R&S®FSW-K10 GSM Measurement User Manual

1173.9263.02 — 13

Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 2.40 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)
- R&S®FSW43 (1312.8000K43)
- R&S®FSW50 (1312.8000K50)
- R&S®FSW67 (1312.8000K67)
- R&S®FSW85 (1312.8000K85)

The following firmware options are described:

- R&S FSW-K10 (1313.1368.02)

Mühldorfstr. 15, 81671 München, Germany
Phone: +49 89 41 29 - 0
Fax: +49 89 41 29 12 164
Email: info@rohde-schwarz.com
Internet: www.rohde-schwarz.com

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

Contents

1 Preface

1.1 About this Manual

This GSM Measurements User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FSW User Manual.

The main focus in this manual is on the measurement results and the tasks required to obtain them. The following topics are included:

- Welcome to the GSM Application
  Introduction to and getting familiar with the application
- GSM I/Q Measurement Results
  Details on supported measurements and their result types
- Basics on GSM Measurements
  Background information on basic terms and principles in the context of the measurement
- Modulation Accuracy Measurement Configuration and Analysis
  A concise description of all functions and settings available to configure measurements and analyze results with their corresponding remote control command
- I/Q Data Import and Export
  Description of general functions to import and export raw I/Q (measurement) data
- How to Perform Measurements in the GSM Application
  The basic procedure to perform each measurement and step-by-step instructions for more complex tasks or alternative methods
- Optimizing and Troubleshooting the Measurement
  Hints and tips on how to handle errors and optimize the test setup
- Remote Commands to Perform GSM Measurements
  Remote commands required to configure and perform GSM measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FSW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S FSW consists of the following parts:

- "Getting Started" printed manual

- Online Help system on the instrument
- User manuals and online manual for base unit and options provided on the product page
- Service manual provided on the internet for registered users
- Instrument security procedures provided on the product page
- Release notes provided on the product page
- Data sheet and brochures provided on the product page
- Application notes provided on the Rohde & Schwarz website

You find the user documentation on the R&S FSW product page mainly at:

http://www.rohde-schwarz.com/product/FSW > "Downloads" > "Manuals"

Additional download paths are stated directly in the following abstracts of the documentation types.

Getting Started

Introduces the R&S FSW and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc.

Online Help

Offers quick, context-sensitive access to the information needed for operation and programming. It contains the description for the base unit and the software options. The Online Help is embedded in the instrument's firmware; it is available using the ? icon on the toolbar of the R&S FSW.

User Manuals and Online Manual

Separate manuals are provided for the base unit and the software options:

- **Base unit** manual
  Contains the description of the graphical user interface, an introduction to remote control, the description of all SCPI remote control commands, programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the **Getting Started** manual.
- **Software option** manuals
  Describe the specific functions of the option. Basic information on operating the R&S FSW is not included.

The **online manual** provides the contents of the user manuals for the base unit and all software options for immediate display on the internet.

Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS).

Instrument Security Procedures

Deals with security issues when working with the R&S FSW in secure areas.

Data Sheet and Brochures

The data sheet contains the technical specifications of the R&S FSW. Brochures provide an overview of the instrument and deal with the specific characteristics, see:

http://www.rohde-schwarz.com/product/FSW > "Downloads" > "Brochures and Data Sheets"

Release Notes

Describes the firmware installation, new and modified features and fixed issues according to the current firmware version. You find the latest version at:

http://www.rohde-schwarz.com/product/FSW > "Firmware"

Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics, see:

http://www.rohde-schwarz.com/ > "Downloads" > "Applications".

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

1.3.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

2 Welcome to the GSM Application

The R&S FSW-K10 is a firmware application that adds functionality to perform GSM measurements to the R&S FSW.

The R&S FSW-K10 features:

- Measurements on downlink or uplink signals according to the Third Generation Partnership Project (3GPP) standards for GSM/EDGE, EDGE Evolution (EGPRS2) and Voice services over Adaptive Multi-user Channels on One Slot (VAMOS)
- Measurement in time, frequency or I/Q domains
- Measurements of mobile devices (MS), single carrier and multicarrier base transceiver stations (BTS)
- Measurement of signals ith GMSK, AQPSK, QPSK, 8PSK, 16QAM and 32QAM modulation, normal or higher symbol rate
- Measurement of signals using different Tx filters (e.g. narrow and wide pulse)
- Measurements for Power vs Time, Modulation Accuracy and Modulation and Transient Spectrum as required in the standard
- Measurements of wideband noise and intermodulation products in multicarrier operation (as defined in 3GPP TS 51.021, chapter 6.12)
- Measurements of wideband noise, narrowband noise, and intermodulation products in multicarrier operation (as defined in 3GPP TS 51.021, chapter 6.12)

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage

http://www2.rohde-schwarz.com/product/FSW.html.

Installation

You can find detailed installation instructions in the R&S FSW Getting Started manual or in the Release Notes.

2.1 Starting the GSM Application

GSM measurements are performed in a separate application on the R&S FSW.

To activate the GSM application

1. Select the MODE key.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSW.

2. Select the "GSM" item.

The R&S FSW opens a new measurement channel for the GSM application.

The measurement is started immediately with the default settings. It can be configured in the GSM "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see Chapter 6.3.1, "Configuration Overview", on page 87).

Remote command:

`INSTrument[:SELect]` on page 201

Multiple Measurement Channels and Sequencer Function

When you activate an application, a new measurement channel is created which determines the measurement settings for that application. The same application can be activated with different measurement settings by creating several channels for the same application.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

Only one measurement channel can be active at any time. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

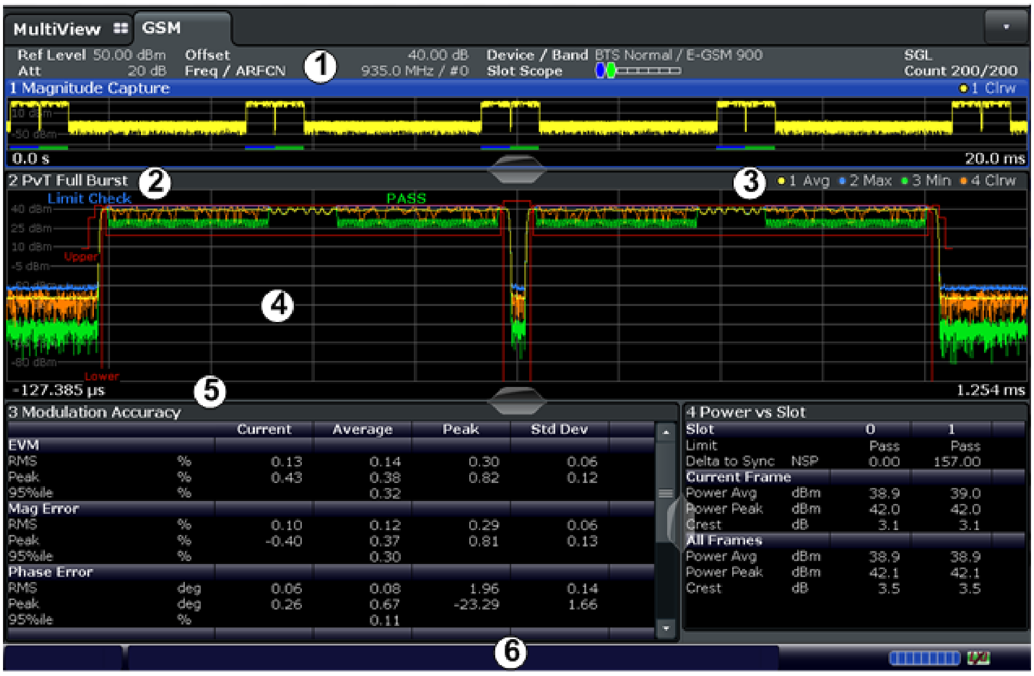
When the Sequencer is activated, the measurements configured in the currently active channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a symbol in the tab label. The result displays of the individual channels are updated in the tabs as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

See also the note on using the Sequencer function in MSRA operating mode in Chapter 5.17, "GSM in MSRA Operating Mode", on page 81.

