbo Mode Bit-Stream Results



Fig. 2-18 IEEE 802.11b & g (Single Carrier) Bit-Stream Results

The bit stream results display shows the demodulated data stream. When IEEE 802.11a, j, g (OFDM) or Turbo Mode is selected, the results are grouped by symbol and carrier. When IEEE 802.11b or g (Single Carrier) is selected, the results are grouped by Burst. When no other dialogs are on display, the results can be scrolled through using the cursor keys or scroll wheel.

Signal Field



The Signal Field measurement results are selected by pressing the *STATISTICS* softkey in the main measurement softkey menu followed by the *SIGNAL FIELD* softkey.

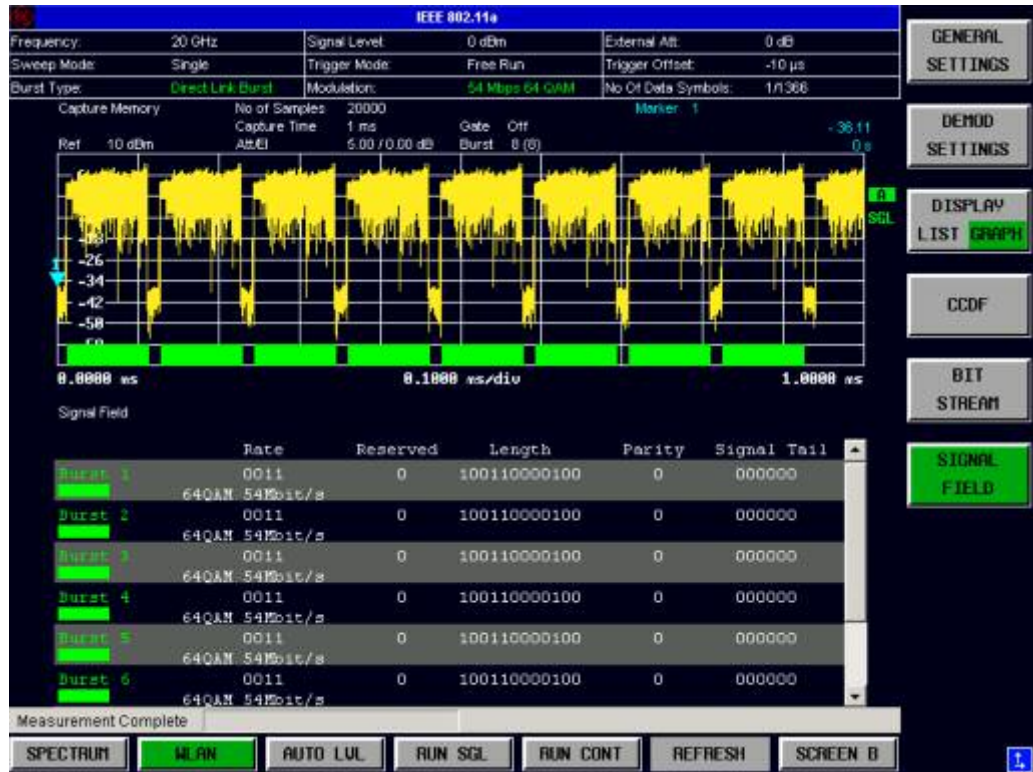
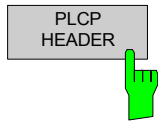


Fig. 2-19 Signal Field Results

The Signal Field results display shows the decoded data from the signal field of the burst. For this reason, the Signal Field Measurement results are only selectable when the *Use Signal Field Content* parameter is selected in the Demod Settings. When no other dialogs are on display, the results can be scrolled through using the cursor keys or scroll wheel. This measurement is not available when the IEEE 802.11b or g (Single Carrier) standards are selected.

PLCP Header



The PLCP Header measurement results are selected by pressing the *STATISTICS* softkey in the main measurement softkey menu followed by the *PLCP HEADER* softkey.



Fig. 2-20 PLCP Header Results

The PLCP Header results display shows the decoded data from the PLCP header of the burst. The format of the results is shown below:

Signal	Service	PSDU Length	CRC
Burst 1 2 Mbits/s	00000000 -- / -- / --	0000000001111000 120 µs	1110100111001110 OK

Shows the number of the decoded burst. If a coloured block appears under the label then this indicates that the burst was successfully decoded.

Shows the length field. The decoded time to transmit the PSDU is shown below

Shows the CRC field. Below this is shown "OK" if the CRC passes or "Failed" if the CRC fails

Shows the signal field. The decoded date rate is shown below

Shows the service field. The highlighted bits are those bits currently used. The text below shows the decoded meaning of the highlighted bits as follows:

- bit 2 - Shows "--" if the symbol clock is not locked
Shows "Locked" if the symol clock is locked
- bit 3 - Shows "--" if the data rate is below 5.5 Mbit/s
Shows "CCK" if CCK modulation is selected
Shows "PBCC" if PBCC modulation is slected
- bit 7 - Shows "--" if the length extension bit is not set
Shows ">8/11" if the length extension bit is set

When no other dialogs are on display, the results can be scrolled through using the cursor keys or scroll wheel. This measurement is only available when the IEEE 802.11b or g (Single Carrier) standard is selected.

Frequency Sweep Measurements

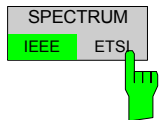
The following measurement results are obtained in frequency sweep mode:

- Spectrum Mask
- Spectrum ACP/ACPR

Frequency sweep measurements use different signal data than IQ measurements. Thus, it is not possible to run an IQ 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 are run in full-screen mode. Frequency sweep measurements are only available when RF input is selected.

Spectrum Mask (IEEE 802.11a, g (OFDM) & Turbo Mode only)



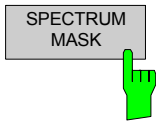
The Spectrum Mask measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM IEEE/ETSI* softkey. Subsequent presses of the *SPECTRUM IEEE/ETSI* softkey toggle the Spectrum measurement between IEEE and ETSI standards.



Fig. 2-21 IEEE 802.11a Spectrum Mask Results

The Spectrum Mask results display shows power against frequency. The span of the results is 100 MHz for IEEE and 500 MHz for ETSI around the specified measurement frequency. 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. If the *Sweep Count (Mask/ACP)* parameter in the General Settings view 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.

Spectrum Mask (IEEE 802.11b, g (Single Carrier) & j only)



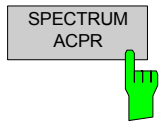
The Spectrum Mask measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM MASK* softkey



Fig. 2-22 IEEE 802.11b/j Spectrum Mask Results

The Spectrum Mask results display shows power against frequency. The span of the results is 100 MHz around the specified measurement frequency. 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. If the *Sweep Count (Mask/ACPR)* parameter in the General Settings view 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.

Spectrum ACPR (IEEE 802.11a, b, g & Turbo Mode only)



The Spectrum ACPR measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM ACPR* softkey.

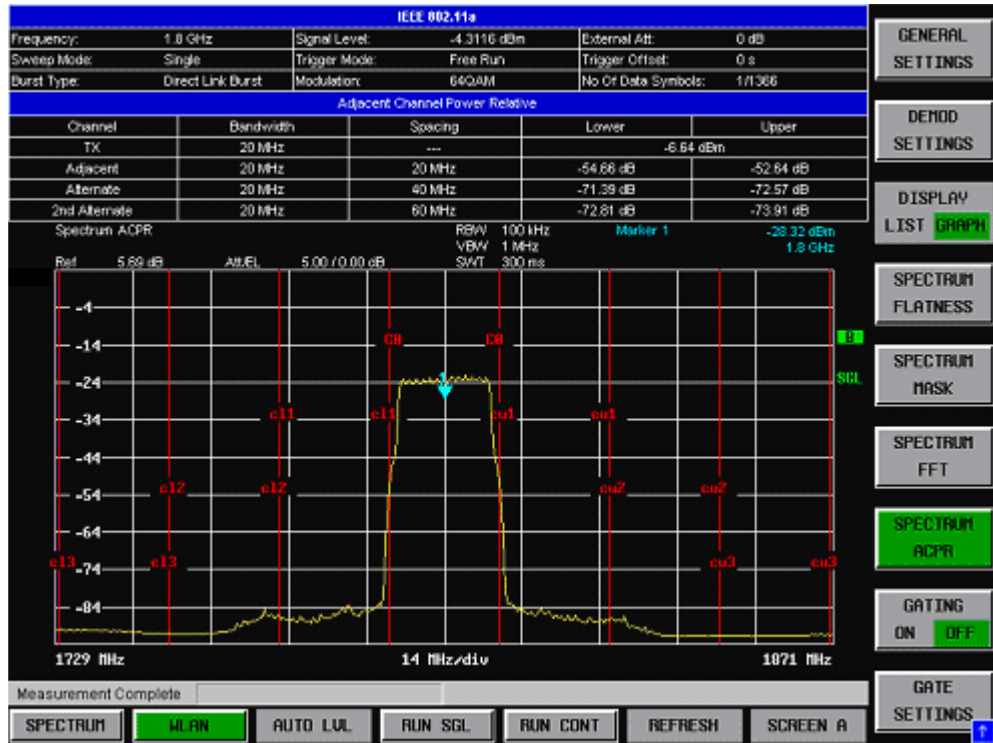
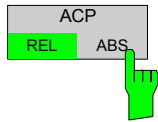


Fig. 2-23 Spectrum ACPR Results

The Spectrum ACPR (Adjacent Channel Power (Relative)) is similar to the Spectrum Mask measurement, and 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 the same as the Adjacent Channel Power measurement provided by the Spectrum Analyzer. If the *Sweep Count (Mask/ACPR)* parameter in the General Settings view 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.

Spectrum ACP (IEEE 802.11j only)



The Spectrum ACP measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *ACP REL/ABS* softkey. Subsequent presses of the *ACP REL/ABS* softkey toggle the measurement between relative and absolute results display.

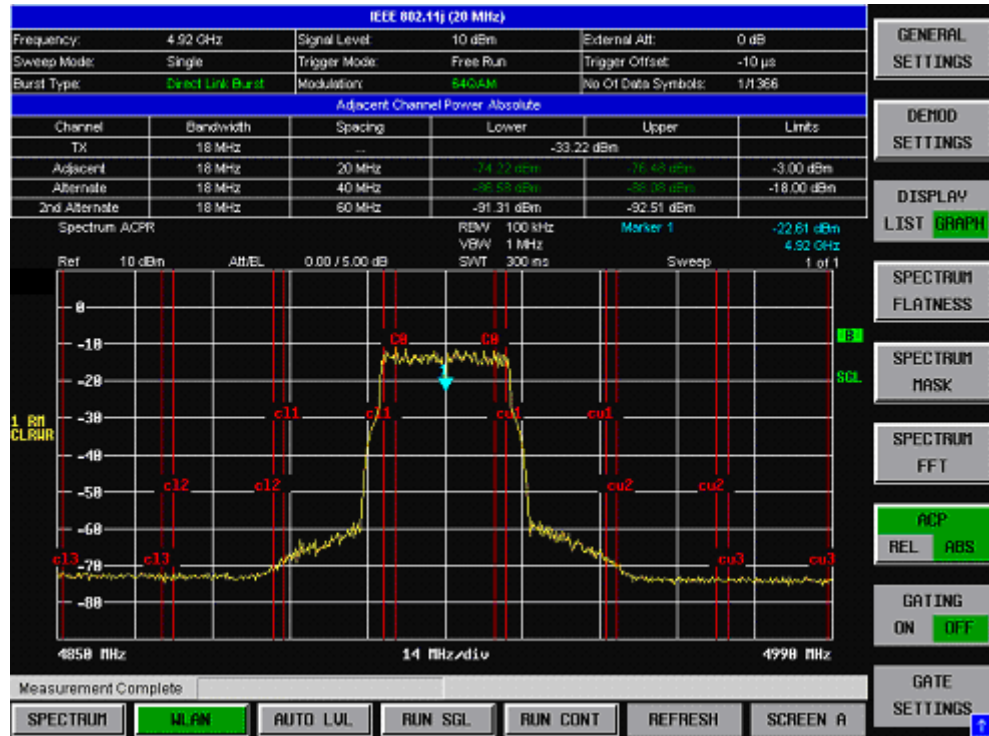


Fig. 2-24 Spectrum ACPR Results

The Spectrum ACPR (Adjacent Channel Power (Relative)) is similar to the Spectrum Mask measurement, and 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 the same as the Adjacent Channel Power measurement provided by the Spectrum Analyzer. If the *Sweep Count (Mask/ACP)* parameter in the General Settings view 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 associated limit.

Automatic Level Detection

Automatic level detection allows the Signal Level setting to be calculated from the input signal.

Automatic level detection can be performed in one of two ways:

Pressing the *AUTO LVL* hot-key
Setting *Auto Level* in the General Settings view to ON

Running the Automatic Level Detection by pressing the *AUTO LVL* hotkey allows the level detection to be run at any time. Once the Automatic Level Detection has been completed, the trace is displayed in the Magnitude Capture Buffer display.

Running the Automatic Level Detection by setting *Auto Level* in the General Settings view to ON means that an Automatic Level Detection measurement is executed before each main measurement sweep.

When running the Automatic Level Detection this way, no trace for the Automatic Level Detection measurement is displayed. This way of running the Automatic Level Detection will cause measurements to run more slowly. Thus, it is recommended that Automatic Level Detection is run in this way only when the speed of measurement is not important or when continuous measurements are being run with a signal that varies in level from one sweep to the next.

Hint for manually changing the Reference Level with *Auto Level* = OFF

To let the K91 automatically adjust the internal attenuator
-> switch AUTO LEVEL = on
-> set the RefLvl ---> the Atten will be adjusted accordingly
-> switch AUTO LEVEL = off.

Automatic Level Detection Vs Manual Settings

In most situations, automatic level detection provides the simplest and most accurate method for setting the signal level. In some cases, it may be preferable to use manual settings to specify the signal level, e.g:

- The automatic level detection algorithm uses a free-run trigger and a sweep time of 100 ms. If the signal being measured has an idle period between bursts of greater than 100 ms, automatic level detection cannot be used.
- The automatic level detection can be used for signals with bursts of varying level only if the highest level burst is always analyzed in a 100 ms sweep.
- If measurement speed or reduction of the mechanical attenuator use is a priority, manual settings should be used.
- The automatic level detection algorithm does not work successfully for signals near 0 Hz. Manual settings should be used in this case.

In the above cases, the *Auto Level* setting in the General Settings view should be switched off. The Signal Level, Reference Level and Attenuation settings can then be set in the Advanced Settings in the General settings view. See Section *Advanced Settings* for further details.

Running measurements

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

A single measurement will complete once the requested number of bursts has been obtained or a single sweep has been completed, depending on the measurement settings. When a measurement is completed in continuous mode, a new measurement will be started.

Note: 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*".

Measurement results

Measurement results

The tabular section below the title bar shows the overall measurement settings used to obtain the current measurement results.

IEEE 802.11a			
Frequency:	4 GHz	Signal Level:	0 dBm
Sweep Mode:	Single	External Att:	0 dB
Burst Type:	Direct Link Burst	Trigger Mode:	Free Run
		Trigger Offset:	0 s
		Modulation:	64QAM
		No Of Data Symbols:	1/1366

Fig. 2-25 Overall measurement settings summary for IEEE 802.11a , g (OFDM), j and Turbo Mode

IEEE 802.11b			
Frequency:	20 GHz	Ref Level:	30 dBm
Sweep Mode:	Single	External Att:	0 dB
Preamble Type:	Long PLCP	Trigger Mode:	Free Run
		Trigger Offset:	-10 µs
		Modulation:	1 Mbps DBPSK
		PSDU Data Length:	1/4095 Bytes

Fig. 2-26 Measurement settings summary for IEEE 802.11b & g (Single Carrier)

The settings summary includes the following information:

- Frequency The frequency of the measured input signal. Note that no value is displayed in this field when baseband input is selected.
- Sweep Mode Shows “Single” for a single measurement and “Continuous” for a continuous measurement.
- Burst Type The type of burst being analyzed. IEEE 802.11a, g (OFDM), j and Turbo Mode only.
- Preamble Type The type of preamble of analyzed bursts. IEEE 802.11b & g (Single Carrier) only.
- Signal Level The expected mean signal level for the input signal. IEEE 802.11a, g (OFDM), j and Turbo Mode only.
- Ref Level The reference level used for the input signal. IEEE 802.11b & g (Single Carrier) only.
- Trigger Mode The trigger source used to start the measurement sweep.
- Modulation Shows either the settings of the *Demodulator* or *PSDU Modulation to Analyze* from the Demod Settings view depending on which parameter is active.
- External Att The attenuation (positive values) or gain (negative values) applied to the signal external (i.e. before the RF or IQ connector of the spectrum analyzer).
 For example:
 External Att = 10 dB means that a 10 dB attenuator is used before the RF connector of the R&S FSQ
 External Att = -20 dB means that an amplifier with 20 dB gain is used before the RF-connector of the R&S FSQ
- Trigger Offset The trigger delay (positive value) or pre-trigger time (negative value) applied to the trigger.
- No Of Data Symbols Shows the minimum and maximum number of data symbols that a burst may have if it is to be considered in results analysis. IEEE 802.11a, g (OFDM), j and Turbo Mode only.
- PSDU Data Length Shows the minimum and maximum number of data bytes that a burst may have if it is to be considered in results analysis. IEEE 802.11b & g (Single Carrier) only.

Results Summary

The results summary table is displayed for IQ measurements when the display mode is set to List. This table shows the overall measurement results and provides limit checking for result values in accordance with the selected standard.

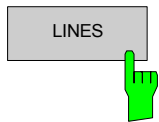
IEEE 802.11a						
Frequency:	20 GHz	Signal Level:	0 dBm	External Att:	0 dB	
Sweep Mode:	Single	Trigger Mode:	Free Run	Trigger Offset:	-10 µs	
Burst Type:	Direct Link Burst	Modulation:	64QAM	No Of Data Symbols:	1/1368	
Result Summary						
No. of Bursts	4					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Carriers	0.65	0.69	5.62	0.71	5.62	%
	-43.76	-43.28	-25.00	-42.98	-25.00	dB
EVM Data Carriers	0.66	0.69	5.62	0.72	5.62	%
	-43.59	-43.19	-25.00	-42.89	-25.00	dB
EVM Pilot Carriers	0.47	0.60	39.81	0.67	39.81	%
	-46.59	-44.42	-8.00	-43.46	-8.00	dB
IQ Offset	-38.76	-38.70	-15.00	-38.66	-15.00	dB
Gain Imbalance	-0.12	-0.11		-0.09		%
	-0.01	-0.01		-0.01		dB
Quadrature Offset	-0.08	-0.06		-0.05		°
Center Frequency Error	-406.42	-408.24	± 400000	-410.36	± 400000	Hz
Symbol Clock Error	0.08	0.04	± 20	-0.27	± 20	ppm
Burst Power	-19.96	-19.85		-19.75		dBm
Crest Factor	8.99	9.31		9.50		dB
Measurement Complete						
SPECTRUM WLAN AUTO LUL RUN SGL RUN CONT REFRESH SCREEN B						

Fig. 2-27 Result Summary Table

Result values that are within the limit specified by the standard are displayed in green. Result values that are outside the limits specified by the standard are displayed in red with a '*' to the left. Results that have no limits specified by the standard are displayed in white. Limit values are displayed in white (not bold).

For a detailed explanation of the results displayed in the Results Summary table, see Section 3.

The limit values in the table of results can be modified.

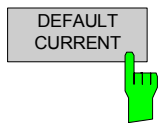


Pressing the *LINES* hardkey allows limits to be selected and modified.

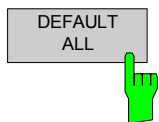
IEEE 802.11a						
Frequency:	20 GHz	Signal Level:	0 dBm	External Att:	0 dB	
Sweep Mode:	Single	Trigger Mode:	Free Run	Trigger Offset:	-10 µs	
Burst Type:	Direct Link Burst	Modulation:	64QAM	No Of Data Symbols:	1/306	
Result Summary						
No. of Bursts	4					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Carriers	0.65	0.69	5.62	0.71	5.62	%
	-43.76	-43.28	-25.00	-42.98	-25.00	dB
EVM Data Carriers	0.66	0.69	5.62	0.72	5.62	%
	-43.59	-43.19	-25.00	-42.69	-25.00	dB
EVM Pilot Carriers	0.47	0.60	39.81	0.67	39.81	%
	-46.59	-44.42	-8.00	-43.46	-8.00	dB
IQ Offset	-38.76	-38.70	-15.00	-38.56	-15.00	dB
Gain Imbalance	-0.12	-0.11		-0.09		%
	-0.01	-0.01		-0.01		dB
Quadrature Offset	-0.08	-0.06		-0.05		°
Center Frequency Error	-406.42	-408.24	± 400000	-410.35	± 400000	Hz
Symbol Clock Error	0.09	0.04	± 20	-0.27	± 20	ppm
Burst Power	-19.96	-19.85		-19.75		dBm
Crest Factor	8.99	9.31		9.50		dB
Measurement Complete						
SPECTRUM MEAN AUTO LUL RUN SGL RUN CONT REFRESH SCREEN B						
						DEFAULT CURRENT
						DEFAULT ALL

Fig. 2-28 Editing Limit Values

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* hardkey resets all limits for the current modulation scheme to the values specified in the selected standard.



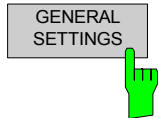
Pressing the *DEFAULT ALL* hardkey resets all limits for all modulation schemes to the values specified in the selected standard.

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

If more than one burst is evaluated (several analyzed bursts 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 burst results.

General Settings

This section of the user manual describes the General Settings view where all settings related to the overall measurement can be modified, i.e. the Signal Characteristics, Data Capture, Trigger, IQ, Input and Advanced Settings.



The *GENERAL SETTINGS* softkey brings up the General Settings view.

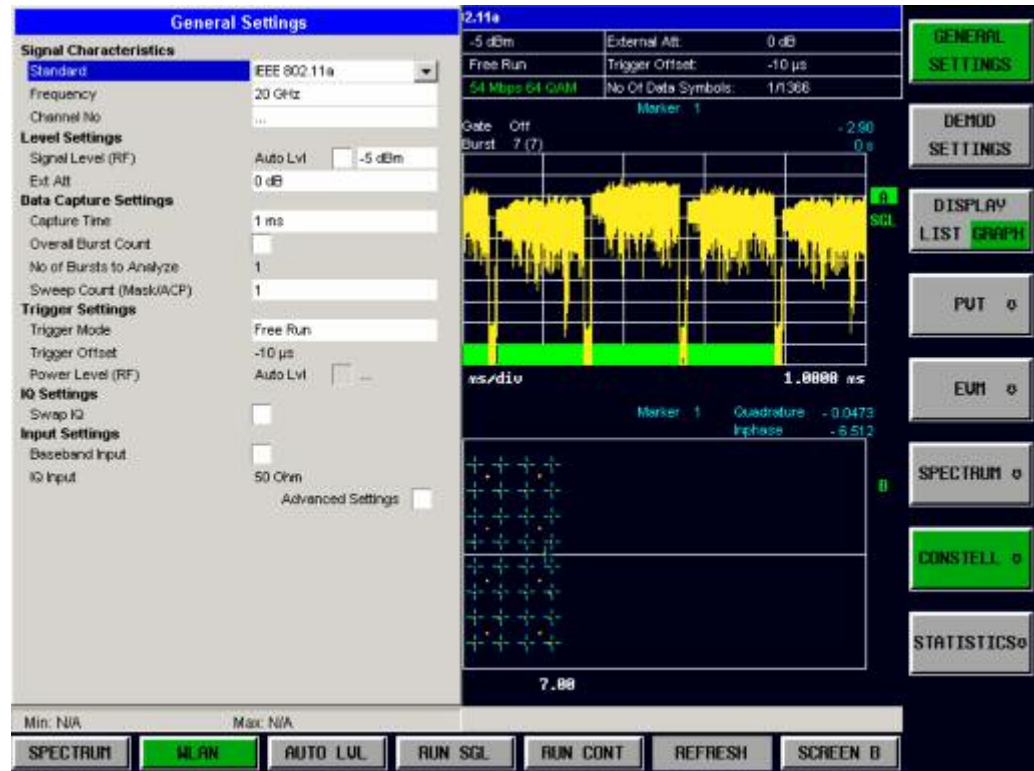


Fig. 2-29 General Settings view

The parameters within the General settings view are logically grouped together into:

- Signal Characteristics
- Level Settings
- Data Capture Settings
- Trigger Settings
- IQ Settings
- Input Settings
- Advanced Settings

Any parameters that are not available for editing will have a grey background. This usually occurs when one parameter setting makes another parameter invalid. For example, if the *Trigger Mode* is Free Run, none of the parameters below this (*Trigger Offset*, *Power Level* and *Auto Power Trigger Level*) has any meaning, so these parameters are greyed out.

When a particular parameter is selected within the General Settings view, the status bar changes to display information about the valid settings for the selected parameter.

Signal Characteristics

The Signal Characteristics settings are the general settings concerning the standard and frequency of the signal to be measured.