For details on the Sequencer function see the R&S FSW User Manual.

2.2 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.



1 = Channel bar for firmware and measurement settings
2+3 = Window title bar with diagram-specific (trace) information
4 = Diagram area
5 = Diagram footer with diagram-specific information, depending on measurement
6 = Instrument status bar with error messages, progress bar and date/time display

MSRA operating mode

In MSRA operating mode, additional tabs and elements are available. An orange background behind the measurement channel tabs indicates that you are in MSRA operating mode.

For details on the MSRA operating mode see Chapter 5.17, "GSM in MSRA Operating Mode", on page 81 and the R&S FSW MSRA User Manual.

Channel bar information

In the GSM application, the R&S FSW shows the following settings for the default I/Q measurement:

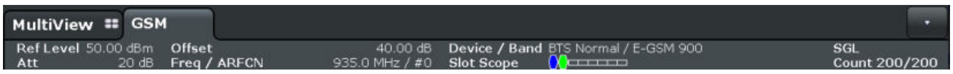


Table 2-1: Information displayed in the channel bar in the GSM application for the default I/Q measurement

Ref Level	Reference level
(m.+el.) Att	Mechanical and electronic RF attenuation
Offset	Reference level offset (if available)
Freq / ARFCN	Center frequency for the GSM signal / Absolute Radio Frequency Channel Number (if available)

Device / Band	Device type and frequency band used by the DUT as defined in the Signal Description settings
Slot Scope	Minimized visualization of the frame configuration and slots to be measured (see Chapter 5.6, "Defining the Scope of the Measurement", on page 52)
SGL	The sweep is set to single sweep mode.
Count	Number of frames already evaluated / Total number of frames required for statistical evaluation (Statistic Count) (For Statistic Count > 1)
TRG	Trigger source (if not "Free Run") and used trigger bandwidth (for IF, RF, IP power triggers) or trigger offset (for external triggers)

MCWN measurement

For the MCWN measurement, the R&S FSW shows the following settings:

Table 2-2: Information displayed in the channel bar in the GSM application for the MCWN measurement

Ref Level	Reference level
(m.+el.) Att	Mechanical and electronic RF attenuation
Offset	Reference level offset (if available)
Carriers	Number of active carriers
Device / Band	Device type and frequency band used by the DUT as defined in the Signal Description settings
Ref Meas	Carrier used for reference measurement (if enabled)
SGL	The sweep is set to single sweep mode
Count	Value of the current average count / Total average count for noise measurement (Noise Average Count)
TRG	Trigger source (if not "Free Run") and used trigger bandwidth (for IF, RF, IP power triggers) or trigger offset (for external triggers)

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. transducer settings). This information is displayed only when applicable for the current application. For details see the R&S FSW Getting Started manual.

Window title bar information

For each diagram, the header provides the following information:

Figure 2-1: Window title bar information in the Pulse application

1 = Window number
2 = Window type
3 = Trace color
4 = Trace number
6 = Trace mode

Diagram footer information

The diagram footer (beneath the diagram) contains the start and stop values for the displayed time, frequency or symbol range.

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

3 About the Measurement

A basic GSM measurement in the R&S FSW GSM application includes a power vs time and a spectrum measurement, as well as modulation accuracy (e.g. EVM, phase error) for a GSM signal as defined by the relevant 3GPP standards. The I/Q data from the GSM signal applied to the RF input of the R&S FSW is captured for a specified measurement time. This data is demodulated and synchronized with a reference signal to identify the individual frames and slots. The slots of interest are then analyzed in order to display the spectral and power results either graphically or numerically, and to calculate the modulation parameters.

The standard distinguishes between single-slot and multi-slot measurements. Single-slot measurements analyze one slot - referred to as the *"Slot to measure"* - within the GSM frame (which consists of 8 slots in total). Modulation-specific parameters such as the phase error, EVM, or spectrum due to modulation are determined on a per-slot basis. Multi-slot measurements, on the other hand, analyze a slot scope of up to 8 consecutive slots, each of which has different burst modulation characteristics. Power vs time limit checks and the transient spectrum measurements, for example, are determined for multiple slots.

Statistical evaluation of several measurements is also possible. Finally, the GSM measurement results can be exported to other applications.

4 Measurements and Result Displays

The R&S FSW GSM application provides two different measurements in order to determine the parameters described by the GSM specifications.

The default GSM **I/Q measurement** captures the I/Q data from the GSM signal. The I/Q data includes magnitude and phase information, which allows the R&S FSW GSM application to demodulate signals and determine various characteristic signal parameters such as the modulation accuracy, power vs time, modulation and transient spectrum in just one measurement.

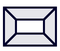
For **multicarrier measurements**, some parameters required by the GSM standard require a frequency sweep with varying resolution bandwidths. Thus, a new separate measurement is provided by the R&S FSW GSM application to determine the wideband noise in multicarrier measurement setups.

For details on selecting measurements see "Selecting the measurement type" on page 84.

4.1 GSM I/Q Measurement Results

The I/Q data that was captured by the default GSM (Modulation Accuracy, etc.) measurement can be evaluated using different methods. All evaluation methods available for the GSM measurements are displayed in the selection bar in SmartGrid mode.

To activate SmartGrid mode, do one of the following:

- 

  Select the "SmartGrid" icon from the toolbar.
- Select the "Display" button in the configuration "Overview".
- Select the "Display Config" softkey from the MEAS CONFIG menu.
- Press the MEAS key.

For details on working with the SmartGrid see the R&S FSW Getting Started manual.

By default, the GSM measurement results for I/Q measurements are displayed in the following windows:

- Magnitude Capture
- PvT Full Burst
- Modulation Accuracy
- Power vs Slot

The following evaluation methods are available for GSM I/Q measurements:

Constellation

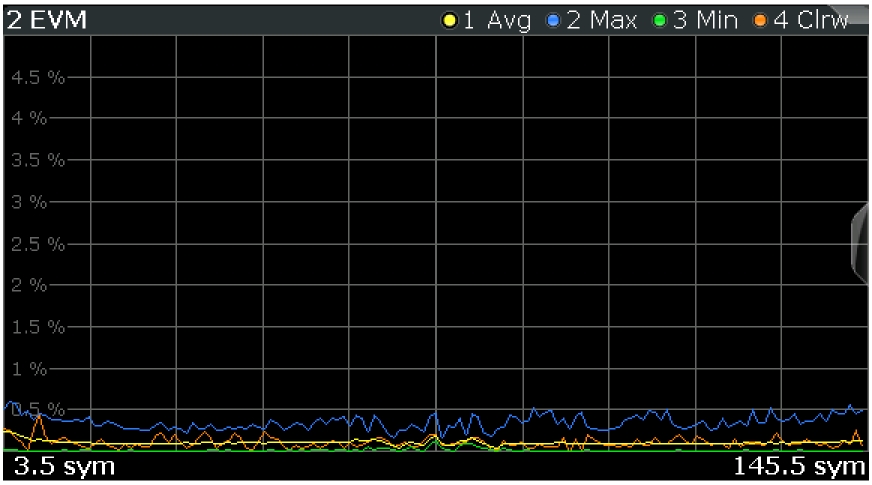
The complex source signal is displayed as an X/Y diagram. The application analyzes the specified slot over the specified number of bursts.

Remote command:

`LAY:ADD? '1',RIGH,CONS`, see `LAYout:ADD[:WINDow]?` on page 275

EVM

Displays the error vector magnitude over time for the Slot to Measure.



Remote command:
`LAY:ADD:WIND '2',RIGH,ETIMe` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297

Magnitude Capture

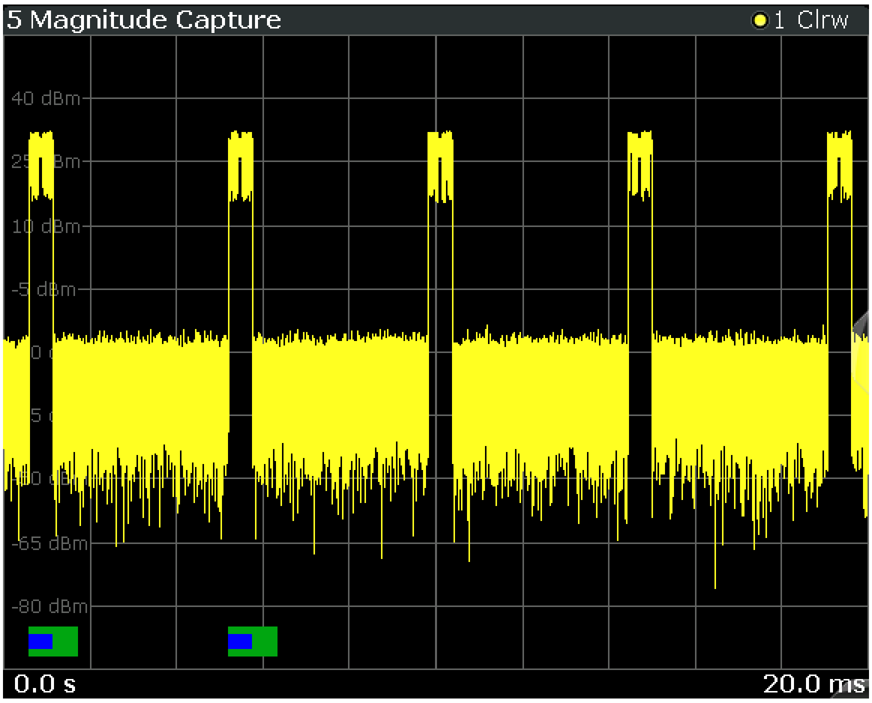
Displays the power vs. time trace of the captured I/Q data.

Pre-trigger samples are not displayed.

The analyzed *slot scopes* (1 to 8 slots of a single GSM frame) are indicated by a green bar, the Slot to Measure in each frame by a blue bar at the bottom of the diagram.

For details see Chapter 5.6, "Defining the Scope of the Measurement", on page 52.

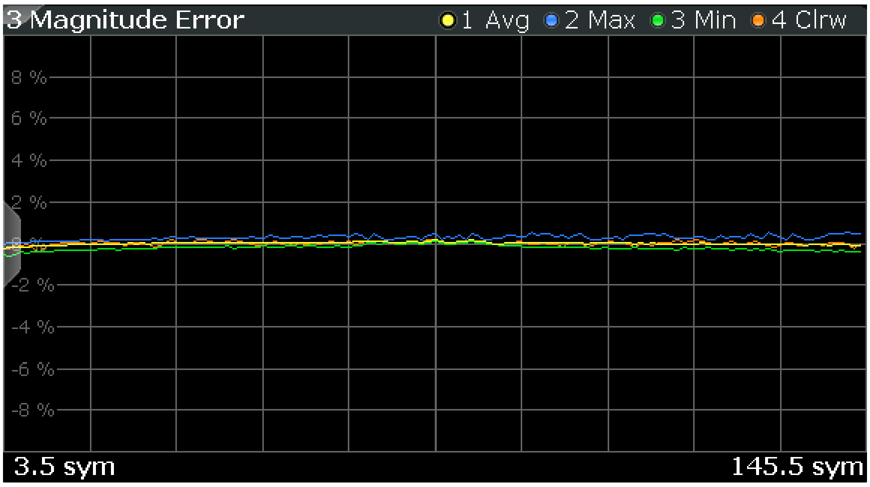
For negative trigger offsets, the trigger is displayed as a vertical red line labeled "TRG".



Remote command:
`LAY:ADD:WIND '2',RIGH,MCAP` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:MCAPture:SLOTs:SCOPe?` on page 305
`FETCh:MCAPture:SLOTs:MEASure?` on page 304
`TRACe<n>[:DATA]?` on page 297

Magnitude Error

Displays the magnitude error over time for the Slot to Measure.



Remote command:
`LAY:ADD:WIND '2',RIGH,MERR` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297

Marker Table

Displays a table with the current marker values for the active markers.

This table may be displayed automatically if configured accordingly (see "Marker Table Display" on page 174).

4 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
1	M1		1	13.25 GHz	-200.0 dBm
1	D2	M1	1	-600.0 kHz	0.0 dB
1	D3	M1	1	600.0 kHz	0.0 dB
1	D4	M1	1	-2.0 MHz	0.0 dB

Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`CALCulate<n>:MARKer<m>:X` on page 346
`CALCulate<n>:MARKer<m>:Y?` on page 346

Modulation Accuracy

Displays the numeric values of the fundamental modulation characteristics of the signal to be analyzed in the vector (I/Q) domain: error vector magnitude (EVM), magnitude and phase error, IQ imbalance, etc.