Standard



Standard is used to select the wireless LAN standard to be measured against. This is necessary to ensure that the measurements are performed according to the specified standard with the correct limit values and limit lines.

This parameter provides a list of settings. The list provided depends on the standards that have been installed.

Frequency



Frequency specifies the Center Frequency of the signal to be measured.

When the *Frequency* is modified, the *Channel No* parameter is updated accordingly.

The *Frequency* parameter is not editable when baseband input is selected because *Frequency* only makes sense for an RF signal.

Channel No



Channel No specifies the channel to be measured.

When the *Channel No* is modified, the *Frequency* parameter is updated accordingly.

The *Channel No* parameter is not editable when baseband input is selected, because *Channel No* only makes sense for an RF signal.

Level Settings

The Level Settings are the general settings concerning the level of the signal to be measured.

Auto Level



Auto Level selects whether the reference level for measurements is measured automatically (ON) or entered manually by the user (OFF).

When *Auto Level* is set to ON, R&S FSQ-K91 will measure the reference level automatically at the start of each measurement sweep. This ensures that the reference level is always set at the optimum level for obtaining accurate results but will result in slightly increased measurement times. For details about automatic level detection, see section *Automatic Level Detection*.

Signal Level (RF)



Signal Level (RF) specifies the expected mean level of the RF input signal.

The *Signal Level (RF)* is updated after an automatic level detection measurement has been executed when RF input is selected.

The *Signal Level (RF)* parameter is not editable when baseband input is selected because *Signal Level (RF)* only makes sense for an RF signal.

For all standards other than IEEE 802.11b & g that apply when the *Signal Level (RF)* is updated, the *Reference Level* will be set 10 dB higher because of the expected Crest Factor of the signal. For standards IEEE 802.11b & g, the *Reference Level* will be set to the *Signal Level (RF)*.

Signal Level (Baseband)



Signal Level (Baseband) specifies the expected level of the Baseband input signal.

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

The *Signal Level (Baseband)* parameter is not editable when RF input is selected because *Signal Level (Baseband)* only makes sense for a baseband signal.

Ext Att



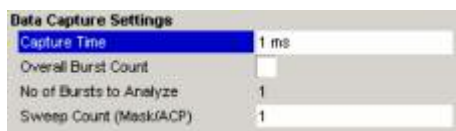
Ext Att specifies the external attenuation or gain applied to the RF signal. A positive value indicates attenuation; a negative value indicates gain.

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

Data Capture Settings

The Data Capture settings specify how much data is to be captured and measured.

Capture Time



Capture Time specifies the time (and therefore the amount of data) to be captured in a single measurement sweep.

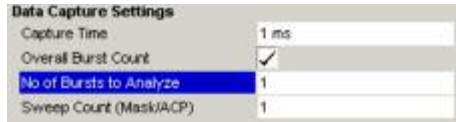
Overall Burst Count



Overall Burst Count specifies whether a specified number of bursts is to be captured and analyzed.

When *Overall Burst Count* is set to OFF, data analysis will be performed on a single measurement sweep. When *Overall Burst Count* is set to ON, data analysis may be performed over a number of consecutive sweeps until the required number of bursts has been captured and analyzed.

No of Burst to Analyze



No of Burst to Analyze specifies the number of bursts to be measured.

If the number of bursts of the specified type is not contained in a single measurement sweep, R&S FSQ-K91 will continue to perform measurement sweeps until the requested number of bursts of the specified type has been captured.

The *No of Burst to Analyze* parameter is not editable when *Overall Burst Count* is set to OFF.

Sweep Count (Mask/ACPR)

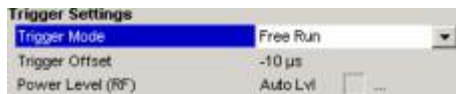


Sweep Count (ACPR/Mask) specifies the number of sweeps that should be performed for Spectrum ACP/ACPR and Spectrum Mask measurements.

Trigger Settings

The Trigger settings contains all the settings related to the triggering of a measurement sweep.

Trigger Mode



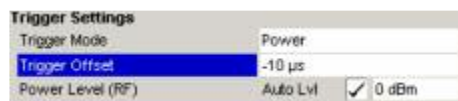
Trigger Mode is the source of the trigger for the measurement sweep.

The possible values for the *Trigger Mode* are:

- Free Run** – The measurement sweep starts immediately.
- External** - Triggering via a TTL signal at the input connector *EXT TRIGGER/GATE* on the rear panel.
- Power** - The measurement sweep starts when the signal power meets or exceeds the specified power trigger level.

Note: The *Trigger Mode* Power setting 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.

Trigger Offset



Trigger Offset specifies the time offset between the trigger signal and the start of the sweep. A negative value indicates a pre-trigger.

The *Trigger Offset* parameter is not editable when *Trigger Mode* is set to Free Run because this indicates that the measurement sweep should trigger immediately. Thus, a trigger delay or pre-trigger would not be appropriate.

Auto Power Trigger Level



Auto Power Trigger Level selects whether the level for the power trigger is measured automatically (ON) or entered manually by the user (OFF).

When *Auto Power Trigger Level* is set to ON, R&S FSQ-K91 will measure and determine the power trigger level automatically at the start of each measurement sweep. This ensures that the power trigger level is always set at the optimum level for obtaining accurate results but will result in slightly increased measurement times.

The *Auto Power Trigger Level* parameter is editable only when *Trigger Mode* is set to Power.

Power Level (RF)



Power Level (RF) specifies the trigger level when a power trigger is selected and RF input is selected.

The *Power Level* parameter is editable only when *Trigger Mode* is set to Power.

The *Power Level (RF)* parameter is not editable when baseband input is selected because *Power Level (RF)* only make sense for an RF signal.

Power Level (Baseband)



Power Level (Baseband) specifies the trigger level when a power trigger is selected and baseband input is selected.

The *Power Level* parameter is editable only when *Trigger Mode* is set to Power.

The *Power Level (Baseband)* parameter is not editable when RF input is selected because *Power Level (Baseband)* only makes sense for a baseband signal.

IQ Settings

The IQ settings contains settings related to the inphase and quadrature phase of the input signal.

Swap IQ

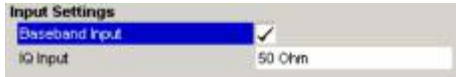


Swap IQ allows selection between normal and inverted I/Q modulation. The settings for this parameter are:
 OFF Normal I/Q modulation.
 ON I and Q signals are interchanged.

Input Settings

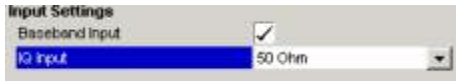
The Input settings contain settings related to the input source of the signal to be measured. Note that this group is only available when the B71 option is installed.

Baseband Input



Baseband Input allows the selection between RF and baseband inputs. The settings for this parameter are:
 OFF RF input
 ON Baseband input

IQ Input



IQ Input allows the selection of the impedance of the baseband inputs. The values that can be selected are 50 Ω and 1 K/1 MΩ (device-dependent).

The *IQ Input* parameter is editable only when baseband input is selected.

Advanced Settings

The Advanced Settings contain settings that control details about how the instrument operates and how measurements are performed.

The advanced settings are displayed on the right-hand side of the general settings view, and are only displayed when the Advanced Settings checkbox is checked.

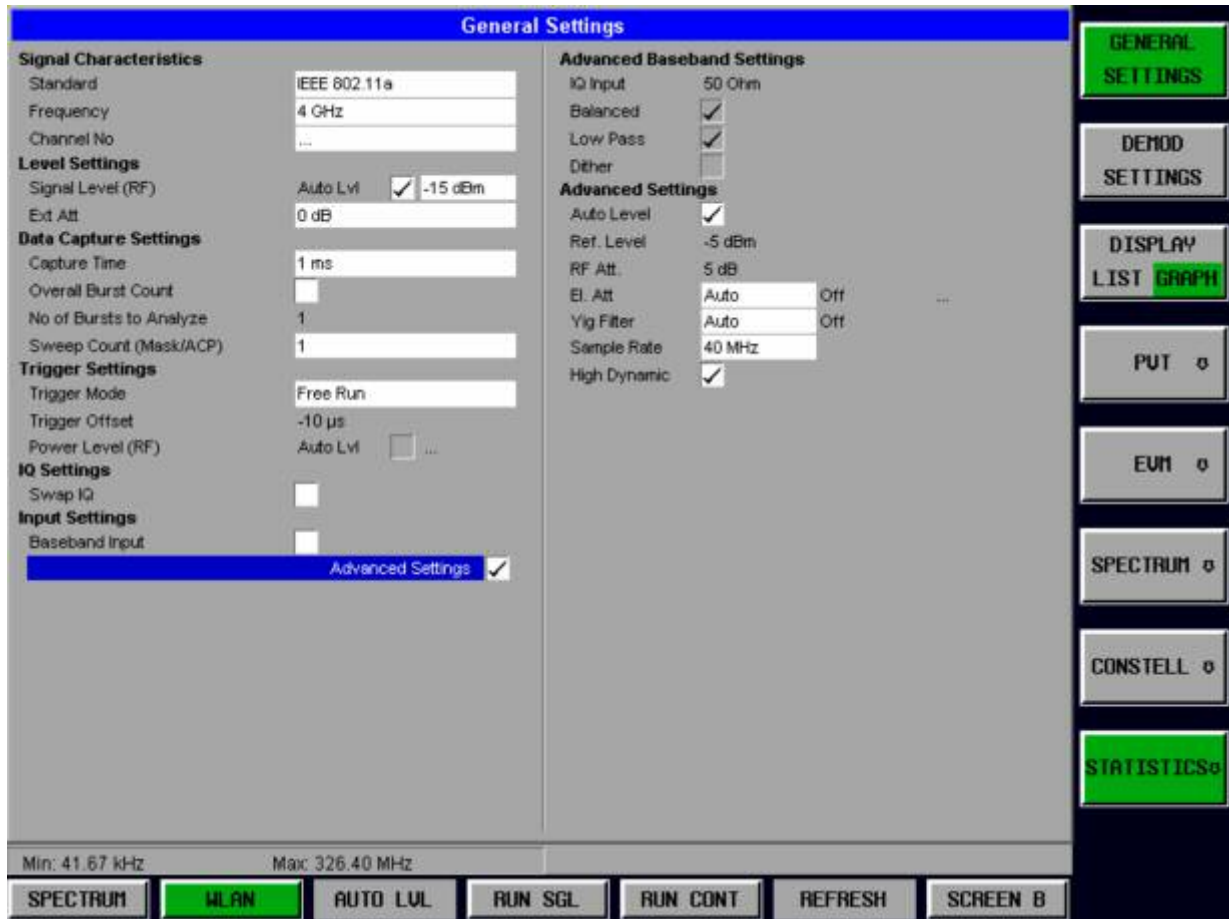
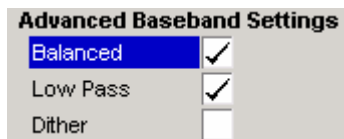


Fig. 2-30 Advanced Settings

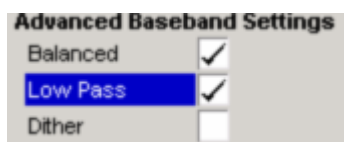
Balanced



Balanced switches the baseband inputs between symmetrical (balanced) and asymmetrical (unbalanced).

The *Balanced* parameter is editable only when baseband input is selected.

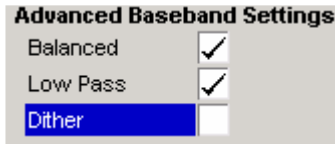
Low Pass



When switched on, the *Low Pass* parameter specifies that a filter is applied from 36 MHz for the IQ inputs.

The *Low Pass* parameter is editable only when baseband input is selected.

Dither



When switched on, the *Dither* parameter specifies that a 2 MHz-wide noise signal at 42.67 MHz is injected into the signal path of the baseband input. It appears in the spectrum at 38.92 MHz.

Auto Level



Auto Level selects whether the reference level for measurements is measured automatically (ON) or entered manually by the user (OFF).

The *Auto Level* advanced setting is the same as the *Auto Level* in the Signal Characteristics. It is repeated in the Advanced Settings for convenience.

Ref Level



Ref Level specifies the reference level to use when running measurements.

When the *Ref Level* is modified, the *Signal Level* parameter is updated accordingly (depending on the currently selected standard and measurement type).

The *Ref Level* is editable only when *Auto Level* is switched off.

RF Att



The *RF Att* parameters specify the settings for the meachanical attenuator.

The *RF Att* is editable only when *Auto Level* is switched off.

When *Auto Level* is switched on, the *RF Att* setting is coupled to the *Ref Level* setting. When *Auto Level* is switched off, the *RF Att* setting is independent from the *Ref Level* setting and must be specified separately.

EI Att



The *EI Att* parameters specify the settings for the electronic attenuator.

The *EI Att* parameters are:

Mode – Specifies whether the electronic attenuator should be controlled manually (Manual) or by the Auto option

State – Specifies whether the electronic attenuator should be switched ON or OFF

Settings – Specifies the attenuation value the electronic attenuator should be switched to

When the mode is set to Auto, the state and setting fields will be automatically calculated by the option, i.e. fields will not be editable.

When the state is switched off, the setting field is non-editable.

When the frequency is set such that the electronic attenuator cannot be used or the electronic attenuator is not installed, all Electronic Attenuator fields are read-only.

YIG Filter



The *YIG Filter* parameter specifies how the YIG filter is used during measurements.

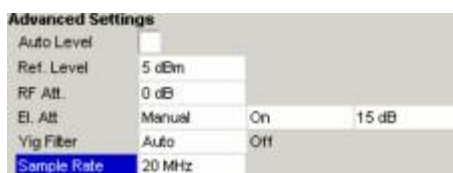
The *YIG Filter* parameters are:

Mode – Specifies whether the YIG filter should be controlled manually (Manual) or by the Auto option

State – Specifies whether the YIG filter should be switched ON or OFF

When the mode is set to Auto, the state field will be automatically calculated by the option, i.e. this field will not be editable.

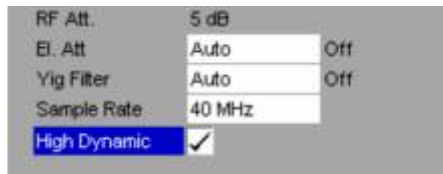
Sample Rate



Sample Rate specifies the sample rate used for IQ measurements

The *Sample Rate* is editable only when *Standard* is set to IEEE 802.11a.

High Dynamic



Sample rates between 20.4 MHz and 40.8 MHz can be supported without using the B72 option with use of the “High Dynamic” setting in the General Settings view.

For sample rates between 20.4 MHz and 40.8 MHz: When High dynamic is switched on then the B72 option will be switched off and measurements will be performed with a wide filter. When “High Dynamic is switched off then the B72 option will be switched on and measurements performed with a normal filter. The advantage with the High Dynamic setting is that a higher resolution is achievable (because the "normal" signal path uses a 14 bit ADC). The disadvantage is that all signals being left or right the spectrum of interest are folded into the spectrum itself. On instruments without the B72 option the High Dynamic settings is always switched on when the sample is set between 20.4 MHz and 40.8 MHz.

Demod Settings

This section of the user manual describes the Demod (short for Demodulation) Settings view where the settings associated with the signal modulation can be modified.

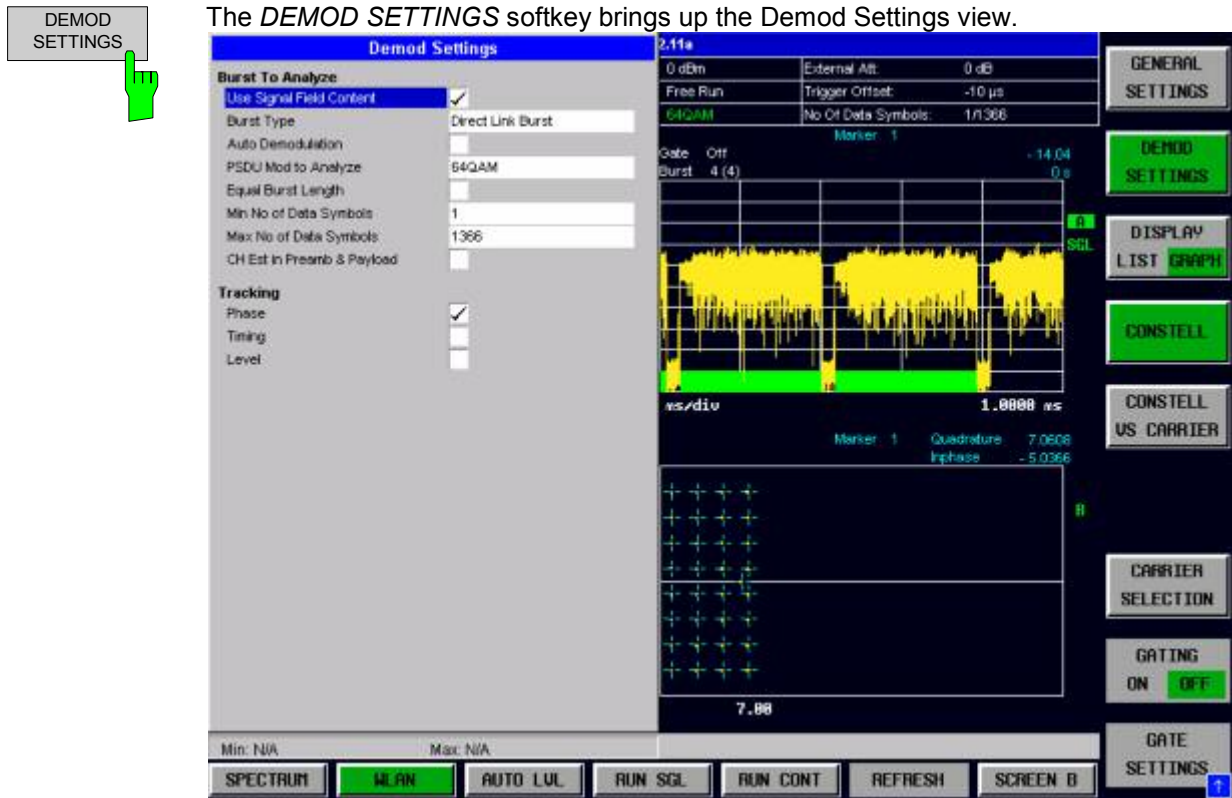


Fig. 2-31 Demod Settings view

The Demod settings are logically grouped together into:

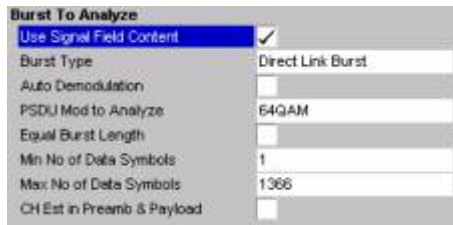
- Burst to Analyze settings
- Tracking settings
- Filter settings

When a particular parameter is selected within the Demod Settings view, the status bar changes to display information about the valid settings for the selected parameter. The parameters available in the Demod setting view are dependent on the currently selected standard.

Burst To Analyze Settings

The Burst to Analyze settings specify the characteristics of the bursts to be considered in the measurement results. Only burst that meet the criteria specified in this group will be included in the measurement analysis.

Use Signal Symbol Field Content (IEEE 802.11a, g (OFDM), j & Turbo Mode only)

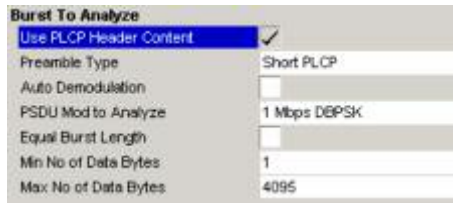


Use Signal Symbol Field Content specifies whether the Signal Symbol field of the captured burst data should be decoded.

When *Use Signal Symbol Field Content* is set to ON, only bursts whose modulation format specified in the signal symbol field matches the modulation format specified in the *PSDU Modulation* parameter are included in the results analysis.

When *Use Signal Symbol Field Content* is set to OFF, the data is demodulated according to the modulation scheme specified in the *Demodulator* parameter. Note: If any of the analyzed data exhibits a modulation different from that specified, the results will be of limited use in this case.

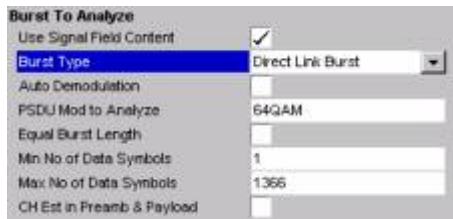
Use PLCP Header Content (IEEE 802.11b & g (Single Carrier) only)



Use PLCP Header Content specifies whether the PLCP Header field of the captured burst data should be decoded.

When *Use PLCP Header Content* is set to ON, only bursts whose modulation format specified in the signal symbol field matches the modulation format specified in the *PSDU Mod to Analyze* parameter are included in the results analysis.

Burst Type (IEEE 802.11a, g (OFDM & Single Carrier), j & Turbo Mode only)



Burst Type specifies the type of burst that should be included in measurement analysis. Only one burst type can be selected for measurement results. The following burst types are supported:

- Direct Link Burst - IEEE 802.11a, j & 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

Preamble Type (IEEE 802.11b only)

Burst To Analyze	
Use PLCP Header Content	<input type="checkbox"/>
Preamble Type	Long PLCP
Auto Demodulation	<input type="checkbox"/>
Demodulator	1 Mbps DBPSK
Equal Burst Length	<input type="checkbox"/>
Min Payload Length	8 <input type="text"/> μ s 1 <input type="text"/> Bytes
Max Payload Length	32760 <input type="text"/> μ s 4095 <input type="text"/> Bytes

Preamble Type specifies the type of burst that should be included in measurement analysis. The following preamble types are supported:

Short PLCP
Long PLCP

Auto Demodulation

Burst To Analyze	
Use Signal Field Content	<input checked="" type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	64QAM
Equal Burst Length	<input type="checkbox"/>
Min No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

Auto Demodulation specifies whether or not the modulation to be applied to the measured data should be automatically detected.

When *Auto Demodulation* is set to ON, the modulation applied to the input data is determined from the modulation type of the first complete burst within the captured data.

Auto Demodulation uses the data held in the signal field of the burst and, thus, is available only when *Use Signal Symbol Field Content* is set to ON

Demodulator

Burst To Analyze	
Use Signal Field Content	<input type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
Demodulator	64QAM
Equal Burst Length	<input type="checkbox"/>
Min No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

Demodulator is used to specify the modulation to be applied to the measured data. If the captured data uses a modulation scheme different from that specified by this parameter, the results will be of limited use.

Demodulator is available only when *Use Signal Symbol Field Content* is set to OFF.

PSDU Mod to Analyze

Burst To Analyze	
Use PLCP Header Content	<input checked="" type="checkbox"/>
Preamble Type	Short PLCP
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	1 Mbps DBPSK
Equal Burst Length	<input type="checkbox"/>
Min No of Data Bytes	1
Max No of Data Bytes	4095

PSDU Mod to Analyze is used to specify the modulation of the bursts to be analyzed. Only bursts using the selected modulation are considered in measurement analysis.

PSDU Mod to Analyze is available only when *Use Signal Symbol Field Content* is set to ON

Equal Burst Length

Equal Burst Length allows bursts with a range of data symbols/bytes or bursts with a specific number of data symbols/bytes to be selected for measurement analysis.

IEEE 802.11a, j & Turbo Mode only

When *Equal Burst Length* is set to ON, the next parameter in the group becomes *No of Data Symbols* and only bursts with exactly the number of symbols specified in *No of Data Symbols* are considered for measurement analysis.

When *Equal Burst Length* is set to OFF, the next parameter in the group becomes *Min No of Data Symbols* and bursts with a number of data symbols within the range specified by the *Min No of Data Symbols* and *Max No of Data Symbols* parameters take part in measurement analysis.

IEEE 802.11b & g (Single Carrier) only

When *Equal Burst Length* is set to ON, the next parameter in the group becomes *Payload Length* and only bursts with exactly the number of bytes or duration specified in *Payload Length* are considered for measurement analysis.

When *Equal Burst Length* is set to OFF, the next parameter in the group becomes *Min Payload Length* and bursts with a number of data bytes or duration within the range specified by the *Min Payload Length* and *Max Payload Length* parameters take part in measurement analysis.

IEEE 802.11 g (OFDM only)

When *Equal Burst Length* is set to ON, the next parameter in the group becomes *Payload Length* and only bursts with exactly the number of symbols or duration specified in *Payload Length* are considered for measurement analysis.

When *Equal Burst Length* is set to OFF, the next parameter in the group becomes *Min Payload Length* and bursts with a number of data bytes or duration within the range specified by the *Min Payload Length* and *Max Payload Length* parameters take part in measurement analysis.

No of Data Symbols (IEEE 802.11a, j & Turbo Mode only)

Burst To Analyze	
Use Signal Field Content	<input checked="" type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	64QAM
Equal Burst Length	<input checked="" type="checkbox"/>
No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

No of Data Symbols specifies the number of data symbols a burst must have for it to be considered in measurement analysis.

No of Data Symbols is only available when *Equal Burst Length* is set to ON.