3 Modulation Accuracy

		Current	Average	Peak	Std Dev
EVM					
RMS	%	13.43	13.99	14.55	0.79
Peak	%	24.73	26.08	27.43	1.91
95%ile	%		25.11		
Mag Error					
RMS	%	11.90	12.34	12.79	0.63
Peak	%	24.73	26.08	27.43	1.91
95%ile	%		25.11		
Phase Error					
RMS	deg	3.59	3.66	3.74	0.11
Peak	deg	6.32	6.46	6.60	0.20
95%ile	%		6.12		
Origin Offset Suppression	dB	47.76	45.96	44.69	2.17
I/Q Offset	%	0.41	0.50	0.58	0.12
I/Q Imbalance	%	0.52	0.66	0.80	0.20
Frequency Error	Hz	16911.34	16912.68	16914.01	1.89
Slot Power	dBm	-1.10	-1.10	-1.10	0.00
Amplitude Droop	dB	0.00	0.34	0.68	0.48

The following modulation parameters are determined:

Table 4-1: Modulation accuracy parameters

Parameter	Description	SCPI query for result value

EVM	Error vector magnitude for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all EVM results for all frames in entire measurement fall
		`READ:BURSt[:MACCuracy][:EVM]:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy][:EVM]:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:EVM?`

Mag Error	Magnitude error for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all Magnitude Error results for *all frames* in entire measurement fall
		`READ:BURSt[:MACCuracy]:MERRor:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy]:MERRor:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:MERRor?`

Phase Error	Phase error for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all Phase Error results for *all frames* in entire measurement fall
		`READ:BURSt[:MACCuracy]:PERRor:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy]:PERRor:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:PERRor?`

Origin Offset Suppression [dB]	Origin offset suppression for the demodulated signal in the Slot to Measure; Indicates the suppression of the DC carrier; the higher the suppression, the better the DUT	`READ:BURSt[:MACCuracy]:OSUPpress:<Resulttype>?`
I/Q Offset [%]	I/Q offset for the demodulated signal in the Slot to Measure	`READ:BURSt[:MACCuracy]:IQOFfset:<Resulttype>?`

Parameter	Description	SCPI query for result value
I/Q Imbalance [%]	A measure for gain imbalances and quadrature errors between the inphase and quadrature components of the signal.	READ:BURSt[:MACCuracy]:IQIMbalance:<Resulttype>?
Frequency Error [Hz]	Frequency error of the center frequency currently measured in the Slot to Measure	READ:BURSt[:MACCuracy]:FERRor:<Resulttype>?
Burst Power [dBm]	Average power measured in the slot	READ:BURSt[:MACCuracy]:BPOWer:<Resulttype>?
Amplitude Droop [dB]	Indicates how much the amplitude decreases over a measured slot	READ:BURSt[:MACCuracy]:ADRoop:<Resulttype>?

The R&S FSW GSM application also performs statistical evaluation over a specified number of results (see "Statistic Count" on page 125). To do so, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count". The default value is 200 in accordance with the GSM standard.

For each parameter, the following results are displayed:

Table 4-2: Calculated summary results

Result type	Description	SCPI query for result value
Current	Value for currently measured frame only	READ:BURSt[:MACCuracy]:<Parameter>:CURRent?
Average	Linear average value of "Current" results from the specified number of frames **Exception**: The average of the "Origin Offset Suppression" is the linear average of the power ratio, converted to dBm subsequently	READ:BURSt[:MACCuracy]:<Parameter>:AVERage?
Peak	Maximum value of "Current" results from specified number of frames **Exception**: The peak of the "Origin Offset Suppression" is the *minimum* value, as this represents the worst case, which needs to be detected	READ:BURSt[:MACCuracy]:<Parameter>:MAXimum?
Std Dev	Standard deviation of "Current" results for specified number of frames	READ:BURSt[:MACCuracy]:<Parameter>:SDEViation?

Remote command:
`LAY:ADD:WIND '2',RIGH,MACC` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`READ:BURSt[:MACCuracy]:ALL` on page 308
Chapter 11.8.4, "Modulation Accuracy Results", on page 305

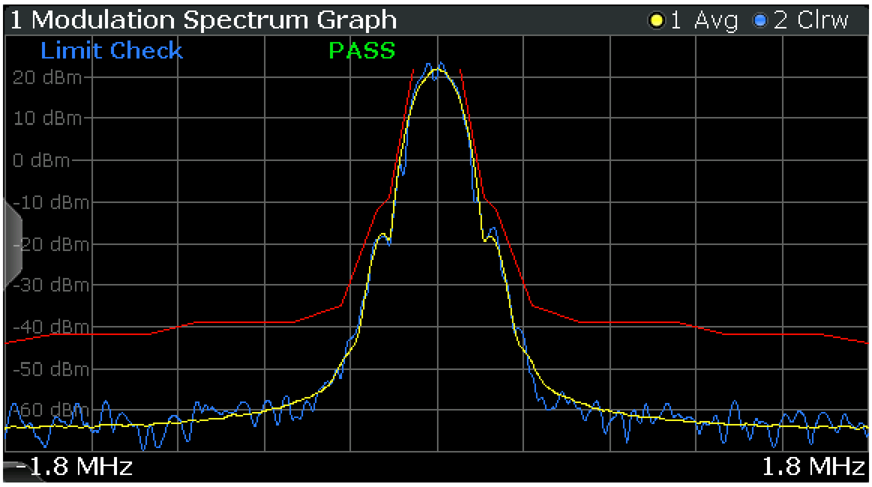
Modulation Spectrum Graph

The modulation spectrum evaluates the power vs frequency trace of a certain part of the burst (50 to 90 % of the useful part, excluding the training sequence TSC) by measuring the average power in this part over several frames at certain fixed frequency offsets.

The "Modulation Spectrum Graph" displays the measured power levels as a trace against the frequencies.

The measured values can be checked against defined limits; the limit lines are indicated as red lines in the diagram. The result of the limit check ("PASS"/"FAIL") are shown at the top of the diagram.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *both* limits are exceeded.



Note: The graphical results only provide an overview of the spectrum. For a detailed conformance check of the DUT to the GSM standard, use the "Modulation Spectrum Table" evaluation, which uses the 5-pole filter required by the 3GPP standard.
The numeric results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Table" on page 24.

The following default settings are used for a "Modulation Spectrum" evaluation.

Table 4-3: Default settings for a "Modulation Spectrum" evaluation

Setting	Default
Measurement Scope	The slot selected as Slot to Measure
Averaging Configuration	Number of bursts as selected in Statistic Count
Limit Check	According to standard: Limit check of average (Avg) trace See Chapter 5.13.1, "Limit Check for Modulation Spectrum", on page 68

Note: Modulation RBW at 1800 kHz.
For the "Modulation Spectrum Graph" both the RBW and VBW are set to 30 kHz.

Remote command:
`LAY:ADD:WIND '2',RIGH,MSFD` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297

CALCulate<n>:LIMit<k>:FAIL? on page 331
CALCulate<n>:LIMit<k>:UPPer[:DATA]? on page 333
CALCulate<n>:LIMit<k>:CONTrol:DATA? on page 331

Modulation Spectrum Table

The modulation spectrum evaluates the power vs frequency trace of a certain part of the burst (50 to 90 % of the useful part, excluding the training sequence TSC) by measuring the average power in this part over several frames.

The "Modulation Spectrum Table" displays the measured power levels and their offset to the limits defined by the standard as numeric results.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *both* limits are exceeded.
Values that exceed both limits are indicated by red characters and an asterisk (*) next to the value, and a negative "Δ to Limit" value.

2 Modulation Spectrum Table

Offset	Power Negative Offsets			Power Positive Offsets		
kHz	dB	dBm	Δ to Limit	dB	dBm	Δ to Limit
100	-7.7	-0.6	8.2	-10.1	-2.9	10.6
200	-44.0	-36.9	14.0	-42.7	-35.6	12.7
250	-43.3	-36.2	10.3	-44.4	-37.2	11.4
400	-63.6	-56.4	3.6	-61.4	-54.3	1.4
600	-63.0	-55.9	3.0	-63.0	-55.9	3.0
800	-62.2	-55.1	2.2	-63.5	-56.3	3.5
1000	-65.9	-58.8	5.9	-62.6	-55.4	2.6
1200	-65.0	-57.9	2.0	-63.8	-56.7	0.8
1400	-63.7	-56.6	0.7	-65.8	-58.6	2.8
1600	*-61.3	*-54.1	-1.7	*-62.6	*-55.4	-0.4
1800	*-61.4	*-54.2	-8.8	*-61.7	*-54.5	-8.5
3000	*-57.5	*-50.4	-7.5	*-59.3	*-52.1	-5.7
6000	*-59.4	*-52.2	-12.8	*-56.5	*-49.3	-15.7

Note: The graphical results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Graph" on page 23.

The following values are displayed:

Table 4-4: Modulation spectrum results

Result	Description
Offset [kHz]	Fixed frequency offsets (from the center frequency) at which power is measured
Power Negative Offsets	Power at the frequency offset to the left of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits
Power Positive Offsets	Power at the frequency offset to the right of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits

Table 4-5: Frequencies and filter bandwidths in modulation spectrum measurements

Offset Frequency (kHz)	RBW (kHz)	VBW (kHz)
± 100	30	30
± 200	30	30
± 250	30	30
± 400	30	30
± 600	30	30
± 800	30	30
± 1000	30	30
± 1200	30	30
± 1400	30	30
± 1600	30	30
± 1800	30 (single-carrier BTS); 100 (multi-carrier BTS);	30 (single-carrier BTS); 100 (multi-carrier BTS);

Note: "Normal" vs "Wide" Modulation Spectrum measurements.
In previous Rohde & Schwarz signal and spectrum analyzers, both a "normal" and a "wide" modulation spectrum were available for GSM measurements. In the R&S FSW GSM application, only one evaluation is provided. The frequency range of the frequency list, however, can be configured to be "wider" or "narrower" (see "Modulation Spectrum Table: Frequency List" on page 135). The RBW and VBW are then adapted accordingly.

Note: RBW at 1800 kHz.

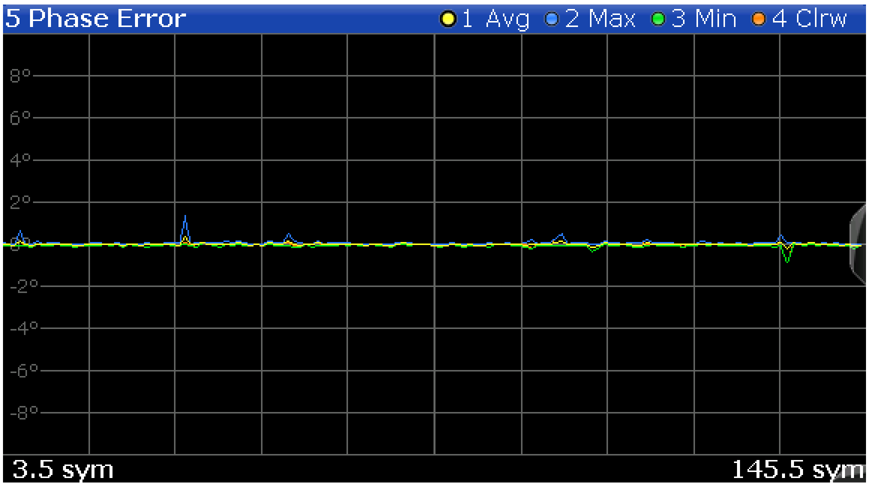
As opposed to previous Rohde & Schwarz signal and spectrum analyzers, in which the RBW at 1800 kHz was configurable, the R&S FSW configures the RBW (and VBW) automatically according to the selected frequency list (see "Modulation Spectrum Table: Frequency List" on page 135). For the "Modulation Spectrum Graph" both the RBW and VBW are set to 30 kHz. For the "Modulation Spectrum Table", they are set according to Table 4-6, depending on the measured Device Type and the number of active carriers as defined in the "Signal Description" settings.

Table 4-6: RBW settings for Modulation Spectrum Table measurements according to standard

Offset	Single-carrier BTS	Multicarrier BTS (N=1)	Multicarrier BTS (N>1)	MS mode
< 1.8 MHz	30 kHz [1)]	30 kHz [3)]	30 kHz [2)]	30 kHz [4)]
1.8 MHz	30 kHz [1)]	100 kHz [3)]	100 kHz [2)]	100 kHz [5)]
> 1.8 MHz	100 kHz [3)]	100 kHz [3)]	100 kHz [2)]	100 kHz [5)]
1) See 3GPP TS 51.021 § 6.5.1.2 c) d) 2) See 3GPP TS 51.021 § 6.12.2 3) See 3GPP TS 51.021 § 6.5.1.2 f) 4) See 3GPP TS 51.010-1 § 13.4.4.2 f) and 3GPP TS45.005 § 4.2.1.3, table a1-c4 5) See 3GPP TS 51.010-1 § 13.4.4.2 d) and 3GPP TS 45.005 § 4.2.1.3				

Remote command:
`LAY:ADD:WIND '2',RIGH,MST` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`READ:SPECtrum:MODulation[:ALL]?` on page 317
`READ:SPECtrum:MODulation:REFerence[:IMMediate]?` on page 318

Phase Error
Displays the phase error over time.



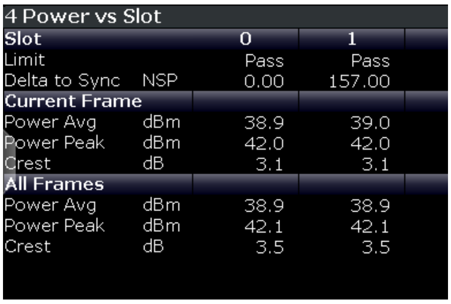
The following default settings are used for a "Phase Error vs Time" measurement.

Setting	Default
Measurement Scope	The slot selected as Slot to Measure
Averaging Configuration	Number of frames as selected in Statistic Count
Limit Check	None

Remote command:
`LAY:ADD:WIND '2',RIGH,PERR` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297

Power vs Slot
Displays the power per slot in the current frame and over all frames. The result of the (Power vs Time) limit check is also indicated.

Note: The power is measured for inactive slots, but not for slots outside the slot scope (see Chapter 5.6, "Defining the Scope of the Measurement", on page 52).