Min No of Data Symbols (IEEE 802.11a, j & Turbo Mode only)

Burst To Analyze	
Use Signal Field Content	<input checked="" type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	64QAM
Equal Burst Length	<input type="checkbox"/>
Min No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

Min No of Data Symbols specifies the minimum number of data symbols a burst must have for it to be considered in measurement analysis.

Min No of Data Symbols is only available when *Equal Burst Length* is set to OFF.

Max No of Data Symbols(IEEE 802.11a_i, j & Turbo Mode only)

Burst To Analyze	
Use Signal Field Content	<input checked="" type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	64QAM
Equal Burst Length	<input type="checkbox"/>
Min No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

Max No of Data Symbols specifies the maximum number of data symbols a burst must have for it to be considered in measurement analysis.

Max No of Data Symbols is only available when *Equal Burst Length* is set to OFF.

Payload Length (IEEE 802.11b & g only)

Burst To Analyze	
Use Header Content	<input type="checkbox"/>
Burst Type	OFDM
Auto Demodulation	<input type="checkbox"/>
Demodulator	54 Mbps 64 QAM
Equal Burst Length	<input checked="" type="checkbox"/>
CH Est in Preamb & Payload	<input type="checkbox"/>
Payload Length	4 μ s 1 Symbols
Max Payload Length	5464 μ s 1366 Symbols

Payload Length specifies the number of symbols, bytes or duration a burst must have for it to be considered in measurement analysis.

Payload Length is only available when *Equal Burst Length* is set to ON.

Min Payload Length (IEEE 802.11b & g only)

Burst To Analyze	
Use Header Content	<input type="checkbox"/>
Burst Type	OFDM
Auto Demodulation	<input type="checkbox"/>
Demodulator	54 Mbps 64 QAM
Equal Burst Length	<input type="checkbox"/>
CH Est in Preamb & Payload	<input type="checkbox"/>
Min Payload Length	4 μ s 1 Symbols
Max Payload Length	5464 μ s 1366 Symbols

Min Payload Length specifies the minimum number of symbols, bytes or duration a burst must have for it to be considered in measurement analysis.

Min Payload Length is only available when *Equal Burst Length* is set to OFF.

Max Payload Length(IEEE 802.11b & g (Single Carrier) only)

Burst To Analyze	
Use PLCP Header Content	<input checked="" type="checkbox"/>
Preamble Type	Short PLCP
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	1 Mbps DBPSK
Equal Burst Length	<input type="checkbox"/>
Min No of Data Bytes	1
Max No of Data Bytes	4095

Max Payload Length specifies the maximum number of symbols, bytes or duration a burst must have for it to be considered in measurement analysis.

Max Payload Length is only available when *Equal Burst Length* is set to OFF.

Chan Est in Preamb and Payl (IEEE 802.11a_i, g (OFDM), j & Turbo Mode only)

Burst To Analyze	
Use Signal Field Content	<input checked="" type="checkbox"/>
Burst Type	Direct Link Burst
Auto Demodulation	<input type="checkbox"/>
PSDU Mod to Analyze	64QAM
Equal Burst Length	<input type="checkbox"/>
Min No of Data Symbols	1
Max No of Data Symbols	1366
CH Est in Preamb & Payload	<input type="checkbox"/>

Chan Est in Preamb and Payl specifies how accurately the EVM results should be calculated.

When *Chan Est in Preamb and Payl* is set to OFF, the EVM results are calculated in accordance with the selected standard. In this case, channel estimation is done in the preamble only.

When *Chan Est in Preamb and Payl* is set to ON, the EVM results are calculated more accurately. In this case, channel estimation is done in payload.

Tracking Settings

The tracking settings allow various errors in measurement results to be compensated for.

Phase

Tracking	
Phase	<input checked="" type="checkbox"/>
Timing	<input checked="" type="checkbox"/>
Level	<input checked="" type="checkbox"/>

Phase is used to specify whether or not the measurement results should be compensated for phase error.

When *Phase* is set to ON, the measurement results will be compensated for phase error on a per-symbol basis.

Timing

Tracking	
Phase	<input checked="" type="checkbox"/>
Timing	<input checked="" type="checkbox"/>
Level	<input checked="" type="checkbox"/>

Timing is used to specify whether or not the measurement results should be compensated for timing error.

When *Timing* is set to ON, the measurement results will be compensated for timing error on a per-symbol basis.

Level

Tracking	
Phase	<input checked="" type="checkbox"/>
Timing	<input checked="" type="checkbox"/>
Level	<input checked="" type="checkbox"/>

Level is used to specify whether or not the measurement results should be compensated for level error.

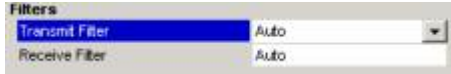
When *Level* is set to ON, the measurement results will be compensated for level error on a per-symbol basis.

Filter Settings (IEEE 802.11b & g only)

The filter settings specify the filters to be used.

Note: 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.

Transmit Filter



Specifies the transmit filter to be used.

The settings provided by default are:

- Auto – Specifies the default filter
- DefRecieve – Default receive filter
- DefTransimt - Default transmit filter

See also chapter “Signal Processing of the IEEE802.11b application”.

Recieve Filter



Specifies the recieve filter to be used.

The settings provided by default are:

- Auto – Specifies the default filter
- DefRecieve – Default receive filter
- DefTransimt - Default transmit filter

See also chapter “Signal Processing of the IEEE802.11b application”.

Gate Settings

This section of the user manual describes the Gate Settings. The gate settings allow the range of captured data used in results calculation to be specified.

When gating is switched on, vertical lines are displayed in the Magnitude Capture trace. The two lines mark the area of data to be used in the calculation of results

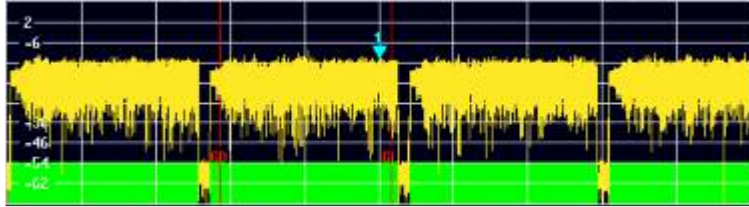


Fig. 2-32 Gate lines displayed in Magnitude Capture Buffer

The gate settings can be used to specify the region of input data to analyze for the following measurements:

- PVT
- Spectrum FFT
- CCDF
- Spectrum Mask
- Spectrum ACP

The softkeys for accessing the gate settings are accessed from each of the measurement softkey menus. Press the NEXT hardkey to access the gate setting menu.

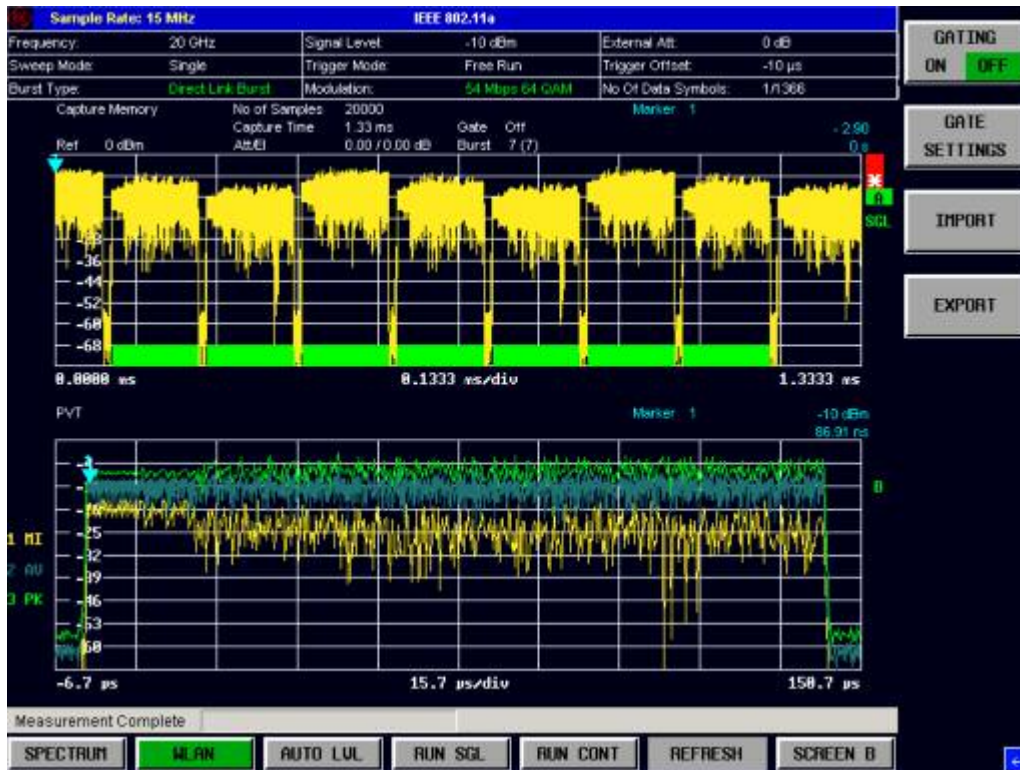
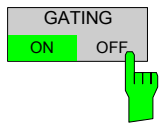
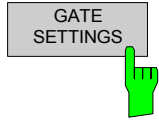


Fig. 2-33 Gate Settings menu view



The *GATING* softkey allows gating to be switched on or off.

When gating is switched off, all captured data is used in results calculation.



The *GATE SETTINGS* softkey displays the Gate Settings pop-up dialog.

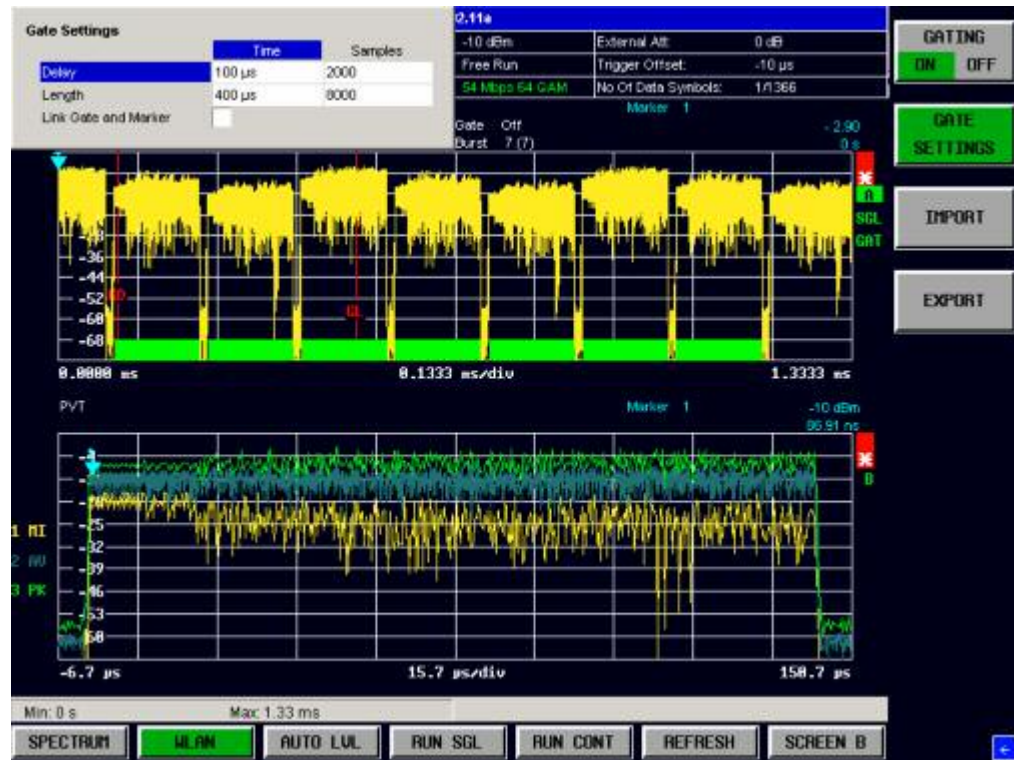


Fig. 2-34 Gate Settings pop-up dialog

Gate Settings

The gate settings specify the characteristics of the gate to be applied to the measurement. Note: If the gate settings dialog is displayed while a frequency sweep measurement is active (Spectrum Mask and Spectrum ACP), the measurement view automatically switches to the Magnitude Capture Buffer display in order to allow the gate to be set to the correct part of the sweep.

Delay

Gate Settings		
	Time	Samples
Delay	129 μ s	2579
Length	196 μ s	3920
Link Gate and Marker	<input type="checkbox"/>	

Delay specifies the starting point of captured data to be used in results calculation, i.e. the delay from the start of the captured data.

Delay can be specified in the following ways:

- Time
- Samples

When the delay is specified in one unit, the other unit field is updated accordingly.

When a value is supplied for the gate delay (in any unit), the gate delay line in the Magnitude Capture Buffer (marker with GD) is displayed in the new position.

Length

Gate Settings		
	Time	Samples
Delay	129 μ s	2579
Length	196 μ s	3920
Link Gate and Marker	<input type="checkbox"/>	

Length specifies the amount of captured data to be used in results calculation.

Length can be specified in the following ways:

- Time
- Sample

When the length is specified in one unit, the other unit field is updated accordingly.

When a value is supplied for the gate length (in any unit), the gate length line in the Magnitude Capture Buffer (marker with GL) is displayed in the new position.

Link Gate and Marker

Gate Settings		
	Time	Samples
Delay	129 μ s	2579
Length	196 μ s	3920
Link Gate and Marker	<input type="checkbox"/>	

Link Gate and Marker allows the position of the marker and the gate lines to be linked.

When *Link Gate and Marker* is switched ON, the marker is positioned half way between the gate start and the gate end. The marker position alters when the gate is modified, and the gate lines move with the marker when the marker position is altered.

Import/Export of IQ Data

This section of the user manual describes the IQ Data Import/Export function, which allows the captured IQ data to be saved and recalled to and from an external file.

The format for the IQW file used by the export/import feature is as follows:

The file is a binary file. Each I and each Q value is written as a 32bit floating point number. All I sample points are written first in chronological order, followed by all the Q points. Thus 1000 IQ samples would be written in the following format

<1000 * 32bit floating point I data><1000 * 32bit floating point Q data>

The unit of the samples is volt. With the input impedance of 50ohm you can directly calculate the power with $P=U^2/R$.

The softkeys for accessing the import/export IQ data settings are located in each of the measurement softkey menus. Press the NEXT hardkey to access the import/export softkeys.

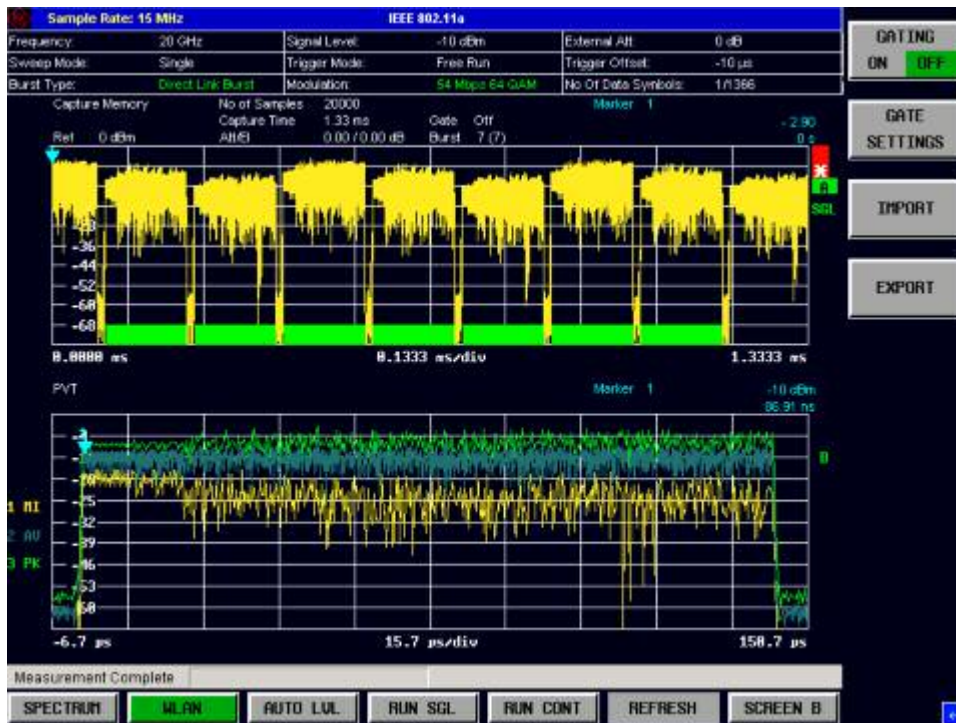
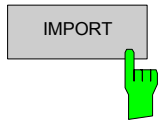


Fig. 2-35 Gate Settings pop-up dialog



The *IMPORT* softkey displays the Import pop-up dialog.

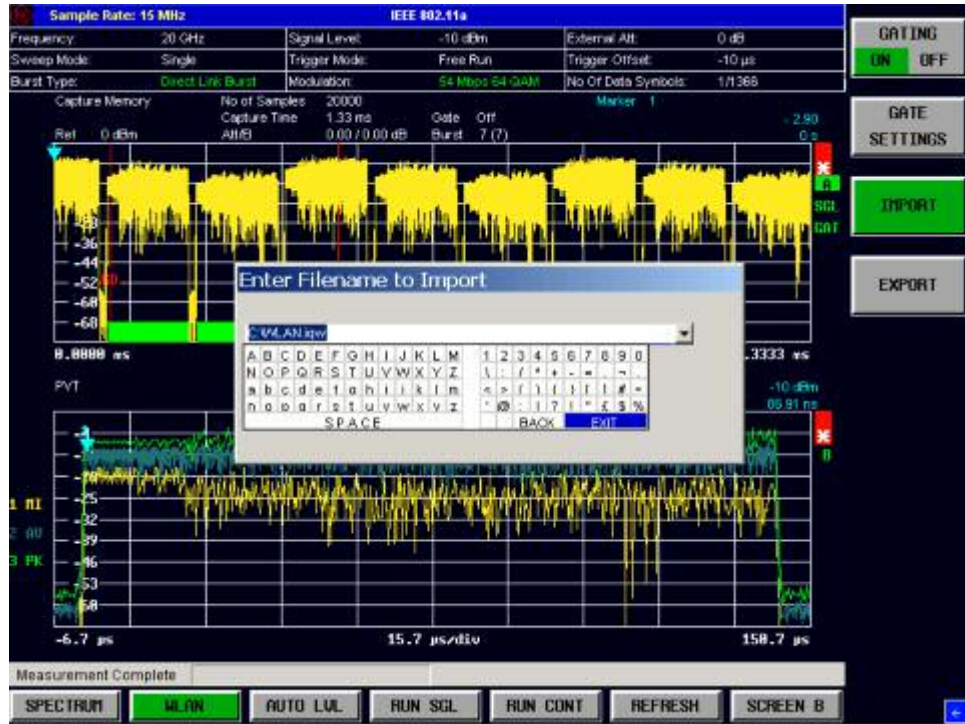
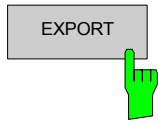


Fig. 2-36 Import pop-up dialog

The import pop-up dialog allows the full name and path of the IQ data file to be imported to be specified. Pressing ENTER causes the specified IQ data file to be loaded and the results displayed.

If the specified file cannot be found or is not a valid IQ data file, an error message will be displayed indicating that the IQ data could not be imported.



The EXPORT softkey displays the Export pop-up dialog.

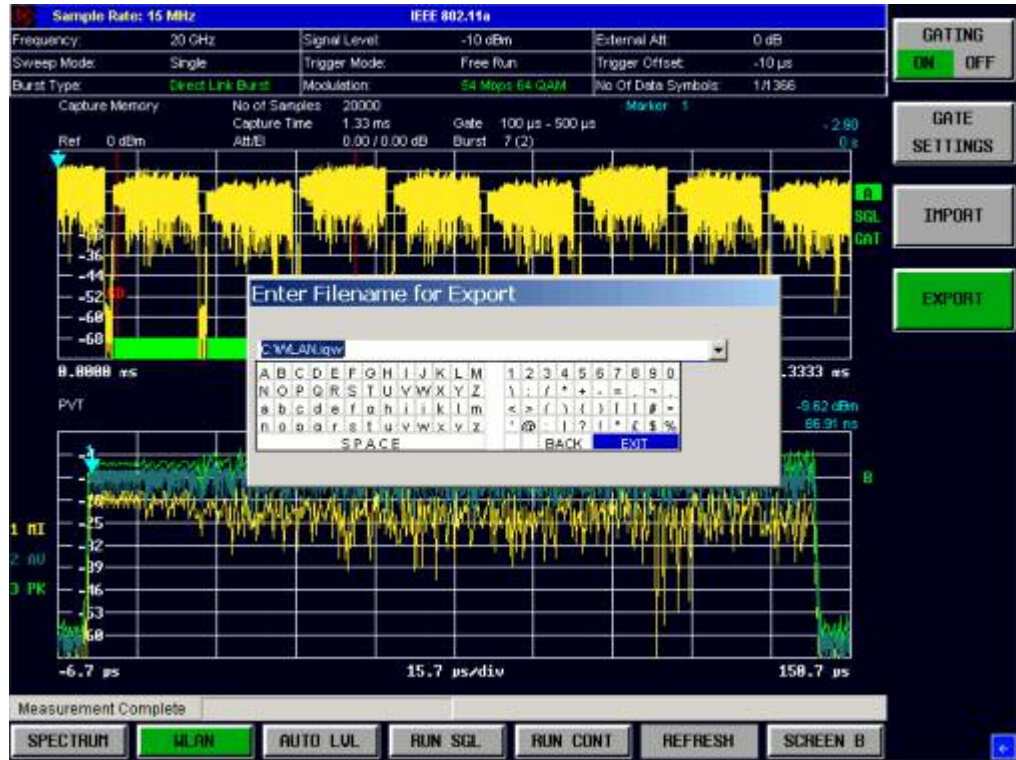


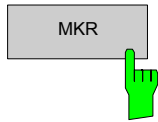
Fig. 2-37 Export pop-up dialog

The export pop-up dialog allows the full name and path of the IQ data file to be exported to be specified. Pressing ENTER causes the IQ data to be written to the specified file.

If the specified file cannot be created or if there is no valid IQ data to export (i.e. IQ measurement has not been executed), an error message will be displayed indicating that the IQ data could not be exported.

Markers

This section of the user manual describes the Marker facility of the option.



The *MKR* hardkey brings up the marker softkey menu. Any setting views on display when the marker softkey menu is displayed will be closed.

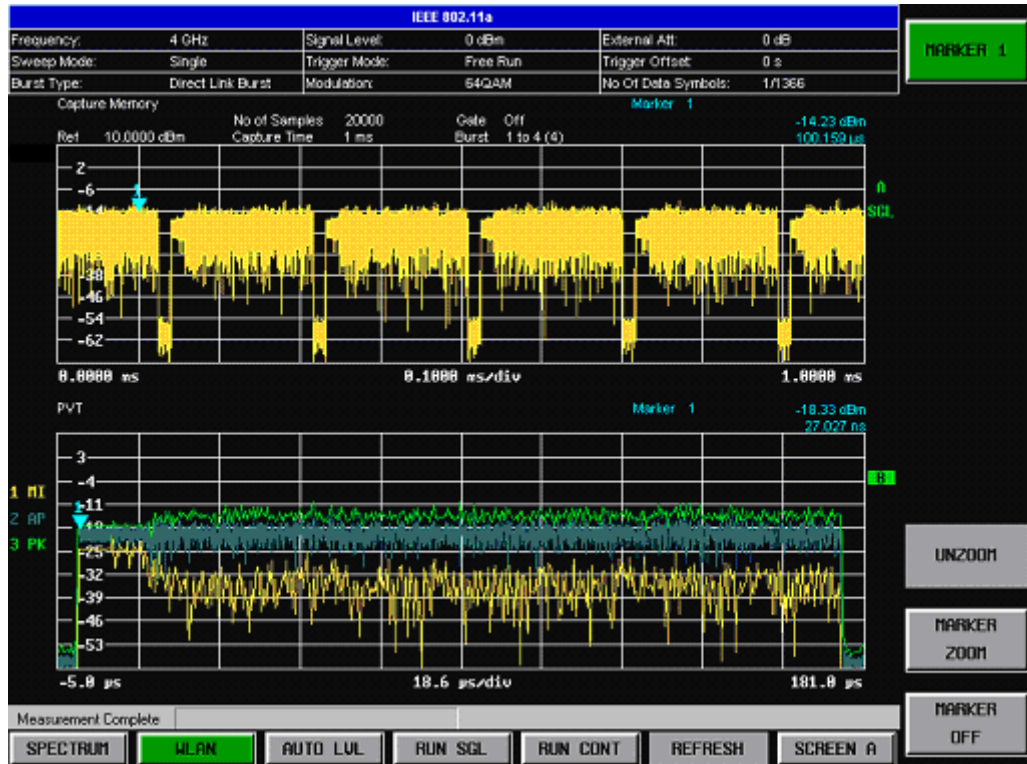
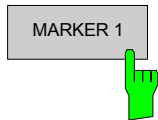


Fig. 2-38 Marker menu

From the marker menu, it is possible to adjust the marker position, use the marker to zoom in & out and switch the marker display off.