The following power values are determined:

Table 4-7: Measured power values for Power vs Slot results

Value	Description	SCPI query for result value
Slot	Analyzed slot number in frame(s) [0..7]	
PvT Limit	Power vs *Time* limit for the power vs time trace of the slot, defined by the standard	`READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?` on page 326
Delta to Sync [NSP]	The distance between the mid of the TSC and the TSC of the Slot to Measure NSP stands for Normal Symbol Period, i.e. the duration of one symbol using a normal symbol rate (approx. 3.69µs). The measured "Delta to Sync" value has a resolution of 0.02 NSP. For details see Chapter 5.12, "Delta to Sync Values", on page 67.	`READ:BURSt:SPOWer:SLOT<Slot>:DELTatosync?` on page 325
Power Avg [dBm]	Average power in slot in current or all frames	`READ:BURSt:SPOWer:SLOT<Slot>:CURRent:AVERage?` on page 322 `READ:BURSt:SPOWer:SLOT<Slot>:ALL:AVERage?` on page 320

Value	Description	SCPI query for result value
Power Peak [dBm]	Maximum power in slot in current or all frames	READ:BURSt:SPOWer:SLOT<Slot>:CURRent:MAXimum? on page 324 READ:BURSt:SPOWer:SLOT<Slot>:ALL:MAXimum? on page 321
Crest [dB]	Crest factor in slot in current or all frames, i.e. Power Peak / Power Avg	READ:BURSt:SPOWer:SLOT<Slot>:CURRent:CRESt? on page 323 READ:BURSt:SPOWer:SLOT<Slot>:ALL:CRESt? on page 320

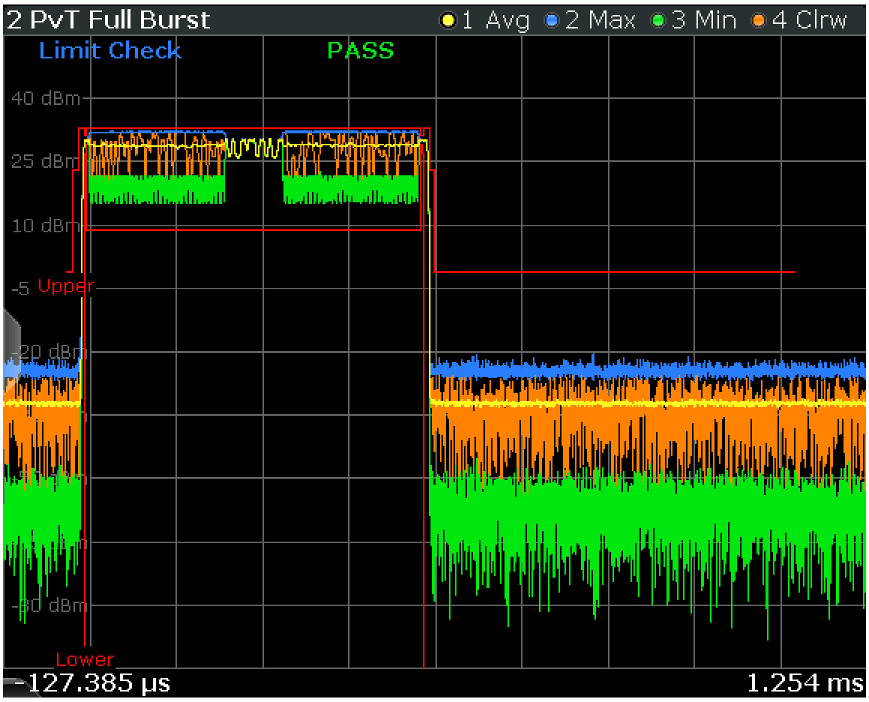
Remote command:
`LAY:ADD:WIND '2',RIGH,PST` see `LAYout:ADD[:WINDow]?` on page 275
Results:
Chapter 11.8.6, "Power vs Slot Results", on page 319

PvT Full Burst

The Power vs Time evaluation determines the power of all slots (bursts) in the selected slot scope and performs a limit check of the power vs time trace against the specified PvT mask.

The "PvT Full Burst" result display shows the power vs time trace, where the time axis corresponds to the selected slot scope. The PvT mask is indicated by red lines, and the *overall* result of the limit check is shown at the top of the diagram.

Note: The result of the Power vs Time limit check *for individual slots* is indicated in the "Power vs Slot" on page 27 evaluation.



Note: *Full burst* refers to the fact that the entire burst is displayed, including the rising and falling edges and the burst top. However, you can easily analyze the edges in more detail using the zoom functions
(See the R&S FSW User Manual).

The following default settings are used for a "Power vs Time" evaluation.

Table 4-8: Default settings for a "Power vs Time" evaluation

Setting	Default
Measurement Scope	The slot scope defined by First Slot to measure and Number of Slots to measure
Averaging Configuration	Number of bursts as selected in Statistic Count
Limit Check	According to standard: ● The maximum (Max) trace is checked against the upper limit. ● The minimum (Min) trace is checked against the lower limit. See Chapter 5.13.3, "Limit Check for Power vs Time Results", on page 69

Remote command:
`LAY:ADD:WIND '2',RIGH,PTF` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297
`TRACe<n>[:DATA]:X?` on page 297
`CALCulate<n>:LIMit<k>:FAIL?` on page 331
`CALCulate<n>:LIMit<k>:UPPer[:DATA]?` on page 333
`CALCulate<n>:LIMit<k>:CONTrol:DATA?` on page 331

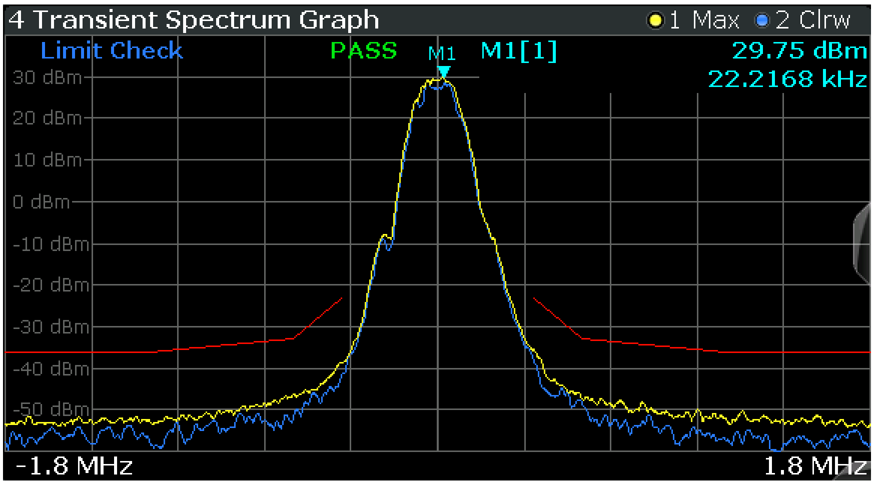
Transient Spectrum Graph
The transient spectrum is very similar to the modulation spectrum evaluation; it evaluates the power vs frequency trace by measuring the power over several frames. However, as opposed to the modulation spectrum evaluation, the entire slot scope (defined by the Number of Slots to measure and the First Slot to measure) is evaluated in each frame, including the rising and falling burst edges, not just the useful part in the Slot to Measure.

Furthermore, the number of fixed frequency offsets is lower, and the peak power is evaluated rather than the average power, as this measurement is used to determine irregularities.

The "Transient Spectrum Graph" displays the measured power levels as a trace against the frequencies for the specified slots.

The measured values can be checked against defined limits; the limit lines are indicated as red lines in the diagram. The result of the limit check ("PASS"/"FAIL") is shown at the top of the diagram.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *both* limits are exceeded.



Note: The graphical results only provide an overview of the spectrum. For a detailed conformance check of the DUT to the GSM standard, use the "Transient Spectrum Table" evaluation, which uses the 5-pole filter required by the 3GPP standard.
The numeric results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Table" on page 24.

The following default settings are used for "Transient Spectrum" measurements.

Setting	Default
Measurement Scope	The slot scope defined by Number of Slots to measure and the First Slot to measure in the "Demodulation Settings" (see Chapter 6.3.6.1, "Slot Scope", on page 127).
Averaging Configuration	Number of frames as selected in Statistic Count
Limit Check	Limit check of maximum (Max) trace See Chapter 5.13.2, "Limit Check for Transient Spectrum", on page 69

Remote command:
`LAY:ADD:WIND '2',RIGH,TSFD` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`TRACe<n>[:DATA]?` on page 297
`CALCulate<n>:LIMit<k>:FAIL?` on page 331

Transient Spectrum Table
The transient spectrum evaluates the power vs frequency trace of the slot scope by measuring the power in these slots over several frames.

For details see "Transient Spectrum Graph" on page 29.

The "Transient Spectrum Table" displays the measured power levels and their offset to the limits defined by the standard as numeric results.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *both* limits are exceeded.
Values that exceed both limits are indicated by red characters and an asterisk (*) next to the value, and a negative "Δ to Limit" value.

2 Transient Spectrum Table

Offset	Power Negative Offsets			Power Positive Offsets		
kHz	dB	dBm	Δ to Limit	dB	dBm	Δ to Limit
400	*-40.0	*-22.1	-13.9	*-40.4	*-22.5	-13.5
600	*-45.5	*-27.6	-8.4	*-45.5	*-27.6	-8.4
1200	-59.1	-41.2	5.2	-56.6	-38.7	2.7
1800	-61.6	-43.7	7.7	-61.7	-43.8	7.8

To determine the relative limit values, a reference power is required (see "Transient Spectrum: Reference Power" on page 135). In order to detect irregularities, it is useful to define the peak power as a reference. However, the standard requires the reference power to be calculated from the RMS power.

To perform the measurement according to the 3GPP standard set the reference power to RMS and the Slot to Measure to the slot with the highest power.

See 3GPP TS 45.005, chapter "4 Transmitter characteristics ":

For GMSK modulation, the term output power refers to the measure of the power when averaged over the useful part of the burst (see annex B).

For QPSK, AQPSK, 8-PSK, 16-QAM and 32-QAM modulation, the term "output power" refers to a measure that, with sufficient accuracy, is equivalent to the long term average of the power when taken over the useful part of the burst as specified in 3GPP TS 45.002 with any fixed TSC and with random encrypted bits.

And 3GPP TS 51.021, chapter "6.5.2 Switching transients spectrum":

The reference power for relative measurements is the power measured in a bandwidth of at least 300 kHz for the TRX under test for the time slot in this test with the highest power.

Note: The graphical results of the transient spectrum evaluation are displayed in the "Transient Spectrum Graph" on page 29.

The following values are displayed:

Table 4-9: Transient spectrum results

Result	Description
Offset [kHz]	Fixed frequency offsets (from the center frequency) at which power is measured
Power Negative Offsets	Power at the frequency offset to the left of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits
Power Positive Offsets	Power at the frequency offset to the right of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits

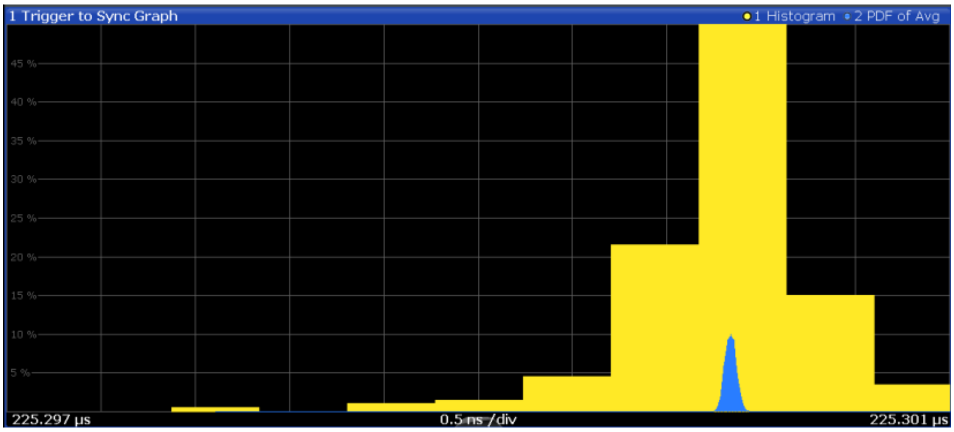
Remote command:
`LAY:ADD:WIND '2',RIGH,TST` see `LAYout:ADD[:WINDow]?` on page 275
Results:
`READ:SPECtrum:SWITching[:ALL]?` on page 327
`READ:SPECtrum:SWITching:REFerence[:IMMediate]` on page 328

Trigger to Sync Graph

The Trigger to Sync measurement determines the time between an *external* trigger event and the start of the first symbol of the TSC. The start of the first symbol of the TSC corresponds to the time 0 of the symbol period (see Chapter 5.9, "Definition of the Symbol Period", on page 59).

Only one result per data capture is provided. Therefore, it is useful to perform several data captures and average the results to obtain an accurate value (see "Statistic Count" on page 125).

Both graphical and numeric (table) results are available. While the graphical results are mainly used to determine the required measurement settings, the numeric results provide the actual trigger to sync value, including statistical evaluation (see "Trigger to Sync Table" on page 33).



The Trigger to Sync diagram shows two traces:

- **Trace1**: a **histogram** shows the probability density function (PDF) of *all measured* Trigger to Sync values. Obviously, the histogram can only provide reasonable results if several I/Q captures are performed and considered. In an ideal case (assuming no noise), the histogram would have a gaussian shape.
  The histogram is helpful to determine the number of Trigger to Sync values to be averaged (Statistic Count) in order to obtain the required time resolution of the averaged Trigger to Sync value. The higher the statistic count, the closer the graph gets to a gaussian shape, and the higher the resolution of the averaged Trigger to Sync value becomes.
- **Trace2**: the second trace is superimposed on the histogram and visualizes the probability density function (PDF) of the *average* Trigger to Sync value and the standard deviation as provided in the Trigger to Sync table. This trace helps you judge the reliability of the averaged values in the table. The narrower this trace, the less the individual values deviate from the averaged result. if this trace is too wide, increase the Statistic Count.

Note: The x-axis of the histogram indicates the individual Trigger to Sync values. Thus, the scaling must be very small, in the range of ns. However, since the value range, in particular the start value, of the possible results is not known, the x-axis must be adapted to the actual values after a number of measurements have taken place. This is done using the adaptive data size setting (see "Adaptive Data Size" on page 137). This setting defines how many measurements are performed before the x-axis is adapted to the measured values, and then fixed to that range.

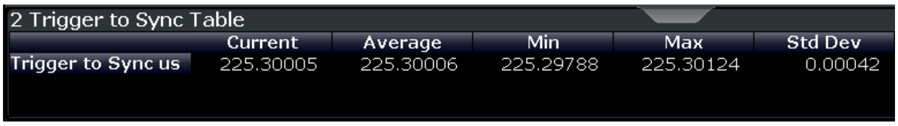
Remote command:
`LAY:ADD? '1',RIGH,TGSG`, see `LAYout:ADD[:WINDow]?` on page 275
`DISPlay:WINDow:TRACe1:MODE WRITe` (for Histogram, see `DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 283)
`DISPlay:WINDow:TRACe2:MODE PDFavg` (for PDF of average, see `DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 283)
Results:
`TRACe<n>[:DATA]?` on page 297
`TRACe<n>[:DATA]:X?` on page 297

Trigger to Sync Table

The Trigger to Sync measurement determines the time between an *external* trigger event and the start of the first symbol of the TSC. The start of the first symbol of the TSC corresponds to the time 0 of the symbol period (see Chapter 5.9, "Definition of the Symbol Period", on page 59).