Adjusting Markers

The marker can be adjusted by pressing the marker softkey in the marker softkey menu.



The *MARKER* softkey displays the marker pop-up dialog. The contents of the marker pop-up depends on the type of graph to which the marker being adjusted belongs.

As soon as a field in the marker pop-up dialog is adjusted, the marker position in the trace will update, along with the results displayed for the marker.

Marker Zoom

A zoom facility is available for markers belonging to the following result traces:

- Magnitude Capture
- PVT
- Constellation Vs Symbol
- Constellation Vs Carrier

MARKER
ZOOM



The *MARKER ZOOM* softkey displays the Marker Zoom pop-up dialog which contains the magnification factor for the zoom.

The maximum magnification depends on the type of results trace.

UNZOOM



The *UNZOOM* softkey cancels the marker zoom.

Toggle Marker Display

Markers can be toggled by pressing the marker softkey as follows:

MARKER 1



Pressing the *MARKER* softkey when the marker is not displayed (softkey has grey background) causes the marker pop-up to be displayed and the marker to be switched on.

MARKER 1



Pressing the *MARKER* softkey when the marker pop-up is displayed (softkey has red background) causes the marker to be switched off.

MARKER 1

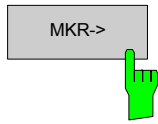


Pressing the *MARKER* softkey when the marker is displayed but the marker pop-up is not displayed (softkey has green background) causes the marker pop-up to be displayed.

All markers in the active screen can be switched off by pressing the *MARKER OFF* softkey.

Assigning Markers to Traces

In result graphs that have more than one trace (e.g. PVT), the marker can be assigned to any of the displayed traces



Pressing the *MKR->* hardkey displays the Marker Extension softkey menu.

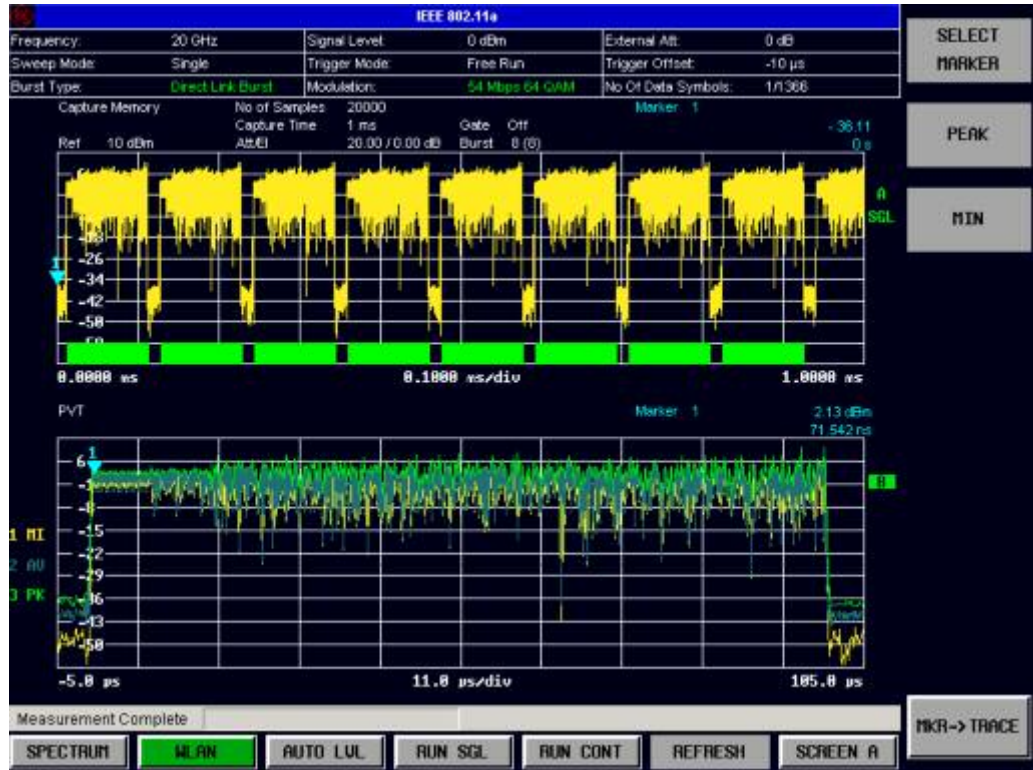
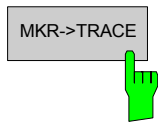


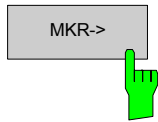
Fig. 2-39 Marker Extension softkey menu



Pressing the *MKR->TRACE* displays the Select Trace pop-up dialog. This allows the ID of the trace to which the marker is to be attached to be supplied.

Assigning Markers to Peak/Min

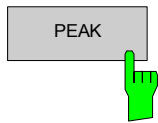
In the Spectrum Flatness measurement results graph, the marker can be assigned to the peak or minimum value for the currently allocated trace



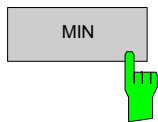
Pressing the *MKR->* hardkey displays the Marker Extension softkey menu.



Fig. 2-40 Marker Extension Softkey Menu



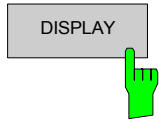
Pressing the *PEAK* softkey sets the marker to the peak value for the allocated trace.



Pressing the *MIN* softkey sets the marker to the minimum value for the allocated trace.

Display Settings

The layout of the display can be controlled using the display menu.



The *DISPLAY* hardkey brings up the display softkey menu. Any setting views on that are open when the display softkey menu is displayed will be closed.

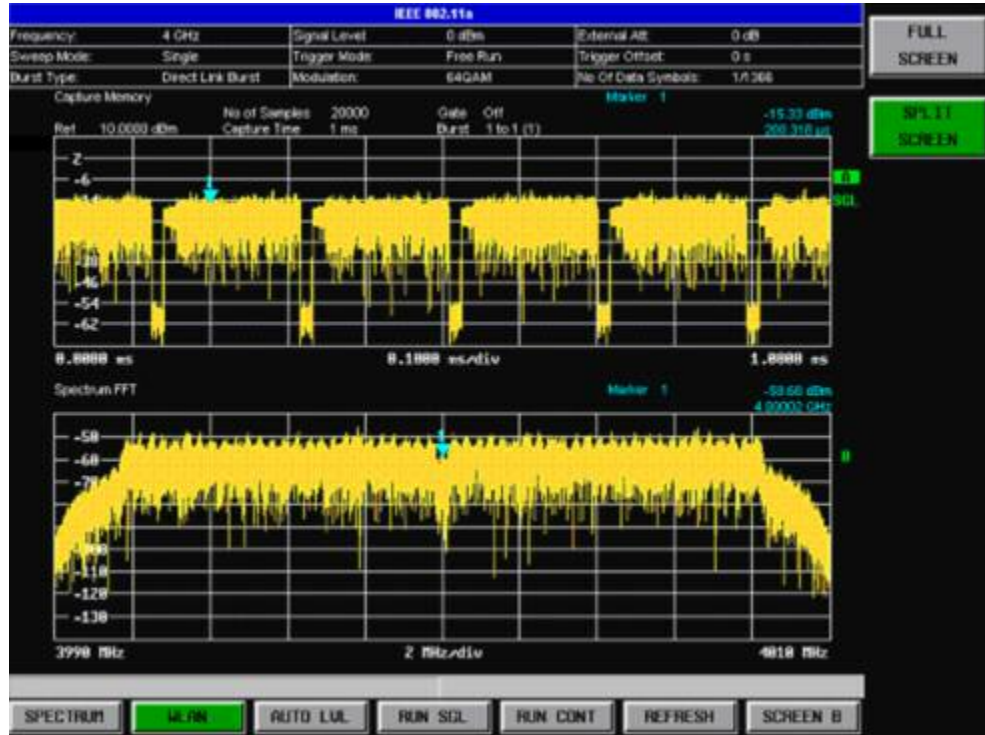


Fig. 2-41 Display Menu

The display menu allows the display to be changed between split-screen and full-screen display for IQ measurement results. Note: For frequency sweep measurement results (Spectrum Mask and Spectrum ACPR), the display is always full screen.

The active screen can be selected by pressing the *SCREEN A/SCREEN B* hotkey. A screen needs to be made active in order to control the markers it displays.

In full-screen mode, the *SCREEN A/SCREEN B* hotkey also toggles which screen is displayed.

3 Measurements in Detail

This section provides a more detailed explanation of the measurements provided by R&S FSQ-K90/91 and provides help for using R&S FSQ-K90/91 to measure the characteristics of specific types of DUT.

Signal Processing of the IEEE802.11a application

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
k	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 IEEE802.11a application signal processing.

A diagram of the blocks of interest is shown in Fig. 3-1. 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.

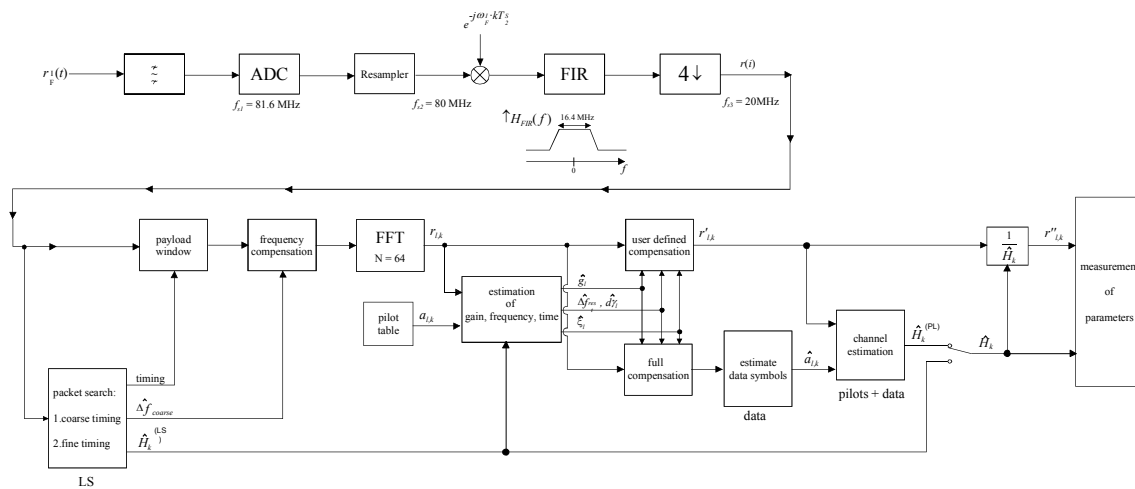


Fig. 3-1 Signal processing of the IEEE 802.11a application

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 Δf_{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 Δf_{coarse}^1 . This is necessary because, otherwise, interchannel interference (ICI) would occur in the frequency domain.

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 $l = [1, \text{nof_symbols}]$ and
- the channel index $k = [-31, 32]$.

In case of an additive white Gaussian noise (AWGN) channel, the FFT is described by [4], [5]

$$r_{l,k} = K_{mod} \cdot a_{l,k} \cdot g_l \cdot H_k \cdot e^{j(\text{phase}_l^{(commom)} + \text{phase}_{l,k}^{(timing)})} + n_{l,k} \quad (1)$$

with

- the modulation-dependent normalization factor K_{mod}

¹ In this paper the hat generally describes an estimate. Example: \hat{x} is the estimate of x .

- 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 $phase_{l,k}^{(timing)}$ 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 in equation (1) is given by

$$phase_l^{(common)} = 2\pi \cdot N_s / N \cdot \Delta f_{rest} \cdot T \cdot l + d\gamma_l \quad (2)$$

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 $\hat{\Delta f}_{coarse}$ (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 $\Delta f = \hat{\Delta f}_{coarse} + \Delta f_{rest}$. 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 burst. 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 in equation (1) 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 R&S FSQ-K90/91.

Furthermore, the timing drift in equation (1) is given by

$$phase_{l,k}^{(timing)} = 2\pi \cdot N_s / N \cdot \xi \cdot k \cdot l \quad (3)$$

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. From equations (1) and (3), 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 $phase_{l,k}^{(timing)}$ is not part of the requirements. Therefore, the “time tracking” (Tracking Time) is not activated as the default setting of the R&S FSQ-K90/91.

The time tracking option should rather be seen as a powerful analyzing option.

In addition, the tracking of the gain g_l in equation (1) 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 R&S FSQ-K91.

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 $d\gamma_l = 0$. Referring to equation (1), the log likelihood function²

$$L_1(\tilde{\Delta f}_{rest}, \tilde{\xi}) \stackrel{\text{eq.(1)}}{=} \sum_{l=1}^{nof_symbols} \sum_{k=-21, -7, 7, 21} \left| r_{l,k} - a_{l,k} \cdot \hat{H}_k^{(LS)} \cdot e^{j(\tilde{p}hase_l^{(common)} + \tilde{p}hase_{l,k}^{(timing)})} \right|^2$$

with

$$\tilde{p}hase_l^{(common)} \stackrel{\text{eq.(2)}}{=} 2\pi \cdot N_s / N \cdot \tilde{\Delta f}_{rest} \cdot T \cdot l$$

$$\tilde{p}hase_l^{(timing)} \stackrel{\text{eq.(3)}}{=} 2\pi \cdot N_s / N \cdot \tilde{\xi} \cdot k \cdot l$$

must be calculated as a function of the trial parameters $\tilde{\Delta f}_{rest}$ and $\tilde{\xi}$. The trial parameters leading to the minimum of the log likelihood function are used as estimates $\hat{\Delta f}_{rest}$ and $\hat{\xi}$. In equation (4), the known pilot symbols $a_{l,k}$ are read from a table.

In the second step, the log likelihood function

$$L_2(\tilde{g}_l, d\tilde{\gamma}_l) \stackrel{\text{eq.(1)}}{=} \sum_{k=-21, -7, 7, 21} \left| r_{l,k} - a_{l,k} \cdot \tilde{g}_l \cdot \hat{H}_k^{(LS)} \cdot e^{j(\tilde{p}hase_l^{(common)} + \tilde{p}hase_{l,k}^{(timing)})} \right|^2$$

with

$$\tilde{p}hase_l^{(common)} \stackrel{\text{eq.(2)}}{=} 2\pi \cdot N_s / N \cdot \hat{\Delta f}_{rest} \cdot T \cdot l + d\tilde{\gamma}_l$$

$$\tilde{p}hase_l^{(timing)} \stackrel{\text{eq.(3)}}{=} 2\pi \cdot N_s / N \cdot \hat{\xi} \cdot k \cdot l$$

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 $r'_{l,k}$.

² In this paper, the tilde generally describes an estimate. Example: \tilde{X} is the trial parameter of X .

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 equation (1), 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 $\hat{H}_k^{(PL)}$ (from the payload) for equalization. In case of using the improved estimate $\hat{H}_k^{(PL)}$, 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 R&S FSQ-K91 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

$$EVM_k = \sqrt{\frac{1}{\text{nof_Symbols}} \cdot \sum_{l=1}^{\text{nof_Symbols}} |r''_{l,k} - K_{\text{mod}} \cdot a_{l,k}|^2} \tag{5}$$

of the subcarrier k of the current packet. Furthermore the packet error vector magnitude

$$EVM = \sqrt{\frac{1}{52} \cdot \sum_{\substack{k=-26 \\ (k \neq 0)}}^{26} EVM_k^2} \tag{6}$$

is derived by averaging the squared EVM_k versus k . Finally, the average error vector magnitude

$$\overline{EVM} = \sqrt{\frac{1}{\text{nof_packets}} \sum_{\text{counter}=1}^{\text{nof_packets}} EVM^2(\text{counter})} \tag{7}$$

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).

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

Signal Processing of the IEEE 802.11b application

Abbreviations

ε	timing offset
Δf	frequency offset
$\Delta \phi$	phase offset
$ARG\{\dots\}$	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
$\hat{h}_s(v)$	estimated baseband filter of the transmitter
$\hat{h}_r(v)$	estimated baseband filter of the receiver
\hat{o}_I	estimate of the IQ offset in the I branch
\hat{o}_Q	estimate of the IQ 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
$REAL\{\dots\}$	calculation of the real part of a complex value
$IMAG\{\dots\}$	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. 3-2. The baseband signal of an IEEE 802.11b wireless LAN system transmitter is sampled with a sampling rate of 44 MHz.

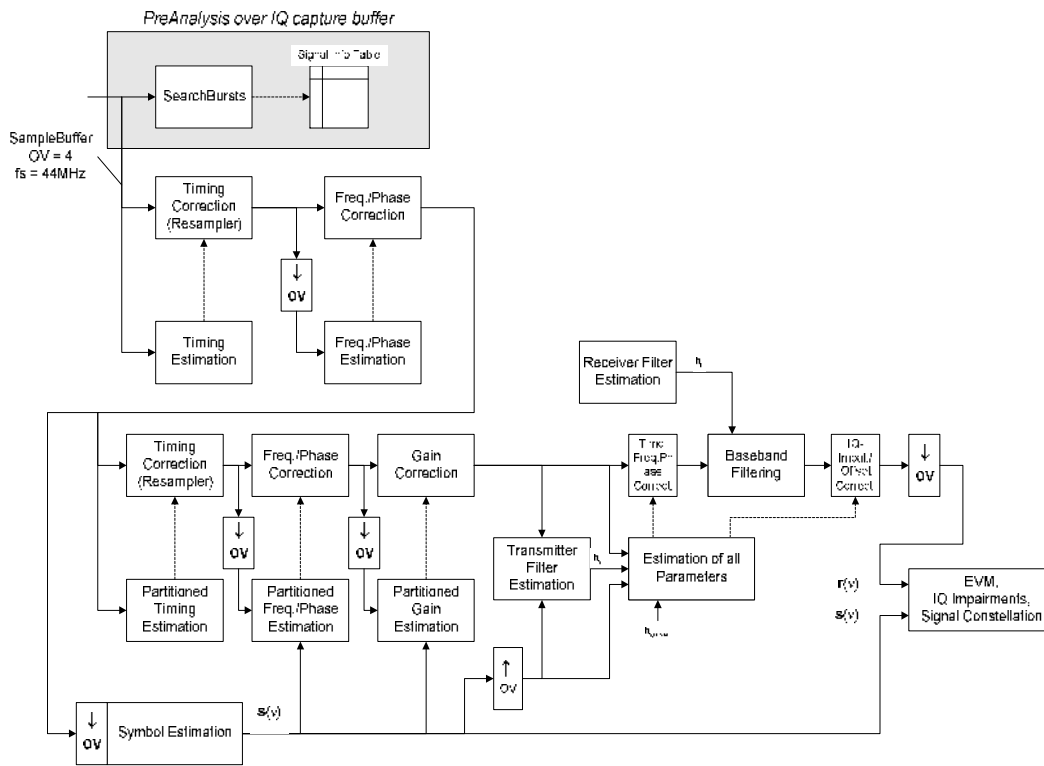


Fig. 3-2 Signal processing of the IEEE 802.11b application

The first task of the measurement application is to detect the position of the bursts within the measurement signal $r_1(v)$. The detection algorithm is able to find the positions of the beginning of short and long bursts 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 burst, the header of the burst can be demodulated. The bits transmitted in the header provide information about the length of the burst and the modulation type used in the PSDU.

After the start position and the burst 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 burst.

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 burst must be estimated and corrected. Additionally, timing offset, timing drift and gain factor can be estimated and corrected in several partitions of the burst. 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

$$L_1 = \sum_{v=0}^{N-1} \left| r(v) \cdot e^{-j2\pi\tilde{\Delta f}v} \cdot e^{-j\tilde{\Delta\phi}} - \sum_{i=-L}^{+L} \tilde{h}_s(i) \cdot \hat{s}_n(v-i) - \tilde{o}_I - j\tilde{o}_Q \right|^2 \quad \text{Eq. 3.1}$$

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, $\tilde{\Delta f}$, $\tilde{\Delta\phi}$, \tilde{o}_I , \tilde{o}_Q and $\tilde{h}_s(v)$ the variation parameters of the frequency offset, the phase offset, the IQ offset and the coefficients of the transmitter filter. The frequency offset, the phase offset and the IQ offset are estimated jointly with the coefficients of the transmitter filter to increase the estimation quality.

Once the transmitter filter is known, all other unknown signal parameters are estimated with a maximum-likelihood-based estimation, which minimizes the cost function

$$L_2 = \sum_{v=0}^{N-1} \left| r(v - \tilde{\varepsilon}) \cdot e^{-j2\pi\Delta f v} \cdot e^{-j\Delta\phi} - \tilde{g}_I \cdot s_I(v) - j\tilde{g}_Q \cdot s_Q(v) + \Delta\tilde{g}_Q \cdot s_Q(v) - \tilde{\delta}_I - j\tilde{\delta}_Q \right|^2, \quad \text{Eq. 3.2}$$

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 IQ imbalance, the quadrature mismatch and the normalized IQ offset are displayed by the measurement software. The IQ imbalance

$$\text{IQ - Imbalance} = \left| \frac{\hat{g}_Q + \Delta\hat{g}_Q}{\hat{g}_I} \right| \quad \text{Eq. 3.3}$$

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

$$\text{Quadrature - Mismatch} = \text{ARG}\{\hat{g}_Q + j \cdot \Delta\hat{g}_Q\} \quad \text{Eq. 3.4}$$

is a measure for the crosstalk of the Q branch into the I branch. The normalized IQ offset

$$\text{IQ - Offset} = \frac{\sqrt{\hat{\delta}_I^2 + \hat{\delta}_Q^2}}{\sqrt{\frac{1}{2} \cdot [\hat{g}_I^2 + \hat{g}_Q^2]}} \quad \text{Eq. 3.5}$$

is defined as the magnitude of the IQ 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, IQ offset and IQ 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)

$$\text{EVM} = \frac{\sqrt{\sum_{v=0}^{N-1} |r(v) - \hat{s}(v)|^2}}{\sqrt{\sum_{v=0}^{N-1} |\hat{s}(v)|^2}} \quad \text{Eq. 3.6}$$

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

$$\text{EVM}(v) = \frac{|r(v) - \hat{s}(v)|}{\sqrt{\sum_{v=0}^{N-1} |\hat{s}(v)|^2}} \quad \text{Eq. 3.7}$$

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 IQ offset in the I branch

$$\hat{\delta}_I = \frac{1}{N} \sum_{v=0}^{N-1} \text{REAL}\{r(v)\} \quad \text{Eq. 3.8}$$

and the IQ offset of the Q branch

$$\hat{\delta}_Q = \frac{1}{N} \sum_{v=0}^{N-1} \text{IMAG}\{r(v)\} \quad \text{Eq. 3.9}$$

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 IQ imbalance and the IQ offset. With these values, the IQ imbalance of the I branch

$$\hat{g}_I = \frac{1}{N} \sum_{v=0}^{N-1} |\text{REAL}\{r(v) - \hat{\delta}_I\}| \quad \text{Eq. 3.10}$$

and the IQ imbalance of the Q branch

$$\hat{g}_Q = \frac{1}{N} \sum_{v=0}^{N-1} |\text{IMAG}\{r(v) - \hat{\delta}_Q\}| \quad \text{Eq. 3.11}$$

are estimated in a non-linear estimation in a second step. Finally, the mean error vector magnitude

$$V_{\text{err}} = \frac{\sqrt{\frac{1}{2} \sum_{v=0}^{N-1} [|\text{REAL}\{r(v)\} - \hat{\delta}_I| - \hat{g}_I]^2 + \frac{1}{2} \sum_{v=0}^{N-1} [|\text{IMAG}\{r(v)\} - \hat{\delta}_Q| - \hat{g}_Q]^2}}{\sqrt{\frac{1}{2} \cdot [\hat{g}_I^2 + \hat{g}_Q^2]}} \quad \text{Eq. 3.12}$$

can be calculated with a non-data-aided calculation. The instant error vector magnitude

$$V_{\text{err}}(v) = \frac{\sqrt{\frac{1}{2} [|\text{REAL}\{r(v)\} - \hat{\delta}_I| - \hat{g}_I]^2 + \frac{1}{2} [|\text{IMAG}\{r(v)\} - \hat{\delta}_Q| - \hat{g}_Q]^2}}{\sqrt{\frac{1}{2} \cdot [\hat{g}_I^2 + \hat{g}_Q^2]}} \quad \text{Eq. 3.13}$$

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 IQ offset and IQ 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. 3.14. If the EVM value is dominated by Gaussian noise, this method yields similar results to those of Eq. 3.15.

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.

802.11b RF Carrier Suppression

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.

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 IQ offset leads to an additional peak at the center frequency.

The following measurement sequence can be used in normal spectrum mode:

1. Use power trigger or external trigger
2. Use gated sweep with gate delay at payload start and gate length = payload length (Delay-Comp ON and RBW = 50 MHz for gate settings)
3. Set RBW = 100 kHz
4. Set Sweep Time = 100 ms
5. Set Span = 20 MHz
6. Set Detector = RMS
7. Set Marker 1 to center frequency
8. Use Marker 2 as Delta Marker and set it to max. peak

Fig. 3-3 is a screenshot of this measurement on the FSQ. The delta marker directly shows the RF carrier suppression in dB (white circled value).

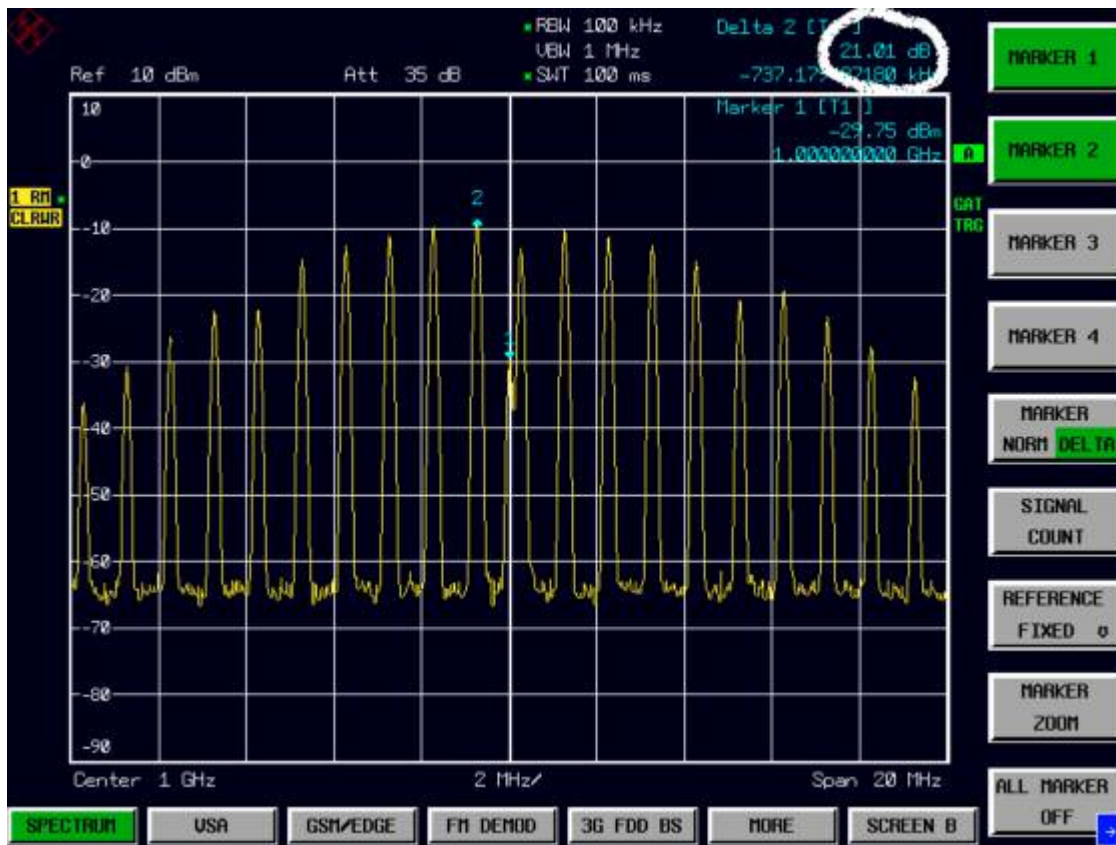


Fig. 3-3 RF carrier suppression measurement

Comparison to IQ offset measurement in K91 list mode

The IQ offset measurement in K91 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 IQ offset measured in K91 list mode. The difference (in dB) between the two values depends on the transmit filter shape and should be determined with one reference measurement.

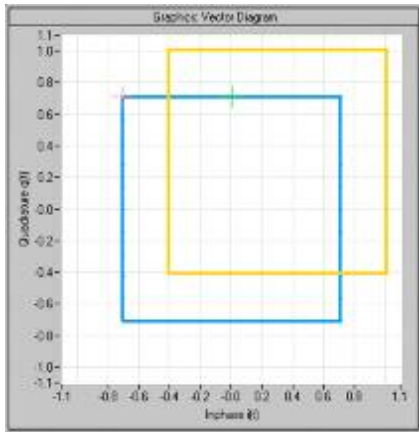
The following table lists the difference between the three transmit filter shapes (± 0.5 dB):

Transmit filter	-IQ-Offset [dB] - RF-Carrier-Suppression [dB]
Rectangular	11 dB
Root Raised Cosine, $\alpha = 0.22$	10 dB
Gaussian, $\alpha = 0.3$	9 dB

IQ Impairments

IQ Offset

An IQ offset indicates a carrier offset with a fixed amplitude. This results in a constant shift of the IQ axes. The offset is normalized by the mean symbol power and displayed in dB.



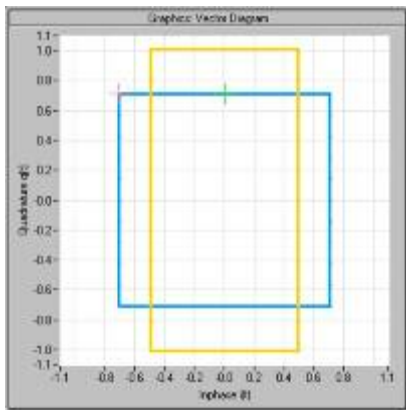
Gain Imbalance

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.

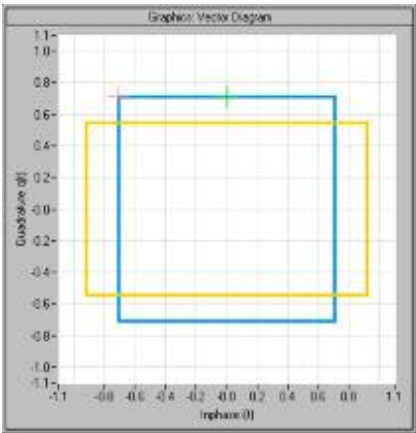
The entry is displayed in dB and %, where 1 dB offset is roughly 12% according to the following:

$$\text{Imbalance [dB]} = 20 \log (| \text{Gain}_Q | / | \text{Gain}_I |)$$

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage:



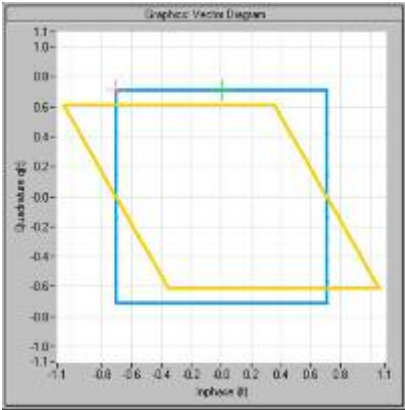
Negative values mean that the I vector is amplified more than the Q vector by the corresponding percentage:



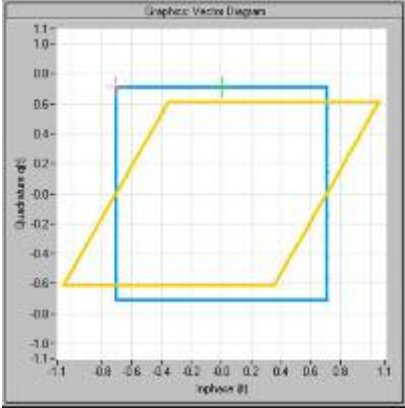
Quadrature Error

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 Remote Control

Description of commands

This section specifies all the remote control commands specific to the R&S FSQ-K91 option. 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.

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: <ul style="list-style-type: none"> – 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:

<code>SENSe</code>	first level
<code>:FREQuency</code>	second level
<code>:CENTer</code>	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 1kHz:

```
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.

SCPI Commands

ABORt Subsystem

The ABORt subsystem provides a mechanism by which running measurements can be aborted

COMMAND	PARAMETERS	UNIT	COMMENT
ABORt			

ABORt

This causes the measurement currently in progress to be aborted.

Example: "ABOR" - The R&S FSQ-K91 option will attempt to abort the currently active measurement.

Characteristics: *RST value: --
SCPI: In compliance

Mode: K91

CALCulate: Subsystem

CALCulate:LIMit Subsystem

COMMAND	PARAMETERS	UNIT	COMMENT
:CALCulate<1 2>			
:LIMit<1 to 8>			
:BURSt			
:ALL	<numeric_value>		
:RESult?	--		query only
:TRISe			
[:AVERage]	<numeric_value>	S	802.11b
:RESult?	--		query only – 802.11b
:MAXimum	<numeric_value>	S	802.11b
:RESult?	--		query only – 802.11b
:TFALI			
[:AVERage]	<numeric_value>	S	802.11b
:RESult?	--		query only – 802.11b
:MAXimum	<numeric_value>	S	802.11b
:RESult	--		query only – 802.11b
:FERRor			
[:AVERage]	<numeric_value>	HZ	
:RESult?	--		query only
:MAXimum	<numeric_value>	HZ	
:RESult?	--		query only
:SYMBolerror			
[:AVERage]	<numeric_value>		
:RESult?	--		query only
:MAXimum	<numeric_value>		
:RESult?	--		query only
:IQOffset			
[:AVERage]	<numeric_value>	DB	
:RESult?	--		802.11b
:MAXimum	<numeric_value>	DB	
:RESult?	--		query only – 802.11b
:EVM			
[:AVERage]	<numeric_value>	PCT	802.11b
:RESult?	--		query only – 802.11b
:MAXimum	<numeric_value>	PCT	802.11b
:RESult?	--		query only – 802.11b
:ALL			
[:AVERage]	<numeric_value>	DB PCT	802.11b
:RESult?	--		query only – 802.11b
:MAXimum	<numeric_value>	DB PCT	802.11a & j
:RESult?	--		query only - 802.11a & j
:DATA			
[:AVERage]	<numeric_value>	DB PCT	802.11a & j
:RESult?	--		query only - 802.11a & j
:MAXimum	<numeric_value>	DB PCT	802.11a & j
:RESult?	--		query only - 802.11a & j
:PILot			
[:AVERage]	<numeric_value>	DB PCT	802.11a & j
:RESult?	--		query only - 802.11a & j
:MAXimum	<numeric_value>	DB PCT	802.11a & j
:RESult?	--		query only - 802.11a & j

COMMAND	PARAMETERS	UNIT	COMMENT
.ACPower		DB	
:ACHannel?	<numeric_value>		query only - 802.11 j
:RESult?	--	DB	query only - 802.11j
:ALternate?	<numeric_value>		query only - 802.11j
:RESult?	--		query only - 802.11 j
:SPECTrum			
:Mask			
:CHECK		HZ	query only
:X?	--	DBM	query only
:Y?	--		query only
FAIL?			

CALCulate<1|2>:LIMit<1>:BURSt:ALL

This command sets or returns all the limit values. The results are input or output as a list of values separated by ',' in the following (ASCII) format:

<average frequency error>, <max frequency error>,
 <average symbol error>, <max symbol error>,
 <average IQ offset>, <maximum IQ offset>,
 <average EVM all bursts>, <max EVM all bursts>,
 <average EVM data carriers >, <max EVM data carriers >
 <average EVM pilots >, <max EVM pilots >

Note that the units for the EVM results are specified with the UNITS:EVM command

Example: "CALC:LIM:BURS:ALL?" All limit values are returned

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:ALL:RESULT

This command returns all the limit results (PASSED | FAILED). The results are output as a list of result strings separated by ',' in the following (ASCII) format:

<average frequency error>, <max frequency error>,
 <average symbol error>, <max symbol error>,
 <average IQ offset>, <maximum IQ offset>,
 <average EVM all bursts>, <max EVM all bursts>,
 <average EVM data carriers >, <max EVM data carriers >
 <average EVM pilots >, <max EVM pilots >

Note that the units for the EVM results are specified with the UNITS:EVM command.

Example: "CALC:LIM:BURS:ALL:RES?" All limit values are returned

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TRISe[:AVERAge]

This command sets the average rise time limit in seconds

Example: "CALC:LIM:BURS:TRIS 0.000001" The average frequency error rise time limit is set to 1 μs.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TRISe[:AVERAge]:RESult

This command returns the average rise time limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:TRIS:RES?" Average rise time limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TRISe:MAXimum

This command sets the maximum rise time limit in seconds

Example: "CALC:LIM:BURS:TRIS:MAX?" Maximum rise time limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TRISe:MAXimum:RESult

This command returns the maximum rise time limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:TRIS:MAX:RES?" Maximum rise time limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TFALI[:AVERAge]

This command sets the average fall time limit in seconds

Example: "CALC:LIM:BURS:TFAL 0.000001" The average fall time limit is set to 1 μ s

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TFALI[:AVERAge]:RESult

This command returns the average fall time limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:TFAL:RES?" Average fall time limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TFALI:MAXimum

This command sets the maximum fall time limit in seconds

Example: "CALC:LIM:BURS:TFALL:MAX 0.000001" The maximum fall time limit set to 1 μ s

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:TFALI:MAXimum:RESult

This command returns the maximum fall time limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:TRIS:MAX:RES?" Maximum fall time limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage]

This command sets the average frequency error limit in Hz

Example: "CALC:LIM:BURS:FERR 10000" The average frequency error limit is set to 10 kHz

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:FERRor[:AVERage]:RESult

This command returns the average frequency error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:FERR:RES?" Average frequency error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum

This command sets the maximum frequency error limit in Hz

Example: "CALC:LIM:BURS:FERR:MAX?" Maximum frequency error limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:FERRor:MAXimum:RESult

This command returns the maximum frequency error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:FERR:MAX:RES?" Maximum frequency error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:SYMBOLerror[:AVERage]

This command sets the average symbol error limit in Hz

Example: "CALC:LIM:BURS:SYMB 10000" The average symbol error limit is set to 10 kHz

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror[:AVERage]:RESult

This command returns the average symbol error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:SYMB:RES?" Average symbol error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror:MAXimum

This command sets the maximum symbol error limit in Hz

Example: "CALC:LIM:BURS:SYMB:MAX?" Maximum symbol error limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:SYMBolerror:MAXimum:RESult

This command returns the maximum symbol error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:SYMB:MAX:RES?" Maximum symbol error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:IQOFFset[:AVERage]

This command sets the average IQ Offset error limit in dB

Example: "CALC:LIM:BURS:IQOF -10.0" Average IQ Offset error limit is set to -10.0 dB

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:IQOFFset[:AVERage]:RESult

This command returns the average IQ Offset error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:IQOF:RES?" Average IQ Offset error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:IQOFFset:MAXimum

This command sets the maximum IQ Offset error limit in dB

Example: "CALC:LIM:BURS:IQOF:MAX 15.0" Maximum IQ Offset error limit is set to -15.0 dB

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:IQOFset:MAXimum:RESult

This command returns the maximum IQ Offset error limit result (PASSED | FAILED)

Example: "CALC:LIM:BURS:IQOF:MAX:RES:?" Maximum IQ Offset error limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM[:AVERAge]

This command sets the average Error Vector Magnitude Limit in dB for the IEEE 802.11b standard.

Example: "CALC:LIM:BURS:EVM -25.0" Average EVM limit is set to -25 dB

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM[:AVERAge]:RESult

This command returns the average Error Vector Magnitude Limit result (PASSED | FAILED) for the IEEE 802.11b standard.

Example: "CALC:LIM:BURS:EVM:RES?" Average EVM limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:MAXimum

This command sets the maximum Error Vector Magnitude Limit in dB for the IEEE 802.11b standard.

Example: "CALC:LIM:BURS:EVM:MAX?" Maximum EVM limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:MAXimum:RESult

This command returns the maximum Error Vector Magnitude Limit result (PASSED | FAILED) for the IEEE 802.11b standard.

Example: "CALC:LIM:BURS:EVM:MAX:RES?" Maximum EVM limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:FAIL?

This command queries the result of the limit check of the limit line indicated in the selected measurement window. 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. Note that no limit lines are displayed in screen A and, thus, all CALCulate1:LIMit:FAIL? commands will return 0. The index for LIMit for specific limit lines is as follows:

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

Example: "`INIT ; WAI`" Starts a new sweep and waits for its end.
 "`CALC2 : LIM3 : FAIL?`" Queries the result of the check for limit line 3 in screen B.

Characteristics: *`RST` value: -
 *`SCPI`: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERAge]

This command sets the average Error Vector Magnitude Limit in dB. This is a combined figure that represents the pilot, data and the free carrier.

Example: "`CALC : LIM : BURS : EVM : ALL -25.0`" Average EVM for all carrier limit is set to -25.0 dB

Characteristics: *`RST` value: -
 *`SCPI`: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:ALL[:AVERAge]:RESult

This command returns the average Error Vector Magnitude Limit result (PASSED | FAILED). This is a combined figure that represents the pilot, data and the free carrier.

Example: "`CALC : LIM : BURS : EVM : ALL : RES?`" Average EVM for all carrier limit result is returned

Characteristics: *`RST` value: -
 *`SCPI`: device-specific

Mode: K91

CALCulate<1|2>:LiMit<1>:BURSt:EVM:ALL:MAXimum

This command sets the maximum Error Vector Magnitude Limit in dB. This is a combined figure that represents the pilot, data and the free carrier.

Example: "CALC:LIM:BURS:EVM:ALL:MAX?" Maximum EVM for all carrier limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LiMit<1>:BURSt:EVM:ALL:MAXimum:RESult

This command returns the maximum Error Vector Magnitude Limit result (PASSED | FAILED). This is a combined figure that represents the pilot, data and the free carrier.

Example: "CALC:LIM:BURS:EVM:ALL:MAX:RES?" Maximum EVM for all carrier limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LiMit<1>:BURSt:EVM:DATA[:AVERage]

This command sets the average Error Vector Magnitude limit summary for the data carrier in dB.

Example: "CALC:LIM:BURS:EVM:DATA -30.0" Average EVM for data carrier limit is set to -30.0 dB

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LiMit<1>:BURSt:EVM:DATA[:AVERage]:RESult

This command returns the average Error Vector Magnitude limit result summary (PASSED | FAILED) for the data carrier in dB.

Example: "CALC:LIM:BURS:EVM:DATA:RES?" Average EVM for data carrier limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LiMit<1>:BURSt:EVM:DATA:MAXimum

This command sets the maximum Error Vector Magnitude limit summary for the data carrier in dB.

Example: "CALC:LIM:BURS:EVM:DATA:MAX?" Maximum EVM for data burst limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:DATA:MAXimum:RESult

This command returns the maximum Error Vector Magnitude limit result summary (PASSED | FAILED) for the data carrier in dB.

Example: "CALC:LIM:BURS:EVM:DATA:MAX:RES?" Maximum EVM for data carrier limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage]

This command sets the average Error Vector Magnitude limit summary for the pilot carriers in dB.

Example: "CALC:LIM:BURS:EVM:PIL -8.0" Average EVM for pilot carrier limit is set to -8.0 dB

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot[:AVERage]:RESult

This command returns the average Error Vector Magnitude limit result summary (PASSED | FAILED) for the pilot carriers in dB.

Example: "CALC:LIM:BURS:EVM:PIL:RES?" Average EVM for pilot carrier limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum

This command sets the maximum Error Vector Magnitude limit summary for the pilot carriers in dB.

Example: "CALC:LIM:BURS:EVM:PIL:MAX?" Maximum EVM for pilot carrier limit is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:BURSt:EVM:PILot:MAXimum:RESult

This command returns the maximum Error Vector Magnitude limit result summary (PASSED | FAILED) for the pilot carriers in dB.

Example: "CALC:LIM:BURS:EVM:PIL:MAX:RES?" Maximum EVM for pilot carrier limit result is returned

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:ACPpower:ACHannel

This command returns the ACP adjacent channel limit for IEEE 802.11j if defined

Example: "CALC:LIM:ACP:ACH?" Returns the IEEE 802.11j ACP adjacent channel limit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:ACPpower:ACHannel:RESult

This command returns the ACP adjacent channel limit for IEEE 802.11j result summary (PASSED | FAILED) for both the lower and upper adjacent channels

Example: "CALC:LIM:ACP:ALT:RES?" limit result for IEEE 802.11j adjacent channel is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:ACPpower:ALternate

This command returns the ACP alternate channel limit for IEEE 802.11j if defined

Example: "CALC:LIM:ACP:ALT?" Returns the IEEE 802.11j ACP alternate channel limit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:ACPpower:ALternate:RESult

This command returns the ACP alternate channel limit result (PASSED | FAILED) for IEEE 802.11j for both the lower and upper alternate channels

Example: "CALC:LIM:ACP:ALT:RES?" limit result for IEEE 802.11j alternate channel is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:SPECTrum:MASK:CHECK:X

This command returns the X-value at the maximum overstepping of the spectrum mask limits

Example: "CALC:LIM:SPEC:MASK:CHECK:X?" Returns the frequency at the maximum overstepping.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:LIMit<1>:SPECtrum:MASK:CHECK:Y

This command returns the Y-value at the maximum overstepping of the spectrum mask limits

Example: "CALC:LIM:SPEC:MASK:CHECK:Y?" Returns the power at the maximum overstepping.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate:MARKer Subsystem

The CALCulate:MARKer subsystem checks the marker functions in the R&S FSQ-K91 option.

CALCulate 1: Screen A

CALCulate 2: Screen B

Note: *Currently, only 1 marker is available per screen.*

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1 2>: MARKer<1> :MAXimum :MINimum :TRACe :X :Y :SYMBol :CARRier :BSYMBol :AOFF [:STATE]	<numeric_value> <numeric_value> <numeric_value> <numeric_value> <numeric_value> <numeric_value>, <numeric_value> <Boolean>	HZ S DB PCT DB	no query no query 802.11b only

CALCulate<1|2>:MARKer<1>:MAXimum

This command sets the selected marker to the maximum peak value in the current trace. This command is only available for the following result displays:

Spectrum Flatness

Example: "CALC2:MARK:TRAC:MAX" Set marker 1 in screen B to maximum value in trace

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:MINimum

This command sets the selected marker to the minimum peak value in the current trace. This command is only available for the following result displays:

Spectrum Flatness

Example: "CALC2:MARK:TRAC:MIN" Set marker 1 in screen B to minimum value in trace

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:TRACe

This command assigns the selected marker to the indicated measurement curve in the selected measurement window.

This command is only available for the following result displays:

Constellation versus Carrier

EVM versus Symbol

Frequency error versus Preamble

Phase error versus Preamble

PVT Full Burst

PVT Rising / Falling

Spectrum Flatness

Spectrum Mask - When Max Hold trace is displayed

Spectrum ACP/ACPR - When Max Hold trace is displayed

Example: "CALC2:MARK:TRAC 2" Assigns marker 1 in screen B to trace 2.

Characteristics: *RST value: 1
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:X

This command positions the selected marker to the indicated inphase (constellation Vs symbol), frequency (spectrum FFT, spectrum mask, spectrum APCR), time (magnitude capture buffer, auto level, PVT full burst, PVT rising / falling), power (CCDF), subcarrier (constellation Vs carrier, EVM Vs carrier, spectrum flatness) or symbol (EVM Vs symbol) in the selected measurement window.

This command is query only for the following result displays:

Constellation Vs Symbol

Constellation Vs Carrier

Example: "CALC:MARK:X 2ms" Positions marker 1 in screen A to time 2 ms.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:Y

This command positions the selected marker to the indicated quadrature (constellation Vs symbol), magnitude of I or Q (constellation Vs carrier), EVM (EVM Vs carrier) or abs (spectrum flatness) in the selected measurement window.

This command is query only for the following result displays:

- Auto level
- Constellation Vs Symbol
- Constellation Vs Carrier
- EVM Vs Symbol
- PVT Full
- PVT Rising / Falling
- Magnitude Capture Buffer
- Spectrum Mask
- Spectrum ACP/ACPR
- Spectrum FFT
- CCDF

Example: "CALC2:MARK:Y -2" Positions marker 1 in screen B to -2.
 "CALC:MARK:Y?" Outputs the measured value of marker 1 in screen A.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:SYMBOL

This command positions the selected marker to the indicated symbol (constellation vs symbol and constellation Vs carrier).

This command is valid only for the following result displays:

constellation Vs symbol

constellation Vs carrier

Example: "CALC2:MARK:SYMB 2" Positions marker 1 in screen B to symbol 2.
 "CALC2:MARK:SYMB?" Outputs the symbol value of marker 1 in screen B.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:CARRier

This command positions the selected marker to the indicated carrier (constellation vs symbol and constellation Vs carrier).

This command is valid only for the following result displays:

constellation Vs symbol

constellation Vs carrier

Example: "CALC2:MARK:CARR -7" Positions marker 1 in screen B to carrier -7.
"CALC2:MARK:CARR?" Outputs the carrier value of marker 1 in screen B.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:BSYMBOL

This command positions the selected marker to the indicated symbol in the indicated burst (Constellation vs Symbol and EVM vs Symbol). The first numeric value is the burst number and the second numeric value is the symbol number. This command is only valid for the following IEEE 802.11b measurements: Constellation vs Symbol EVM vs Symbol

Example: "CALC2:MARK1:BSYM 2, 10" Positions marker 1 in screen B to symbol 10 of burst 2.

"CALC2:MARK1:BSYM?" Outputs the burst and symbol values of marker 1 in screen B.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:AOFF

This command switches off all active markers in the specified measurement window. The window will either be "screen a" or "screen b" and will be determined by the numeric value that follows the "CALCulate" keyword.

Example: "CALC1:MARK:AOFF" 'Switches off all markers in the screen A window.
"CALC2:MARK:AOFF" 'Switches off all markers in the screen B window.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CALCulate<1|2>:MARKer<1>:STATE

This command switches the specified marker in the specified screen on or off

Example: "CALC1:MARK1:STATE ON" Switches the screen A marker 1 ON.
"CALC2:MARK1:STATE OFF" Switches the screen B marker 1 OFF.

Characteristics: *RST value: 1
SCPI: device-specific

Mode: K91

CALCulate:MARKer:FUNcTion Subsystem

The measurement window is selected by CALCulate 1 (screen A) or 2 (screen B).

COMMAND	PARAMETERS	UNIT	COMMENT
CALCulate<1 2> :MARKer<1> :FUNcTion :ZOOM :POWer :RESult [:CURRent] :MAXHold	<numeric_value>		
		DB	Query only
		DB	Query only

CALCulate<1|2>:MARKer<1>:FUNcTion:ZOOM

This command defines the ratio to be zoomed around the marker 1 in the selected measurement window. The default value is 1, where the full trace is shown.

This command is only available for the following result displays:

- Constellation versus Carrier
- Constellation versus Symbol
- PVT Full Burst
- PVT Rising / Falling
- Magnitude Capture Buffer

Example:

"CALC:MARK:FUNC:ZOOM 2"	Zooms 50% in screen A.
"CALC:MARK:FUNC:ZOOM 4"	Zooms 25% in screen A.
"CALC:MARK:FUNC:ZOOM 1"	Deactivates zooming in screen A.

Characteristics: *RST value: 1
SCPI: device-specific

Mode: K91

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.

Results are output 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 output in dB.

Example: "CALC2:MARK:FUNC:POW:RES?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

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.

Results are output 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 output in dB.

Example: "CALC2:MARK:FUNC:POW:RES:MAXH?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

Configure Subsystem

The CONFigure subsystem contains commands for configuring complex measurement tasks. The CONFigure subsystem is closely linked to the functions of the FETCH subsystem, where the measurement results of the measurements are queried.

COMMAND	PARAMETERS	UNIT	COMMENT
CONFigure			
:POWer			
:EXPeCted			
:RF	<numeric_value>	DBM	
:IQ	<numeric_value>	V	
:AUTO	<boolean> ONCE		
:CHANnel	<numeric_value>		
:STANdard	<numeric_value>		
:BURSt			
:PVT			
:AVERage	<numeric_value>		802.11b & g (single carrier) only
:RPOWer	MEAN MAXimum		802.11b & g (single carrier) only
:SElect	EDGE FULL RISE FALL		
[:IMMediate]			
:EVM			
:ECARrier			802.11a & j
[:IMMediate]			
:ESYMBOL			
[:IMMediate]			
:SPEctrum	IEEE ETSI		
:MASK			802.11a
:SElect			
[:IMMediate]			
:FLATness			802.11a & j
[:IMMediate]			
:FFT			
[:IMMediate]			
:ACPR			
[:IMMediate]			
:CONStellation			
:CCARrier			
[:IMMediate]			
:CSYMBOL			802.11a & j
[:IMMediate]			
:CARRier			802.11a & j
:SElect			
:STATistics			
:CCDF			
[:IMMediate]			
:BSTReam			
[:IMMediate]			
:SField			
[:IMMediate]			
:PREamble			
[:IMMediate]			

CONFigure:POWer:EXPeCted:RF

This remote control command is used to specify the mean power level of the source signal as supplied to the analyzer RF input. This value will be overwritten if Auto Level is turned on.

Example: “CONF:POW:EXP:RF 9” The R&S FS-K91 option assumes an input signal strength of 9 dBm

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:POWer:EXPeCted:IQ

This remote control command is used to specify the mean power level of the source signal as supplied to the analyzer IQ inputs. This value will be overwritten if Auto Level is turned on.

Example: “CONF:POW:EXP:IQ 1” The R&S FSQ-K91 option assumes an input signal strength of 1 Volt

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:POWer:AUTO

This remote control command is used to switch on or off automatic power level detection. When switched on, power level detection is performed at the start of each measurement sweep. If this command is issued with the ONCE parameter, the auto level routine is immediately performed one time regardless of the current state of this parameter (ON or OFF).

Example: “CONF:POW:AUTO 1” The R&S FSQ-K91 option will automatically detect the input power level.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:CHANnel

This remote control command is used to specify the input channel for which measurements are to be performed. This command will automatically cause the internal measurement frequency to be re-calculated.

Example: “CONF:CHAN 9” - The R&S FSQ-K91 option will perform measurements at the frequency represented by channel 9.

Characteristics: *RST value: 0
SCPI: device-specific

Mode: K91

CONFigure:STANdard

This remote control command specifies which wireless LAN standard the option is configured to measure. The values are as follows:

- 0 = IEEE 802.11a
- 1 = IEEE 802.11b
- 2 = IEEE 802.11j (10 MHz)
- 3 = IEEE 802.11j (20 MHz)

Example: "CONF:STAN 0" -

The R&S FSQ-K91 option will perform measurements in compliance with IEEE 802.11a.

Characteristics: *RST value: 0
SCPI: device-specific

Mode: K91

CONFigure:BURSt:PVT:AVERAge This remote control command configures the R&S FS-K91 measurement type to set the burst power averaging length to the desired value. This command is only valid when the selected standard is IEEE 802.11b.

Example: "CONF:BURS:PVT:AVER 31"

The R&S FS-K91 option is configured to use burst power average length of 31.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:PVT:RPOWer

This remote control command configures R&S FS-K91 to use either mean or maximum burst power as the reference power for the 802.11b PVT measurement

Example: "CONF:BURS:PVT:RPOW MEAN"

R&S FS-K91 option is configured to use mean burst power as the reference power

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:PVT:SElect

This remote control configures how R&S FSQ-K91 will interpret the power versus time measurement results.

The supplied string can be one of the following:

IEEE 802.11a & j

'EDGE' - configures the measurement to be rising and falling edge.

'FULL' - configures the measurement to be full burst.

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 FULL"

The R&S FSQ-K91 option will interpret the measurement results as full burst.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:PVT[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be Power Versus Time. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command.

Example: "CONF: BURS: PVT" The R&S FSQ-K91 option is configured to run a Power Versus Time measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:EVM:ECARrier[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be EVM Versus Carrier. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command.

Example: "CONF: BURS: EVM: ECAR" R&S FSQ-K91 option is configured to run an EVM versus carrier measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:EVM:ESYMBOL[:IMMEDIATE]

This remote control command configures the FSQ-K91 measurement type to be EVM Versus Symbol. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: "CONF: BURS: EVM: ESYM" R&S FSQ-K91 option is configured to run an EVM versus symbol measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:SPECTrum:MASK:SElect

This remote control configures how R&S FS-K91 will interpret the Spectrum MASK measurement results. This is either performed using the IEEE or ETSI standard. This command is only available for IEEE 802.11a.

Example: "CONF: BURS: SPECT: MASK: SEL ETSI" R&S FS-K91 option is will interpret the measurement results using the ETSI standard

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:SPECTrum:MASK[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be Spectrum mask. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: "CONF: BURS: SPEC: MASK" R&S FSQ-K91 option is configured to run a Spectrum Mask measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:SPECTrum:FLATness[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be Spectrum flatness. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: "CONF: BURS: SPEC: FLAT" R&S FSQ-K91 option is configured to run a Spectrum Flatness measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:SPECTrum:FFT[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be FFT (Fast Fourier Transform). After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: "CONF: BURS: SPEC: FFT" R&S FSQ-K91 option is configured to run an FFT measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:SPECTrum:ACPR[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be ACPR (adjacent channel power ratio). After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: "CONF: BURS: SPEC: ACPR" R&S FSQ-K91 option is configured to run an ACPR measurement.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

CONFigure:BURSt:CONStellation:CCARrier[:IMMediate]

This remote control command configures the R&S FSQ-K91 measurement type to be Constellation versus Carrier. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command.

Example: “CONF: BURS: CONS: CCAR” R&S FSQ-K91 option is configured to run a Constellation versus Carrier measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:CONStellation:CSYMBOL[:IMMediate]

This remote control command configures the R&S FSQ-K91 measurement type to be Constellation versus Symbol. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: “CONF: BURS: CONS: CSYM” R&S FSQ-K91 option is configured to run a Constellation versus Symbol measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:CONStellation:CARRier:SElect

This remote control command is only available when Constellation versus Symbol measurement is selected. When the Constellation versus Symbol measurement is initiated, it will calculate the results of the selected carrier.

Example: “CONF: BURS: CONS: CARR: SEL -26” - Carrier -26 is selected.
 “CONF: BURS: CONS: CARR: SEL 10” - Carrier 10 is selected.
 “CONF: BURS: CONS: CARR: SEL ALL” - All carriers are selected.
 “CONF: BURS: CONS: CARR: SEL PIL” - Pilots only.

Characteristics: *RST value: ALL
SCPI: device-specific

Mode: K91

CONFigure:BURSt:STATistics:CCDF[:IMMediate]

This remote control command configures the R&S FSQ-K91 measurement type to be CCDF (conditional cumulative distribution functions.). After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: “CONF: BURS: STAT: CCDF” R&S FSQ-K91 option is configured to run a CCDF measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:STATistics:BSTReam[:IMMEDIATE]

This remote control command configures the R&S FSQ-K91 measurement type to be bit stream. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: “CONF: BURS: STAT: BSTR” R&S FSQ-K91 option is configured to run a bit stream measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:STATistics:SFIeld [:IMMEDIATE]

This remote control command configures the R&S FS-K91 measurement type to be signal field. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: “CONF: BURS: STAT: SFIeld” R&S FS-K91 option is configured to run a bit stream measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

CONFigure:BURSt:PREamble[:IMMEDIATE]

This remote control command configures the FS-K90/91 measurement type to be Phase or Frequency Vs Preamble. After this command has been executed, the specified measurement will only be started when the user issues the INITiate command

Example: “CONF: BURS: PRE” FS-K90/91 option is configured to run a Preamble measurement.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

DISPlay Subsystem

The DISPLay subsystem controls the selection and presentation of textual and graphic information as well as of measurement data on the display.

COMMAND	PARAMETERS	UNIT	COMMENT
:DISPlay			
:FORmat	SPLit SINGle		
[:WINDow<1 2>]			
:SElect			
:SSElect			
:TABLE	<boolean>		
:TRACe<1...3>			
:Y			
:SCALE			
:AUTO	<boolean>		
:PDIVision	<numeric_value>		
:RLEVel	<numeric_value>	DB	
:OFFSet	<numeric_value>	DB	

DISPlay:FORMat

This command sets the visible screen display type to full or split screen.

Example: "DISP:FORM SINGLE" Sets the R&S FSQ-K91 display to full screen.

Characteristics: *RST value: SPL
SCPI: device-specific

Mode: K91

DISPlay[:WINDow<1|2>]:SElect

This command selects whether screen A or screen B is active

Example: "DISP:WIND1:SEL" Sets the R&S FSQ-K91 screen A active.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

DISPlay[:WINDow<1|2>]:SSElect

This is an alias for DISPlay:WINDow[1|2]:SElect. SSElect means Screen SElect.

Example: "DISP:WIND1:SSEL" Sets the R&S FSQ-K91 screen A active.

Characteristics: *RST value: 1
SCPI: device-specific

Mode: K91

DISPlay[:WINDow<1|2>]:TABLe

This command selects whether the results table is displayed

Example: "DISP:WIND1:TABL 0" Hides the results table

Characteristics: *RST value: 0
 SCPI: device-specific

Mode: K91

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:AUTO

This command switches on or off automatic scaling of the Y-axis for the specified trace display. Automatic scaling sets the Y-axis to automatically scale to best fit the measurement results. This command is only 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. The numeric suffix at TRACe<1 to 3> must be 1

Example: "DISP:WIND2:TRAC:Y:SCAL:AUTO ON" switches on automatic scaling of the Y-axis for the active trace

Characteristics: *RST value: ON

Mode: K91

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision

This command sets the size of each Y scale division for the specified trace display. Note that this command has no affect if automatic scaling of the Y-axis is enabled. This command is only 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. The numeric suffix at TRACe<1 to 3> must be 1.

Example: "DISP:WIND2:TRAC:Y:SCAL:DPIV 2" Sets the Y scale division to size to 2.

Characteristics: *RST value: 3

Mode: K91

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel

This remote control command can be used to set the current internal instrument reference level used when performing measurements. The numeric suffix at WINDow<1|2> and TRACe<1 to 3> are irrelevant.

Example: "DISP:TRAC:Y:RLEV?" returns the current reference level in use

Characteristics: *RST value: -

Mode: K91

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel:OFFSet

This remote control command specifies the external attenuation/gain applied to measurements. The value corresponds to the reference level offset in the spectrum analyzer mode. The numeric suffix at WINDow<1|2> and TRACe<1 to 3> are irrelevant.

Example: "DISP:TRAC:Y:RLEV:OFFS 10" external attenuation (level offset) of the analyzer is 10 dB

"DISP:TRAC:Y:RLEV:OFFS -10" external attenuation of the analyzer is -10 dB. i.e. a gain of 10 dB

Characteristics: *RST value: 0 dB
SCPI: in compliance

Mode: K91

FETCh – Subsystem

The FETCh subsystem contains commands for reading out results of complex measurement tasks. This subsystem is closely linked to the CONFigure and SENSE subsystems.

COMMAND	PARAMETERS	UNIT	COMMENT
FETCh			
:BURSt			
:ALL?		--	query only
:PREAmble?		DBM	query only
:PAYLoad?		DBM	query only
:RMS			
[:AVERAge?]		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only
:PEAK?		DB	query only
:CRESt			
[:AVERAge?]		DBM	query only
:MINimum?		DBM	query only
:MAXimum?		DBM	query only
:TRISe			
:AVERAge?		S	query only – 802.11b
:MINimum?		S	query only – 802.11b
:MAXimum?		S	query only – 802.11b
:TFALI			
:AVERAge?		S	query only – 802.11b
:MINimum?		S	query only – 802.11b
:MAXimum?		S	query only – 802.11b
:FERRor			
:AVERAge?		HZ	query only
:MINimum?		HZ	query only
:MAXimum?		HZ	query only
:SYMBolerror			
:AVERAge?			
:MINimum?			
:MAXimum?			
:IQOFFset			
:AVERAge?		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only
:GIMBalance			
:AVERAge?		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only
:QUADoffset			
:AVERAge?		DEG	query only – 802.11a & j
:MINimum?		DEG	query only – 802.11a & j
:MAXimum?		DEG	query only – 802.11a & j

COMMAND	PARAMETERS	UNIT	COMMENT
:EVM			
[:IEEE]			
:AVERage?		PCT	query only – 802.11b
:MINimum?		PCT	query only – 802.11b
:MAXimum?		PCT	query only – 802.11b
:DIRect			
:AVERage?		PCT	query only – 802.11b
:MINimum?		PCT	query only – 802.11b
:MAXimum?		PCT	query only – 802.11b
:ALL			
:AVERage?		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only
:DATA			
:AVERage?		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only
:PILot			
:AVERage?		DB	query only
:MINimum?		DB	query only
:MAXimum?		DB	query only

FETCH:BURSt:ALL?

This command returns all the results. The results are output as a list of result strings separated by ',' in the following (ASCII) format:

IEEE 802.11a & j

<preamble power>,
 <payload power>,
 <min rms power>,<average rms power>,<max rms power>,>,
 <peak power>,
 <min crest factor>,<average crest factor>,<max crest factor>,
 <min frequency error>,<average frequency error>,<max frequency error>,
 <min symbol error>,<average symbol error>,<max symbol error>,
 <min IQ offset>,<average IQ offset>,<maximum IQ offset>,
 <min gain imbalance>,<average gain imbalance>,<max gain imbalance>,
 <min quadrature offset>,<average quadrature offset>,<max quadrature offset>,
 <min EVM all bursts>,<average EVM all bursts>,<max EVM all bursts>,
 <min EVM data carriers>,<average EVM data carriers >,<max EVM data carriers >
 <min EVM pilots>,<average EVM pilots >,<max EVM pilots >

IEEE 802.11b

<min rise time>,<average rise time>,<max rise time>,
 <min fall time>,<average fall time>,<max fall time>,
 <min rms power>,<average rms power>,<max rms power>,
 <min peak power>,<average peak power>,<max peak power>,
 <min crest factor>,<average crest factor>,<max crest factor>,
 <min frequency error>,<average frequency error>,<max frequency error>,
 <min chip clock error>,<average chip clock error>,<max chip clock error>,
 <min phase error>,<average phase error>,<max phase error>,
 <min IQ offset>,<average IQ offset>,<maximum IQ offset>,
 <min gain imbalance>,<average gain imbalance>,<max gain imbalance>,
 <min quadrature offset>,<average quadrature offset>,<max quadrature offset>,
 <min EVM IEEE>,<average EVM IEEE>,<max EVM IEEE>,
 <min EVM Direct>,<average EVM Direct >,<max EVM Direct >

Note that the units for the EVM results are specified with the UNITS:EVM command

Example: "FETC: BURS: ALL?" All calculated results are returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh: BURSt: PREAmble?

This command returns the measured power in the burst preamble.

Example: "FETC: BURS: PREAmble?" The burst preamble power is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh: BURSt: PAYLoad?

This command returns the measured power in the payload of the burst.

Example: "FETC: BURS: PAYLoad?" The burst payload power is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh: BURSt: RMS?

This command returns the average, minimum or maximum RMS burst power in dBm measured during the measurement.

Example: "FETC: BURS: RMS: MAX?" The maximum calculated RSM burst power from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh: BURSt: PEAK?

This command returns the peak power in dBm measured during the measurement time.

Example: "FETC: BURS: PEAK?" The calculated peak power from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:CRESt?

This command returns the average, minimum or maximum determined CREST factor (= ratio of peak power to average power) in dB.

Example: "FETC:BURS:CRES:MAX?" The maximum calculated crest factor from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:TRISe?

This command returns the average, minimum or maximum burst rise time in seconds.

Example: "FETC:BURS:TRIS:MAX?" The maximum calculated rise time from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:TFALI?

This command returns the average, minimum or maximum burst fall time in seconds.

Example: "FETC:BURS:TFAL:MAX?" The maximum calculated fall time from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:FERRor

This command returns the measured average, minimum or maximum frequency errors in Hz.

Example: "FETC:BURS:FERR:MAX?" The maximum frequency error from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:SYMBolerror

This command returns the percentage of symbols that were outside the permissible demodulation range within a burst.

Example: "FETC:BURS:SYMB:MAX?" The maximum number of symbols that were out of range per burst.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:IQOFset

This command returns the measured average, minimum or maximum IQ offset errors in dB.

Example: "FETC:BURS:IQOF:MAX?" The maximum IQ offset error from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:GIMBalance

This command returns the measured average, minimum or maximum IQ imbalance errors in dB.

Example: "FETC:BURS:GIMB:MAX?" The maximum IQ imbalance error from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:QUADoffset

This command returns the accuracy in terms of the phase error of symbols within a burst.

Example: "FETC:BURS:QUAD:MAX?" The maximum angle error recorded for a symbol during the measurement.

Characteristics: *RST value: --
SCPI: device-specific

Mode: K91

FETCh:BURSt:EVM:[IEEE]

This command returns the error vector magnitude measurement results summary (average, minimum or maximum value) in dB for the IEEE 802.11b standard. This result is the value before filtering.

Example: "FETC:BURS:EVM:MAX?" The maximum EVM recorded before filtering.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:EVM:DIRect

This command returns the error vector magnitude measurement results summary (average, minimum or maximum value) in dB for the IEEE 802.11b standard. This result is the value after filtering.

Example: "FETC:BURS:EVM:DIR:MAX?" The maximum EVM recorded after filtering.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:EVM:ALL

This command returns the error vector magnitude measurement results summary (average, minimum or maximum value) in dB. This is a combined figure that represents the pilot, data and the free carrier.

Example: "FETC: BURS: EVM: ALL: MAX?" The maximum EVM recorded for all measurement carrier is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:EVM:DATA

This command returns the error vector magnitude measurement results summary for the data carrier (average, minimum or maximum value) in dB.

Example: "FETC: BURS: EVM: DATA: MAX?" The maximum EVM recorded for the data carrier is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FETCh:BURSt:EVM:PILOt

This command returns the error vector magnitude measurement results summary for the EVM pilot carrier (average, minimum or maximum value) in dB.

Example: "FETC: BURS: EVM: PIL: MAX?" The maximum EVM recorded for the EVM pilot carrier is returned.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

FORMat Subsystem

The FORMat subsystem specifies the data format of the data transmitted from and to the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
FORMat [:DATA]	ASCIi REAL UINT[,<numeric_value>]	-	

FORMat[:DATA] ASCIi | REAL| UINT [, 8 | 32]

This command specifies the data format for the data transmitted from the instrument to the control PC. It controls whether the bit stream data is sent as ASCII or UINT8 binary format.

Example: "FORM UINT, 8" The FS-K91 option will send bit stream data requested by the TRACE:DATA? command as unsigned integers in binary format.

Characteristics: *RST value: ASCIi
SCPI: In compliance

Mode: K91

INITiate Subsystem

The INITiate subsystem configures the instrument prior to a measurement being carried out. It is basically used to tell the instrument which measurement is to be performed and takes any necessary steps to set up the instrument for the measurement.

COMMAND	PARAMETERS	UNIT	COMMENT
INITiate [:IMMEDIATE] :CONTinuous	<Boolean>		no query no query

INITiate[:IMMEDIATE]

This remote control command requests the R&S FSQ-K91 option to start a new measurement sequence. If a measurement sequence is already in progress, the command will be ignored.

Example: "INIT" - The R&S FSQ-K91 option will attempt to start a new measurement.

Characteristics: *RST value: -
SCPI: In compliance

Mode: K91

INITiate:CONTinuous

This command determines whether the trigger system is continuously initiated (continuous) or performs single measurements (single).

Example: "INIT:CONT OFF" The R&S FSQ-K91 option will attempt a non-continuous measurement when initiated.

Characteristics: *RST value: 0
SCPI: In compliance

Mode: K91

INPut Subsystem

The INPut subsystem controls the input characteristics of the RF inputs of the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
:INPut			
:ATTenuation	<numeric_value>	DB	
:EATT	<numeric_value>	DB	
:AUTO	<Boolean>		
:STATe	<Boolean>		
:FILTer			
:YIG			
[:STATe]	<Boolean>		
:AUTO	<Boolean>		
:SElect	AIQ RF		
:IQ			
:BALanced			
[:STATe]	<Boolean>		B71 option only
:IMPedance	50 1000		B71 option only

INPut:ATTenuation

This command specifies the current input mechanical attenuator. To protect the input mixer against damage from overloads, the setting 0 dB can only be obtained by entering numerals, not by using the command DEC. The step width is 10 dB without the electronic attenuator option, and the range is 0 dB to 70 dB. The input attenuation can be set in 5 dB steps between 0 dB and 75 dB with the electronic attenuator option.

Example: "INP:ATT?" 'Returns the current mechanical attenuator setting in use

Characteristics: *RST value: -

Mode: K91

INPut:EATT

This command specifies the attenuation of the current input electronic input attenuator. The attenuation setting can only be varied in 5 dB steps from 0 to 30 dB. Other entries are rounded to the next lower integer value. The electronic attenuator is switched off in the default state.

Example: "INP:EATT?" 'Returns the current electronic attenuator setting in use

Characteristics: *RST value: -

Mode: K91

The command is only available with the electronic attenuator option (B25).

INPut:EATT:AUTO

This command automatically couples the electronic input attenuation to the reference level and the attenuation of the mechanical attenuator (state ON) or switches the input attenuation to manual entry (state OFF).

Example: "INP:EATT:AUTO ON" Couples the attenuation of the electronic attenuator to the reference level.

Characteristics: *RST value: ON
SCPI: device-specific

Mode: K91

The command is only available with the electronic attenuator option (B25).

INPut:EATT:STATe

This command switches the electronic input attenuation into the signal path (state ON) or removes it from the signal path (state OFF).

Example: "INP:EATT:STAT ON" Switches the electronic attenuator into the signal path.

Characteristics: *RST value: OFF
SCPI: device-specific

Mode: K91

The command is only available with the electronic attenuator option (B25).

INPut:FILTer:YIG[:STATe]

This command switches the YIG filter for image frequency suppression into the signal path (condition ON) and/or removes it from the signal path (condition OFF).

Example: "INP:FILT:YIG OFF" Switches the YIG filter off

Characteristics: *RST value: ON
SCPI: device-specific

Mode: K91

INPut:SELect

This remote control command specifies whether the baseband input or RF input is the currently selected signal input. Note that baseband input requires option B71. When option B71 is not installed, only RF selection is allowed.

Example: "INPut:SEL AIQ" Select baseband input

Characteristics: *RST value: RF
SCPI: in compliance

Mode: K91

INPut:IQ:BALanced[:STATe]

This remote control command specifies whether the IQ inputs are symmetrical (balanced) or asymmetrical (unbalanced). Note that this command requires option B71.

Example: "INPut:IQ:BAL 1" Specifies symmetrical (balanced) IQ inputs.

Characteristics: *RST value: ON
SCPI: device-specific

Mode: K91

INPut:IQ:IMPedance

This remote control command specifies the input impedance for the IQ inputs. Note that this command requires option B71.

Example: "INPut:IQ:IMP 50" Specifies 50 Ω input impedance for IQ inputs.

Characteristics: *RST value: 50
SCPI: device-specific

Mode: K91

INSTrument Subsystem

COMMAND	PARAMETERS	UNIT	COMMENT
INSTrument :SElect :NSElect	WLAN <numeric_value>		

INSTrument:SElect

This remote control command selects active operation of the R&S FSQ-K91 option by specifying its name.

Example: "INST:SEL WLAN" The R&S FSQ-K91 option will be selected as the active option.

Characteristics: *RST value: SANalyzer
 SCPI: device-specific

Mode: FSQ Base System

INSTrument:NSElect

This remote control command selects active operation of the FSQ-K91 option by specifying its associated option number.

Example: "INST:NSEL 6" The R&S FSQ-K91 option will be selected as the active option.

Characteristics: *RST value: 1
 SCPI: device-specific

Mode: FSQ Base System

SENSe Subsystem

The SENSe command is used to set and get the values of parameters in the remote instrument. The "get" variant of the SENSe command differs from "set" in that it takes no parameter values (unless otherwise stated) but is followed by the character '?' and will return the parameter's value in the same format as it is set.

e.g SENS:FREQ 10GHZ - sets the frequency to 10 GHz
 SENS:FREQ? - response 10 GHZ - returns the current frequency

COMMAND	PARAMETERS	UNIT	COMMENT
[[:SENSE]			
:FREQuency			
:CENTer	<numeric_value>	Hz	
:IQ			
:DITHer			
[:STATe]	<Boolean>		
:LPASs			
[:STATe]	<Boolean>		
:SWEep			
:TIME	<numeric_value>	S	
:COUNT	<numeric_value>		
:EGATE	<Boolean>		
:HOLDoff			
[:TIME]	<numeric_value>	S	
:SAMPle	<numeric_value>		
:LENgth			
[:TIME]	<numeric_value>	S	
:SAMPle	<numeric_value>		
:LINK	<Boolean>		
:DEMod			
:CESTimation	<Boolean>		IEEE 802.11a & j
:FILTer			
:CATalog?			query only
:MODulation	<String>,<String>		
:FORMat			
:SIGSymbol	<Boolean>		
[:BCONTent]			
:AUTo	<Boolean>		
:BTRate	10 20 55 110		IEEE 802.11b
:BANalyze	<String>		
:BTYPe	<String>		
:SYMBOLs			
:EQUal	<Boolean>		IEEE 802.11a & j
:MIN	<numeric_value>		IEEE 802.11a & j
:MAX	<numeric_value>		IEEE 802.11a & j
:DBYTes			
:EQUal	<Boolean>		IEEE 802.11b
:MIN	<numeric_value>		IEEE 802.11b
:MAX	<numeric_value>		IEEE 802.11b
:DURation			
:EQUal	<Boolean>		802.11b/g
:MIN	<numeric_value>		802.11b/g
:MAX	<numeric_value>		802.11b/g
:BURSt			
:COUNT	<numeric_value>		
:STATe	<Boolean>		
:SWAPiq	<Boolean>		
:TRACking			
:LEVel	<Boolean>		
:PHASe	<Boolean>		
:TIME	<Boolean>		
:POWer			
:ACHannel			IEEE 802.11j
:MODE	ABS REL		

[SENSe:]FREQUency:CENTer

The remote control command is used to specify the frequency that the analyzer will use to make measurements against the input signal.

Example: "SENS:FREQ:CENT 5GHZ" The R&S FSQ-K91 option uses the specified frequency value to set the analyzer detection frequency.

Characteristics: *RST value: $f_{\max} / 2$
SCPI: in compliance

Mode: K91

[SENSe:]IQ:DITHer[:STATe]

This instruction links a 2 MHz-wide dither signal with 42.67 MHz into the signal path of the baseband inputs. Note that this command requires option B71.

Example: "SENS:IQ:DITH 1" Switches on the 2 MHz broad dither signal

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]IQ:LPASs[:STATe]

This instruction switches a 36 MHz filter into the I and Q branch of the baseband inputs. Note that this command requires option B71

Example: "SENS:IQ:LPASs 1" Switches on the lowpass filter for the IQ inputs.

Characteristics: *RST value: 1
SCPI: device specific

Mode: K91

[SENSe:]SWEep:TIME

The remote control command is used to specify the sweep acquisition period (capture time) for which the input signal is to be measured.

Example: "SENS:SWEep:TIME 20ms" The R&S FSQ-K91 option uses the specified sweep acquisition period.

Characteristics: *RST value: 1 ms
SCPI: in compliance

Mode: K91

[SENSe:]SWEep:COUNT

The remote control command is used to specify the number of sweeps for Spectrum Mask and Spectrum ACPR measurements.

Example: "SENS:SWEep:COUNT 64" Sets the number of sweeps to 64.

Characteristics: *RST value: 1
SCPI: in compliance

Mode: K91

[SENSe:]SWEep:EGATe

This command switches the gating on/off .

Example: “SENS:SWE:EGAT ON” Switches gating on.

Characteristics: *RST value: OFF
 SCPI: device specific

Mode: K91

[SENSe:]SWEep:EGATe:HOLDoff[:TIME]

This command defines the gate delay in the capture buffer in time units. The range of this value is dependent on the measurement that was last run.

Example: “SENS:SWE:EGAT:HOLD 125µs” The R&S FSQ-K91 option will enforce a delay of 125 µs in the capture buffer

Characteristics: *RST value: 100µs
 SCPI: device specific

Mode: K91

[SENSe:]SWEep:EGATe:HOLDoff:SAMPle

This command defines the gate delay in the capture buffer as a number of samples. The range of this value is dependent on the measurement that was last run.

Example: “SENS:SWE:EGAT:HOLD:SAMP 2500” The R&S FSQ-K91 option will enforce a delay of 2500 samples in the capture buffer.

Characteristics: *RST value: 2000
 SCPI: device specific

Mode: K91

[SENSe:]SWEep:EGATe:LENGth[:TIME]

This command defines the gate time in the capture buffer in time units. The range of this value is dependent on the measurement that was last run.

Example: “SENS:SWE:EGAT:LENG 20ms” The R&S FSQ-K91 option will enforce a length of 20 ms between sweeps.

Characteristics: *RST value: 400µs
 SCPI: device specific

Mode: K91

[SENSe:]SWEep:EGATe:LENGth:SAMPle

This command defines the gate time in the capture buffer as a number of samples. The range of this value is dependent on the measurement that was last run.

Example: “SENS:SWE:EGAT:LENG:SAMP 200000” The R&S FSQ-K91 option will enforce a gate length of 200000 samples in the capture buffer.

Characteristics: *RST value: 8000
 SCPI: device specific

Mode: K91

[SENSe:]SWEep:EGATe:LINK

This command links together the movement of the gating lines and the capture buffer marker.

Example: "SENS:SWE:EGAT:LINK ON" Links the gating lines with marker 1.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:CESTimation

This command defines whether channel estimation will be done in the preamble and payload (if set to 1) or only in the preamble (if set to 0). 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.

Example: "SENS:DEMod:CEST 1" Specifies that the IQ measurement results will use channel estimation in preamble & payload.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FILTer:CATalog?

This command reads the names of all available filters. The file names are output without file extension. Syntax of output format: filter_1,filter_2, ... ,filter_n

Example: "SENS:DEM:FILT:CAT?" Reads all filter names

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FILTer:MODulation

This command selects the TX and RX filters. The names of the filters correspond to the file names; a query of all available filters is possible by means of the "SENS:DEM:FILT:CAT?" command.

Example: "SENS:DEM:FILT:MOD 'DEF_TX', 'DEF_RX'" DEF_TX is selected for the TX filter and DEF_RX for the RX filter

Characteristics: *RST value: AUTO,AUTO
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:SIGSymbol

When this command is set to ON, the signal symbol field of the burst is analyzed to determine the details of the burst. When this field is set to ON, only bursts that match the supplied burst type and modulation are considered in results analysis. For IEEE 802.11b, this command can only be queried, as the decoding of the signal field is always performed for the IEEE 802.11b standard.

Example: "SENSe:DEM:FORM:SIGS ON" Specifies that the signal symbol field should be decoded.

Characteristics: *RST value:
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat[:BContent]:AUTO

When this command is set to ON, the signal symbol field of the burst is analyzed to determine the modulation scheme of the first burst. When this field is set to ON, only bursts that match the modulation scheme are considered in results analysis.

Example: "SENSe:DEM:FORM:AUT ON" Specifies that the signal symbol field should be decoded.

Characteristics: *RST value:
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BTRate

The remote control command is used to specify the bit rate for IEEE 802.11b signals. This command can be used as an alternative to [SENSe:]DEMod:FORMat:BANalyze. The bit rate can be set as follows:

10 - 1Mbit/s
20 - 2Mbit/s
55 - 5.5Mbit/s
110 - 11Mbit/s

Example: "SENS:DEM:FORM:BTR 20" The R&S FS-K91 option will demodulate 2 Mbit/s signals.

Characteristics: *RST value: 10 (= 1mbit)
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze

The remote control command sets the analysis modulation format that will be assumed when the measurement is performed. If the [SENSe:]DEMod:FORMat:SIGSymbol parameter has been set to ON, this command can be used to measure only certain burst types within a measurement sequence.

The supplied string can be one of the following:

'BPSK3' - IEEE 802.11j (10 MHz) - BI-Phase shift keying at 3 Mbps
'BPSK45' - IEEE 802.11j (10 MHz) - BI-Phase shift keying at 6 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
'BPSK' - Alias for BI-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
'QPSK18' - IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature phase shift keying at 18 Mbps
'QPSK' - Alias for Quadrature phase shift keying 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
'QAM1636' - IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 36 Mbps
'QAM16' - Alias for Quadrature Amplitude Modulation at higher data rate for selected standard
'QAM6424' - IEEE 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
- 'QAM6454' - IEEE 802.11a, g (OFDM), j (20 MHz) & Turbo - Quadrature Amplitude Modulation at 54 Mbps
- 'QAM64' - Alias for Quadrature Amplitude Modulation at higher data rate for selected standard
- 'DBPSK' - IEEE 802.11b & g (Single Carrier) - Differential BI-Phase shift keying
- 'DQPSK' - IEEE 802.11b & g (Single Carrier) – Differential Quadrature phase shift keying
- 'CCK55' - IEEE 802.11b & g (Single Carrier) - Complementary Code Keying at 5.5 Mbps
- 'CCK11' - IEEE 802.11b & g (Single Carrier) – Complementary Code Keying at 11 Mbps
- 'PBCC55' - IEEE 802.11b & g (Single Carrier) - PBCC at 5.5 Mbps
- 'PBCC11' - IEEE 802.11b & g (Single Carrier) – PBCC at 11 Mbps
- 'PBCC22' - IEEE 802.11g (Single Carrier) – PBCC at 11 Mbps

Example: "SENS:DEM:FORM:BAN 'QAM16'" The R&S FSQ-K91 option will only analyze bursts that are of the QAM16 modulation format

Characteristics: *RST value: 'QAM64'
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:BTYPe

This remote control command specifies the type of burst to be analyzed. Only bursts of the specified type take part in measurement analysis.

The supplied string can be one of the following:

'DIRECT'	IEEE 802.11a, IEEE 802.11j (10 MHz), IEEE 802.11j (20 MHz), IEEE 802.11g, 802.11 OFDM Turbo - Direct Link Burst
'LONG-OFDM'	IEEE 802.11g - Long DSSS OFDM
'SHORT-OFDM'	IEEE 802.11g - Short DSSS OFDM
'LONG'	IEEE 802.11b, IEEE 802.11g – Long PLCP Burst
'SHORT'	IEEE 802.11b, IEEE 802.11g – Short PLCP Burst

Example: "SENS:DEM:FORM:BAN:BTYPe 'DIRECT'" The R&S FSQ-K91 option will only analyze DIRECT bursts

Characteristics: *RST value: 'DIRECT'
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:EQUal

When this command is set to ON, only bursts of equal length will take part in the measurement analysis. When this command is set to true, the value specified by the [SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:MIN command specifies the number of symbols that a burst must have in order to take part in analysis

Example: "SENS:DEM:FORM:BAN:SYM:EQU 1" Only bursts of equal length will take part in analysis.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:MIN

This command specifies the number of data symbols required for bursts to qualify for measurement analysis. Only bursts with the specified number of symbols will be used in the measurement analysis. The number of data symbols is defined as the uncoded bits including service and tail bits.

When the [SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:EQUal command has been set to true, this command specifies the exact number of symbols required for a burst to take part in measurement analysis. When the [SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:EQUal command is set to false, this command specifies the minimum number of symbols required for a burst to take part in measurement analysis.

Example: "SENS:DEM:FORM:BAN:SYM:MIN 16" The R&S FSQ-K91 option will only analyze bursts that contain a symbol count of 16.

Characteristics: *RST value: 1
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:MAX

This command specifies the maximum number of data symbols required for bursts to qualify for measurement analysis. Only bursts with the specified number of symbols will be used in the measurement analysis. The number of data symbols is defined as the uncoded bits including service and tail bits.

This value will not have any immediate effect if the [SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:EQUAL command has been set to true, as in this case no range of symbols is allowed and only bursts with exactly the number of symbols specified by the [SENSe:]DEMod:FORMat:BANalyze:SYMBOLs:MIN command will take part in measurement analysis.

Example: "SENS:DEM:FORM:BAN:SYM:MAX 1300" The R&S FSQ-K91 option will only analyze bursts that contain a maximum symbol count of 1300.

Characteristics: *RST value: 64
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:DBYTeS:EQUal

When this command is set to ON, only bursts of equal length will take part in the measurement analysis. When this command is set to true, the value specified by the [SENSe:]DEMod:FORMat:BANalyze:DBYTeS:MIN command specifies the number of data bytes that a burst must have in order to take part in measurement analysis.

Example: "SENS:DEM:FORM:BAN:DBYTeS:EQU ON" Only bursts of equal length will take part in the measurement analysis.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:DBYTeS:MIN

This command specifies the number of data bytes required for bursts to qualify for measurement analysis. Only bursts with the specified number of data bytes will be used in the measurement analysis. When the [SENSe:]DEMod:FORMat:BANalyze:DBYTeS:EQUal command has been set to true, this command specifies the exact number of data bytes required for a burst to take part in measurement analysis. When the [SENSe:]DEMod:FORMat:BANalyze:DBYTeS:EQUal command is set to false, this command specifies the minimum number of data bytes required for a burst to take part in measurement analysis.

Example: "SENS:DEM:FORM:BAN:DBYTeS:MIN 16" The R&S FS-K91 option will only analyze bursts that contain 16 data bytes.

Characteristics: *RST value: 1
SCPI: device specific

Mode: K91

[SENSe:]DEMod:FORMat:BANalyze:DBYTeS:MAX

This command specifies the maximum number of data bytes required for bursts to qualify for measurement analysis. Only bursts with the specified number of data bytes will be used in the measurement analysis. This value will not have any immediate effect if the [SENSe:]DEMod:FORMat:BANalyze:DBYTeS:EQUal command has been set to true, as in this case no range of symbols is allowed and only bursts with exactly the number of data bytes specified by the [SENSe:]DEMod:FORMat:BANalyze:DBYTeS:MIN command will take part in measurement analysis.

Example: "SENS:DEM:FORM:BAN:DBYTeS:MAX 1300" The R&S FS-K91 option will only analyze bursts that contain a maximum of 1300 data bytes.

Characteristics: *RST value: 64
SCPI: device specific

Mode: K91

[SENSe:]DEMod:BANalyze:DURation:EQUal

When this command is set to ON, only bursts of equal length will take part in the PVT analysis. When this command is set to true, the value specified by the [SENSe:]DEMod:BANalyze:DURation:MIN command specifies the required burst duration in order for a burst to take part in measurement analysis.

Example: "SENS:DEM:BAN:DUR:EQU ON" Only bursts of equal length will take part in the measurement analysis.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]DEMod:BANalyze:DURation:MIN

This command specifies the duration in microseconds required for bursts to qualify for measurement analysis. Only bursts with the specified duration will be used in the measurement analysis. When the [SENSe:]DEMod:BANalyze:DURation:EQUal command has been set to true, this command specifies the exact duration required for a burst to take part in measurement analysis. When the [SENSe:]DEMod:BANalyze:DBYTeS:EQUal command is set to false, this command specifies the minimum duration required for a burst to take part in measurement analysis.

Example: "SENS:DEM:BAN:DBYTeS:MIN 45" The FS-K90 option will only analyze bursts that last 48 microseconds.

Characteristics: *RST value: 1
SCPI: device specific

Mode: K91

[SENSe:]DEMod:BANalyze:DURation:MAX

This command specifies the maximum duration in microseconds required for bursts to qualify for measurement analysis. Only bursts with the specified duration will be used in the measurement analysis.

This value will not have any immediate effect if the [SENSe:]DEMod:BANalyze:DURation:EQUal command has been set to true, as in this case no range of durations is allowed and only bursts with exactly the duration specified by the [SENSe:]DEMod:BANalyze:DURation:MIN command will take part in measurement analysis.

Example: "SENS:DEM:BAN:DUR:MAX 1300" The FS-K90 option will only analyze bursts that have a maximum duration of 1300 microseconds.

Characteristics: *RST value: 5464
SCPI: device specific

Mode: K91

[SENSe:]BURSt:COUNT

This command defines the number of bursts that will be analyzed by the measurement. This parameter is ignored if the setting for the [SENSe:]BURSt:COUNT:STATe parameter is off.

Example: "BURS:COUN 16" - Sets the number of bursts to 16.

Characteristics: *RST value: 1
SCPI: device specific

Mode: K91

[SENSe:]BURSt:COUNT:STATe

When this command is set to on, the burst count parameter will be used by the measurement; otherwise, the burst count parameter will be ignored.

Example: "BURS:COUN:STAT 1" Sets the burst count state to ON.

Characteristics: *RST value: OFF
SCPI: device specific

Mode: K91

[SENSe:]SWAPiq

This command defines whether or not the recorded IQ pairs should be swapped (I->Q) before being processed.

Example: "SWAP 1" Specifies that IQ values should be swapped.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]TRACking:LEVEl

This command defines whether or not the measurement results should be compensated for level.

Example: "TRAC:LEV 1" - Specifies that the measurement results should be compensated for level.

Characteristics: *RST value: 0
SCPI: device specific

Mode: K91

[SENSe:]TRACking:PHASe

This command defines whether or not the measurement results should be compensated for phase.

Example: "TRAC:PHAS 1" Specifies that the measurement results should be compensated for phase.

Characteristics: *RST value: 1
 SCPI: device specific

Mode: K91

[SENSe:]TRACking:TIME

This command defines whether or not the measurement results should be compensated for time.

Example: "TRAC:TIME 1" Specifies that the measurement results should be compensated for time.

Characteristics: *RST value: 0
 SCPI: device specific

Mode: K91

[SENSe:]POWer:ACHannel:MODE

This command sets the ACP measurement mode for the IEEE 802.11j standard to either absolute or relative. The mode can be specified as follows:

ABS - Absolute measurement

REL - Relative measurement

Example: "POW:ACH:MODE ABS" Sets the ACP measurement to absolute mode

Characteristics: *RST value: REL
 SCPI: device specific

Mode: K91

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.

COMMAND	PARAMETERS	UNIT	COMMENT
STATus:			
:QUESTionable			
:LIMit<1 2>			
[:EVENT]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:ACPLimit			
[:EVENT]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:POWer			
[:EVENT]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:SYNC			
[:EVENT]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	

STATus:QUESTionable:LIMit<1|2>[:EVENT]?

This command queries the contents of the EVENT section of the STATus:QUESTionable:LIMit Register for screen A and B. Readout deletes the contents of the EVENT section.

Example: "STAT:QUES:LIM?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:LIMit<1|2>:CONDition?

This command queries the contents of the CONDition section of the STATus:QUESTionable:LIMit register for screen A and B. Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:LIM:COND?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUEStionable:LIMit<1|2>:ENABle

This command sets the bits of the ENABle section of the STATus:QUEStionable:LIMit register for screen A and B. The ENABle register selectively enables the individual events of the associated EVENT section for the summary bit.

Example: "STAT:QUES:LIM:ENAB 65535" All events bits will be represented in the LIMit summary bit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUEStionable:LIMit<1|2>:PTRansition

This command determines what bits in the STATus:QUEStionable:LIMit Condition register of screen A or B will set the corresponding bit in the STATus:QUEStionable:LIMit Event register when that bit has a positive transition (0 to 1). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:LIMit:PTR 65535" All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUEStionable:LIMit<1|2>:NTRansition

This command determines what bits in the STATus:QUEStionable:LIMit Condition register of screen A or B will set the corresponding bit in the STATus:QUEStionable:LIMit Event register when that bit has a negative transition (1 to 0). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:LIM:NTR 65535" All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUEStionable:ACPLimit[:EVENT]?

This command queries the contents of the EVENT section of the STATus:QUEStionable:ACPLimit Register. Readout deletes the contents of the EVENT section.

Example: "STAT:QUES:ACPL?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUEStionable:ACPLimit:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:ACPLimit register. Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:ACPL:COND?"

Characteristics: *RST value: -
SCPI: In compliance

Mode: K91

STATus:QUESTIONable:ACPLimit:ENABLE

This command sets the bits of the ENABLE section of the STATus:QUESTIONable:ACPLimit register. The ENABLE register selectively enables the individual events of the associated EVENT section for the summary bit.

Example: "STAT:QUES:ACPL:ENAB 65535" All events bits will be represented in the LIMit summary bit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTIONable:ACPLimit:PTRansition

This command determines what bits in the STATus:QUESTIONable:ACPLimit Condition register of screen A or B will set the corresponding bit in the STATus:QUESTIONable:ACPLimit Event register when that bit has a positive transition (0 to 1). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:ACPL:PTR 65535" - All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTIONable:ACPLimit:NTRansition

This command determines what bits in the STATus:QUESTIONable:ACPLimit Condition register of screen A or B will set the corresponding bit in the STATus:QUESTIONable:ACPLimit Event register when that bit has a negative transition (1 to 0). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:ACPL:NTR 65535" All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTIONable:POWER[:EVENT]?

This command queries the contents of the EVENT section of the STATus:QUESTIONable:POWER Register. Readout deletes the contents of the EVENT section.

Example: "STAT:QUES:POW?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:POWer:CONDition?

This command queries the contents of the CONDition section of the STATus:QUESTionable:POWer register. Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:POW:COND?"

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:POWer:ENABLE

This command sets the bits of the ENABle section of the STATus:QUESTionable:POWer register. The ENABle register selectively enables the individual events of the associated EVENTsection for the summary bit.

Example: "STAT:QUES:POW:ENAB 65535" - All events bits will be represented in the POWer summary bit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:POWer:PTRansition

This command determines what bits in the STATus:QUESTionable:POWer Condition register will set the corresponding bit in the STATus:QUESTionable:POWer Event register when that bit has a positive transition (0 to 1).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:POW:PTR 65535" All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:POWer:NTRansition

This command determines what bits in the STATus:QUESTionable:POWer Condition will set the corresponding bit in the STATus:QUESTionable:POWer Event register when that bit has a negative transition (1 to 0).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:POW:NTR 65535" - All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:SYNC:CONDition?

This command queries the contents of the CONDition section of the STATus:QUESTionable:SYNC register. Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:SYNC:COND?"

Characteristics: *RST value: -
SCPI: In compliance

Mode: K91

STATus:QUESTionable:SYNC:ENABle

This command sets the bits of the ENABle section of the STATus:QUESTionable:SYNC register. The ENABle register selectively enables the individual events of the associated EVENT section for the summary bit.

Example: "STAT:QUES:SYNC:ENAB 65535" - All events bits will be represented in the SYNC summary bit.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:SYNC:PTRansition

This command determines what bits in the STATus:QUESTionable:SYNC Condition register will set the corresponding bit in the STATus:QUESTionable:SYNC Event register when that bit has a positive transition (0 to 1). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:SYNC:PTR 65535" All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

STATus:QUESTionable:SYNC:NTRansition

This command determines what bits in the STATus:QUESTionable:SYNC Condition will set the corresponding bit in the STATus:QUESTionable:SYNC Event register when that bit has a negative transition (1 to 0). The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: "STAT:QUES:SYNC:NTR 65535" - All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: -
SCPI: device-specific

Mode: K91

TRACe Subsystem

The TRACe subsystem controls access to the instrument's internal trace memory.

COMMAND	PARAMETERS	UNIT	COMMENT
TRACe [:DATA]	TRACE1 TRACE2 TRACE3 TRACE4 TRACE5 TRACE6		Query only
:IQ :DATA: :MEMory?	<numeric_value>, <numeric_value>		Query only
:SRATe	<numeric_value>	Hz	IEEE 802.11a
:FILTer :FLATness	NORMal WIDE		

TRACE[:DATA]

This command returns all the measured data that relates to the currently selected measurement type. All results are returned in ASCII format. The returned data is particular to the currently selected measurement type and is specified below. DISPLAY:FORMat is not supported with this command.

Error Vs Preamble

Three traces types are available with this measurement. The basic trace types shows either the minimum, mean or maximum frequency or phase value as measured over the preamble part of the burst.

IQ Measurements

There are a number of measurements that can be performed in IQ mode. No data will be returned for any of the following measurements, should it be requested, until a measurement belonging to the IQ group has been run.

Running a frequency sweep measurement for example, Spectrum Mask, will not generate results for this measurement group.

Constellation vs Symbol

This measurement represents I and Q data. For IEEE 802.11a and j, the data will be returned as a repeating array of interleaved I and Q data in groups of selected carriers until all the data is exhausted. For IEEE 802.11b, the data will be returned as a repeating array of interleaved I and Q data in symbol order until all the data is exhausted.

Each I and Q point will be returned in floating point format. TRACE1 is used for these measurement results.

IEEE 802.11a & j only If "All Carriers" is selected, it will return 52 groups of I and Q data.

If "Pilots Only" is selected, it will return 4 groups of I and Q per symbol in the following order: Carrier -21, Carrier -7, Carrier 7, Carrier 21.

If a single carrier is selected, it will return 1 group of I and Q data.

Constellation vs Carrier

This measurement represents I and Q data. Data will be returned as a repeating array of interleaved I and Q data in groups of 53 channels including the channel 0 until all the data is exhausted.

Each I and Q point will be returned in floating point format. TRACE1 is used for these measurement results.

Power vs Time – Full Burst and Rising /Falling data

Both measurement results are once again simply slightly different views of the same results data.

All complete bursts within the capture time are analyzed in three master bursts. The three master bursts relate to the minimum, maximum and average values across all complete bursts. This data is returned in dBm values to the user on a per sample basis. Each sample will in some way relate to an analysis of each corresponding sample within each processed burst.

The type of PVT data returned will be determined by the TRACE number passed as an argument to the SCPI command, in addition to the graphic type that is selected.

If the graphic type selected is full burst, the return data is as follows.

TRACE1 – full burst, minimum burst data values.

TRACE2 – full burst, mean burst data values.

TRACE3 – full burst, maximum burst data values.

If the graphic type selected is EDGe, the return data is as follows.

TRACE1 – rising edge, minimum burst data values.

TRACE2 – rising edge, mean burst data values.

TRACE3 – rising edge, maximum burst data values.

TRACE4 – falling edge, minimum burst data values.

TRACE5 – falling edge, mean burst data values.

TRACE6 – falling edge, maximum burst data values.

For IEEE 802.11b If the graphic type selected is RISing or FALLing, only 3 traces are available (1 to 3) and represent the minimum, mean and maximum bursts data for the respective graph selection.

The number of samples returned during full burst analysis will depend on the modulation type and will typically be 5000.

The number of samples returned when the rising and falling graphic type is selected will be less than what is returned for full burst and will be approximately 400 samples.

The samples will be returned in floating point format as a single sequence of comma-delimited values.

Spectrum Flatness

There are four separate traces that are available with this measurement. Trace data for a particular trace will only be returnable by querying the appropriate trace.

Spectrum flatness provides two basic graph types. These are an absolute power value graph (ABS) and a relative group delay graph, which are both plotted on a per carrier basis. All 52 carriers are drawn, in addition to the unused 0 carrier. Both the absolute power and group delay graph groups will allow all the data points to be returned as one trace and an average of all the channels as the other trace.

For example, the return data will either be one single group of 53 carriers if the average trace is selected or a repeating group of 53 carriers if all the data is requested.

TRACE1 – ABS (all analyzed trains)

TRACE2 – Group Delay (all analyzed trains)

TRACE3 – ABS (average trace)

TRACE4 – Group Delay (average trace)

Absolute power results are returned in dB and group delay results are returned in ns.

Spectrum FFT

All FFT points will be returned if the data for this measurement is requested. This will be an exhaustive call, due to the fact that there are nearly always more FFT points than IQ samples. The number of FFT points is the number presented by a power of 2 that is higher than the total number of samples.

For example, if there were 20000 samples, 32768 FFT points would be returned.

Data will be returned in floating point format in dBm. TRACE1 is used for these measurement results.

Statistics bit stream data

IEEE 802.11a & j only Data will be returned in repeating groups of 52 data channels where each symbol value will be represented by an integer value within one byte. Channel 0 is unused and will therefore not have any data associated with it, with no return data being provided.

The number of repeating groups that are returned will be equal to the number of measured symbols.

Currently, 64QAM has the highest data rate and it contains symbol values up to 63, making the proposal of one byte sufficient in size to represent all symbol data values, regardless of the modulation type in use.

Data will be returned in ASCII printable hexadecimal character format.

TRACE1 is used for these measurement results.

IEEE 802.11b only Data will be returned in burst order. Each burst will be represented as a series of bytes. For each burst, the first 9 or 18 bytes represent the PLCP Preamble for Short and Long burst types, respectively. The next 6 bytes represent the PLCP Header. The remaining bytes represent the PSDU. Data will be returned in ASCII printable hexadecimal character format. TRACE1 is used for these measurement results.

Statistics CCDF - Complementary cumulative distribution function

A maximum of 201 data points will be returned in addition to a data count value. The first value in the return data will represent the quantity of probability values that follow. Each of the potential 201 data points will be returned as a probability value and will represent the total number of samples that are equal to or exceed the corresponding power level. Probability data will be returned up to the power level that contains at least one sample. It is highly unlikely that the full 201 data values will ever be returned. Each probability value will be returned as a floating point number, with a value less than 1.

Statistics Signal Field data

IEEE 802.11a & j only Data will be returned as an array of hexadecimal values, with each hexadecimal value representing the 24 bit long signal field for a single burst.

IEEE 802.11b only Data will be returned as an array of hexadecimal values, with each hexadecimal value representing the 48 bit long signal field for a single burst

EVM vs Carrier

Two trace types are provided with this measurement. There is an average EVM value for each of the 53 channels or a repeating group of EVM values for each channel. The number of repeating groups will correspond to the number of fully analyzed trains.

Each EVM value will be returned as a floating point number, expressed in units of dBm.

TRACE1 – Average EVM values per channel

TRACE2 – All EVM values per channel for each full train of the capture period

EVM vs Symbol

Three trace types are available with this measurement. The basic trace types show either the minimum, mean or maximum EVM value, as measured over the complete capture period.

The number of repeating groups that are returned will be equal to the number of measured symbols.

Each EVM value will be returned as a floating point number, expressed in units of dBm.

IEEE 802.11a & j only TRACE1 – Minimum EVM values
TRACE2 – Mean EVM values
TRACE3 – Maximum EVM values

IEEE 802.11b only TRACE1 – EVM IEEE values
TRACE2 - EVM Direct values

Error Vs Preamble

Three traces types are available with this measurement. The basic trace types show either the minimum, mean or maximum frequency or phase value as measured over the preamble part of the burst.

Frequency Sweep Measurements

No data will be returned for this type of measurement, should it be requested, until a measurement has been run.

Running an IQ measurement will not generate results for this type of measurement.

Spectrum Mask

Result data will be returned as 625 trace points in floating point format. These trace points are obtained directly from the base system via the measurement API, and the quantity is therefore a fixed value. Only an array of Y data will be returned. TRACE1 is used for these measurement results.

Spectrum ACPR

Result data will be returned as 625 trace points in floating point format. These trace points are obtained directly from the base system via the measurement API, and the quantity is therefore a fixed value. Only an array of Y data will be returned. TRACE1 is used for these measurement results.

Example: "TRAC? TRACE2" The measurement data for the selected graph is returned.

Characteristics: *RST value: -
SCPI: in compliance

Mode: K91

TRACE:IQ:DATA:MEMory?

Returns all the IQ data associated with the measurement acquisition time.

The result values are scaled linear in unit *Volt* and correspond to the voltage at the RF input of the instrument. The command returns a comma-separated list of the measured voltage values in floating point format (Comma Separated Values = CSV). The number of values returned is 2 * number of samples, the first half being the I values, the second half the Q values.

Parameter: <offset samples> Offset of the values to be read related to the start of the acquired data.
 Value range: 0 to <# of samples> - 1
 <# of samples> Number of measurement values to be read.
 Value range: 1 to <# of samples> - <offset samples>

Example: "TRAC:IQ:DATA:MEM? 0,2000" - Requests first 2000 samples.

Characteristics: *RST value: -
 SCPI: device specific.

Mode: K91

TRACE:IQ:SRATE

This command allows the sample rate for IQ measurements to be specified

Example: "TRACE:IQ:SRAT 20000" - Specifies a sample rate of 20 MHz.

Characteristics: *RST value: -
 SCPI: device-specific

Mode: K91

TRACE:IQ:FILTer:FLATness

This command determines whether the wideband detector filters are to be used in preference to the wideband detector board, (B72 option), for a specified sample rate. The use of the wideband filters is restricted to the 20.4MHz to 40.8MHz range. These filters are only switchable if the B72 option is available in the test instrument. An FSQ which does not have the B72 option will automatically use the wideband filters where the sample rate is in the 20.4MHz to 40.8MHz range.

Example: "TRACE:IQ:FILT:FLAT WIDE" - Specifies the use of wideband detector filters.

Characteristics: *RST value: NORMal-
 SCPI: Device Specific

Mode: K91

Trigger Subsystem

The trigger subsystem is used to synchronize device action(s) with events.

COMMAND	PARAMETERS	UNIT	COMMENT
:TRIGger [:SEQUence] :MODE :LEVel :Power :AUTO :HOLDoff	IMMediate EXTErnal POWer <numeric_value> <Boolean> <numeric_value>	 DBM V S	

TRIGger[:SEQUence]:MODE

This command configures how triggering is to be performed.

- Parameter:**
 - IMMediate Automatically triggers the next measurement at the end of the previous measurement. This corresponds to the FREE RUN setting.
 - EXTErnal The next measurement is triggered by the signal at the external trigger input, e.g. a gated trigger
 - POWer The next measurement is triggered by the detection of a signal with sufficient power.

Example: "TRIG:MODE IMM" AUTO triggering will occur for the next measurement at the specified video percentage value.

Characteristics: *RST value: IMMediate
SCPI: device specific

Mode: K91

TRIGger[:SEQUence]:LEVel:POWer

This command accepts the level of the input signal for which triggering will occur. The value is specified in dBm for RF input and V for baseband inputs.

Example: "TRIG:LEV:POW 10 DBM" Set to 10 dBm for RF measurement.
"TRIG:LEV:POW 1 V" Set to 1 V for baseband measurement.

Characteristics: *RST value: 0 DBM
SCPI: device-specific

Mode: K91

TRIGger[:SEQuence]:LEVel:POWer:AUTO

This command specifies whether or not an automatic power trigger level calculation is performed before each main measurement. The setting of this command is ignored if the setting for TRIGger[:SEQuence]:MODE is not POWER.

Example: “TRIG:LEV:POW:AUTO 1” Specifies that an automatic power trigger level calculation should be performed before the start of each main measurement.

Characteristics: *RST value: 0
SCPI: device-specific

Mode: K91

TRIGger[:SEQuence]:HOLDoff

This command defines the length of the trigger delay. A negative delay time (pretrigger) can be set.

Example: “TRIG:HOLD 500us” The R&S FSQ-K91 option use a holdoff period of 500 μ s after the trigger condition has been met.

Characteristics: *RST value: -10 μ s
SCPI: In compliance

Mode: K91

Unit Subsystem

The unit subsystem specifies the units for specific result types.

COMMAND	PARAMETERS	UNIT	COMMENT
:UNIT			
:EVM	DB PCT		
:GIMBalance	DB PCT		
:PREamble	HZ PCT		

UNIT:EVM

This command specifies the units for EVM results.

Parameter: DB EVM results returned in dB
 PCT EVM results returned in %

Example: "UNIT:EVM PCT" EVM results to be returned in %.

Characteristics: *RST value: DB
 SCPI: device specific

Mode: K91

UNIT:GIMBalance

This command specifies the units for gain imbalance results.

Parameter: DB Gain imbalance results returned in dB
 PCT Gain imbalance results returned in %

Example: "UNIT:GIMB PCT" Gain imbalance results to be returned in %.

Characteristics: *RST value: DB
 SCPI: device specific

Mode: K91

UNIT:PREamble

This command specifies the units for preamble error results.

Parameter:
 HZ Preamble error results returned in Hz
 PCT Preamble error results returned in %

Example: "UNIT:PRE PCT" - Preamble error results to be returned in %.

Characteristics: *RST value: DB
 SCPI: device specific

Mode: K91

Status reporting registers

The status reporting system (see Fig. 4-1) 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 SStatus") 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.

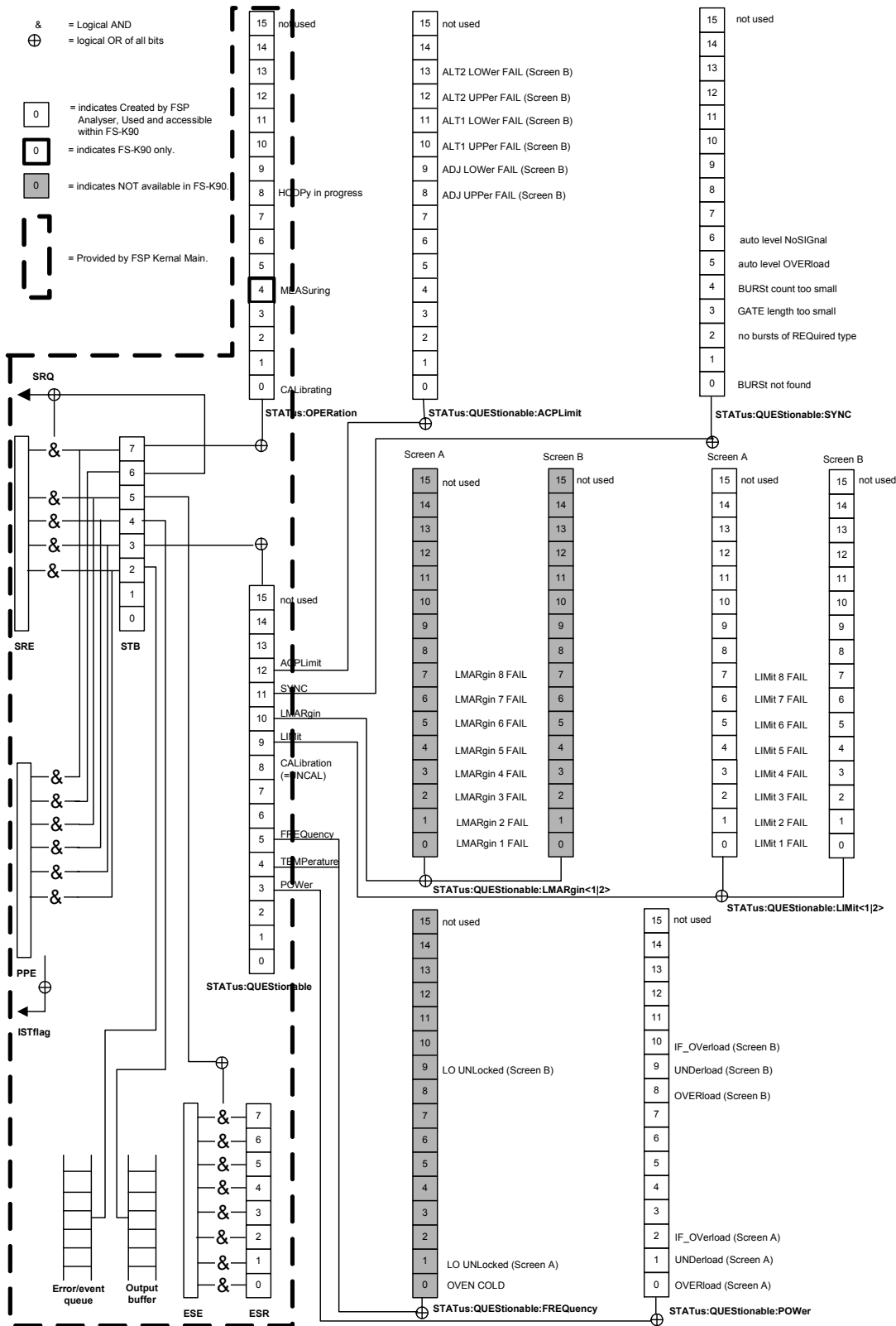


Fig. 4-1 Overview of the status registers

Description of the Status Registers

All the status registers shown in Fig. 4-1 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, R&S FSQ-K91 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 R&S FSQ-K91 command tree

STATUS:QUESTionable:LIMit2 – This register is provided by the analyzer and is not available from the R&S FSQ-K91 command tree

STATUS:QUESTionable:LMARgin<1|2> – These registers are provided by the analyzer and are not available from the R&S FSQ-K91 command tree

The deviations from the status register structure of the base system are detailed below.

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

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 (see 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 (see 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 (= ^ label "UNCAL")
9	LIMit (device-specific) This bit is set if a limit value is violated (see also section <code>STATus:QUESTionable:LIMit Register</code>). 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 <code>STATus:QUESTionable:LMARgin Register</code>)
11	SYNC (device-dependent) This bit is set if, in measurements or pre-measurements in the WLAN mode, synchronization fails, no signal is detected or no burst 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

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

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

STATus:QUESTionable:SYNC Register

This register contains information about sync and bursts 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 bursts are detected.
1	This bit is not used
2	no bursts of REQuired type This bit is set if an IQ measurement is performed and no bursts 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 to a large enough value.
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 burst 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.

Error Reporting

Error reporting for the K91 option 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.

Table of softkeys with assignment of IEC/IEEE bus commands

Key MEAS or Hotkey WLAN

GENERAL SETTINGS	<pre> :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] </pre>
DEMOM SETTINGS	<pre> :[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 </pre>
DISPLAY LIST GRAPH	<pre> :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 </pre>

PVT	:CONFigure:BURSt:PVT[:IMMediate]
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]
DEMOM 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
FULL BURST	:CONFigure:BURSt:PVT:SElect FULL
UPRAMP ON OFF	:CONFigure:BURSt:PVT:SElect RISE (query only - 802.11b)
RISING FALLING	:CONFigure:BURSt:PVT:SElect EDGE
DOWNRAMP ON OFF	:CONFigure:BURSt:PVT:SElect FALL (query only - 802.11b)
REF MEAS MAX MEAN	: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	---
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
EVM VS SYMBOL	:CONFigure:BURSt:EVM:ESYMBOL[:IMMediate]
EVM VS CARRIER	:CONFigure:BURSt:EVM:ECARRIER[:IMMediate]
Y AXIS/ DIV	:DISPlay[:WINDow<1 2>]:TACel:Y[:SCALE]:AUTO :DISPlay[:WINDow<1 2>]:TRACel:Y[:SCALE]:PDIVision
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

SPECTRUM

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]
```

DEMODO
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
```

SPECTRUM
FLATNESS

```
: CONFigure:BURSt:SPECTrum:FLATness[:IMMediate]
```

SPECTRUM
ESTI

```
:CONFigure:BURSt:SPECTrum:MASK:SElect IEEE | ETSI
```

SPECTRUM
MASK

```
:CONFigure:BURSt:SPECTrum:MASK[:IMMediate]
(query only 802.11b)
```

SPECTRUM
FTT

```
: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
RELABS

```
:[SENSe:]POWer:ACHannel:MODE REL | ABS query only – 802.11j
```

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
```

CONSTELL	---
GENERAL SETTINGS	<pre> :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] </pre>
DEMODO SETTINGS	<pre> :[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 </pre>
DISPLAY LIST GRAPH	<pre> :DISPlay[:WINDow<1 2>]:TABLe </pre>
CONSTELL	<pre> :CONFigure:BURSt:CONStellation:CSYMBOL[:IMMediate] </pre>
CONSTELL VS CARRIER	<pre> :CONFigure:BURSt:CONStellation:CCARRIER[:IMMediate] </pre>
CARRIER SELECTION	<pre> :CONFigure:BURSt:CONStellation:CARRIER:SElect </pre>
GATING ON OFF	<pre> :[SENSe:]SWEep:EGATe </pre>
GATE SETTINGS	<pre> :[SENSe:]SWEep:EGATe:HOLDoff[:TIME] :[SENSe:]SWEep:EGATe:HOLDoff:SAMPle :[SENSe:]SWEep:EGATe:LENGth[:TIME] :[SENSe:]SWEep:EGATe:LENGth:SAMPle :[SENSe:]SWEep:EGATe:LINK </pre>

STATISTICS

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
```

CCDF

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

BIT STREAM

```
:CONFigure:BURSt:STATistics:BSTReam[:IMMediate]
```

SIGNAL FIELD

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

PCL HEADER

```
:CONFigure:BURSt:STATistics:SFIeld[:IMMediate]
(query only - 802.11b)
```

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
```

Key DISP

FULL SCREEN

:DISPlay:FORMat SINGle

SPLIT SCREEN

: DISPlay:FORMat SPLit

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
```


Key MKR

MARKR 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 :CALCulate<1 2>:MARKer<1>:FUNCTION:ZOOM 1
UNZOOM	
MARKER ZOOM	:CALCulate<1 2>:MARKer<1>:FUNCTION:ZOOM <numeric value>
MARKER OFF	:CALCulate<1 2>:MARKer<1>:AOFF

Key MKR->

SELECT MARKER	---
MKR->TRACE	:CALCulate<1 2>:MARKer<1>:TRACE

Hotkeys

SPECTRUM	:INSTRument:SElect SANalyzer :INSTRument:NSElect 1
WLAN	---
AUTO LVL	:CONFIgure:POWer:AUTO ONCE
RUN SGL	:INITiate:CONTinuous OFF; INITiate[:IMMediate]
CONT	:INITiate:CONTinuous ON; INITiate[:IMMediate]
REFRESH	---
SCREEN A/B	:DISPlay[:WINDow<1 2>]:SElect :DISPlay[:WINDow<1 2>]:SSElect

5 Remote Control - Programming Examples

The following section provides some examples of commonly performed operations when using R&S FSQ-K91. For more general remote control examples, refer to the programming examples chapter in the instrument user manual.

Synchronization of Entry of Option

The following example shows how to synchronize the entry of the FS-KWLAN option.

```
analyzer% = 20      ,Instrument address
CALL IBWRT(analyzer%, " INST:SEL WLAN;*OPC?" ) ,waits for 1 from *OPC?
```

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 burst (802.11a only)
PVT:SElect:RISE	PVT rising burst (802.11b only)
PVT:SElect:FALL	PVT falling burst (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")
```

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 the
REM command INIT:CONT OFF was previously sent. It should be ensured that
REM the next command is executed only when the entire sweep is
REM 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 setting
REM "Disable Auto Serial Poll" must be changed to "yes" by means of
REM IBCONF!
CALL IBWRT(analyzer%, "*SRE 32")      'Permit service request for ESR
CALL IBWRT(analyzer%, "*ESE 1")      'Set event-enable bit for
                                      'operation-complete bit

CALL IBWRT(analyzer%, "INIT:IMM; *OPC") 'Start sweep and
                                      'synchronize with OPC

CALL WaitSRQ(boardID%,result%)      'Wait for service request

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 setting
REM "Disable Auto Serial Poll" must be changed to "yes" by means of
REM IBCONF!
CALL IBWRT(analyzer%, "*SRE 128")    'Permit service request for ESR
CALL IBWRT(analyzer%, "*ESE 0")      'Set event-enable bit for
                                      'operation-complete bit

CALL IBWRT(analyzer%, "STATus:OPERation:ENABLE 16") 'Enable bit 4 of status
                                                    'operation register'
CALL IBWRT(analyzer%, "STAT:OPERation:NTRansition 16") 'Set Negative
                                                    'transition to 1
CALL IBWRT(analyzer%, "STATus:OPERation:PTRansition 0") 'Set Positive
                                                    'transition to 0
CALL IBWRT(analyzer%, "INIT:IMM")      'Start sweep and synchronize with OPC
CALL WaitSRQ(boardID%,result%)      'Wait for service request
REM Continue main program here.

END SUB
REM *****

```

6 List of 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 <i>REFRESH</i> hotkey to remove this error.
No valid analyzed bursts within gating lines	This message is only displayed for the PVT measurement. This message indicates that there are no complete & valid bursts contained within the gating lines. Increase the Gate length and then press the <i>REFRESH</i> hotkey to remove this error.
No bursts found	<p>This message is displayed if no valid burst was detected in the input data. To correct this problem, check the following:</p> <p>The connections between the DUT and analyzer are correct.</p> <p>The input signal is of a sufficient level.</p> <p>The capture time is long enough to capture at least one complete burst. If running with a Free Run trigger, the capture time must be greater than the burst length (ideally at least twice the burst length) to ensure that a complete burst is recorded.</p> <p>Check that the demod settings are correct.</p>
No bursts of desired type to analyze	This message is displayed if bursts are found, but none of the desired type to analyze. 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.
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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