Only one result per data capture is provided. Therefore, it is useful to perform several data captures and average the results to obtain an accurate value (see "Statistic Count" on page 125).

Both graphical and numeric (table) results are available. While the graphical results are mainly used to determine the required measurement settings (see "Trigger to Sync Graph" on page 32), the numeric results provide the actual trigger to sync value, including statistical evaluation.



The Trigger to Sync table shows the following values:

Value	Description
Current	Trigger to Sync value for current measurement in µs
Average	Trigger to Sync value averaged over the Statistic Count number of measurements
Min	Minimum Trigger to Sync value in the previous Statistic Count number of measurements
Max	Maximum Trigger to Sync value in the previous Statistic Count number of measurements
Std Dev	Standard deviation of the individual Trigger to Sync values to the average value

Remote command:
`LAY:ADD? '1',RIGH,TGST`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
Chapter 11.8.8, "Trigger to Sync Results", on page 329

4.2 Multicarrier Wideband Noise Measurements

The I/Q data captured by the default GSM I/Q measurement includes magnitude and phase information, which allows the R&S FSW GSM application to demodulate signals and determine various characteristic signal parameters such as the modulation accuracy, modulation or transient spectrum in just one measurement.

As the result of a swept measurement, on the other hand, the signal cannot be demodulated based on the power vs. frequency trace data. Frequency sweep measurements can tune on a constant frequency ("Zero span measurement") or sweep a frequency range ("Frequency sweep measurement").

For multicarrier measurements, the GSM standard defines limits for some parameters concerning noise and intermodulation products. Thus, a new separate measurement is provided by the R&S FSW GSM application: the *Multicarrier Wideband Noise Measurement* (MCWN). This measurement comprises:

- I/Q based measurements on the carriers to determine their power levels and reference powers
- Frequency sweeps with RBWs of 100 kHz (to measure wideband noise) and 300 kHz (to measure intermodulation products)
- Gated zero span measurements with an RBW of 30 kHz to measure narrowband noise

MCWN measurements and MSRA mode

MCWN measurements are only available in Signal and Spectrum Analyzer operating mode, not in MSRA mode (see Chapter 5.17, "GSM in MSRA Operating Mode", on page 81).

For more information on MCWN measurements see also Chapter 5.15, "Multicarrier and Wideband Noise", on page 70.

4.2.1 Multicarrier Evaluation Methods

The GSM multicarrier wideband noise measurement can be evaluated using different methods. All evaluation methods available for the measurement are displayed in the selection bar in SmartGrid mode.

For details on working with the SmartGrid see the R&S FSW Getting Started manual.

By default, the MWCN measurement results are displayed in the following windows:

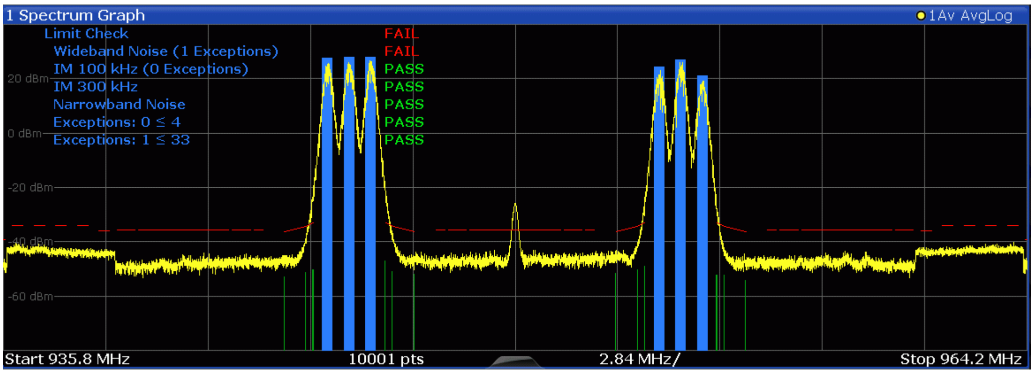
- Spectrum Graph
- Carrier Power Table

The following evaluation methods are available for GSM MCWN measurements:

Spectrum Graph

Displays the level results for the frequencies in the defined frequency span (typically the Tx band).

The trace is calculated from a frequency sweep with a 100 kHz RBW and one sweep with a 300 kHz RBW. The displayed trace is averaged over the Noise Average Count number of noise measurements.



The narrowband noise results (if available) are indicated as vertical green bars at the distinct measurement frequencies (see "Outer Narrowband Table" on page 39).

The results of the limit check are also indicated in the diagram (see also Chapter 5.15.4, "Limit Check for MCWN Results", on page 75):

Table 4-10: Limit line checks

Label	Possible values	Description / Limit line suffix (<k>)
Limit check	PASS | FAIL	Overall limit check for all limit lines
Wideband Noise (<current> exceptions)	PASS | FAIL	Limit check for wideband noise (trace) (Number of detected exceptions; provided only if exceptions are enabled) <k> = 1
IM 100 kHz	PASS | FAIL	Limit check for intermodulation at 100 kHz (Number of detected exceptions; provided only if exceptions are enabled) <k> = 2
IM 300 kHz	PASS | FAIL	Limit check for intermodulation at 300 kHz <k> = 3

Label	Possible values	Description / Limit line suffix (<k>)
Narrowband Noise	PASS | FAIL	Limit check for narrowband noise <k> = 4
Exceptions: <current> < <maximum>	PASS | FAIL	Number of bands with exceptions in range A (currently detected vs. maximum allowed); provided only if exceptions are enabled <k> = 5
Exceptions: <current> < <maximum>	PASS | FAIL	Number of bands with exceptions in range B (currently detected vs. maximum allowed); provided only if exceptions are enabled <k> = 6

Note: Markers are now available in the Spectrum Graph result display.

Remote command:
LAY:ADD? '1',RIGH,WSFDomain, see LAYout:ADD[:WINDow]? on page 275
Results:
TRACe:DATA? TRACe1, see TRACe<n>[:DATA]? on page 297
Limit results:
FETCh:SPECtrum:MODulation:LIMit:FAIL? on page 336
CALCulate<n>:LIMit<k>:FAIL? on page 331
CALCulate<n>:LIMit<k>:CONTrol:DATA? on page 331
CALCulate<n>:LIMit<k>:UPPer[:DATA]? on page 333
CALCulate<n>:LIMit<k>:EXCeption:COUNt:CURR? on page 334
CALCulate<n>:LIMit<k>:EXCeption:COUNt:MAX? on page 335

Carrier Power Table

Displays the measured power levels and reference powers of all active carriers.

2 Carrier Power Table

Carrier		Power Level	Reference Power dBm		
No.	Freq MHz	dBm	RBW 300 kHz	RBW 100 kHz	RBW 30 kHz
max 1	938.00	12.2	11.9	10.2	5.7
2	938.60	12.2	11.9	10.1	5.3
3	939.20	12.2	11.9	10.1	4.0
4	939.80	12.2	11.9	10.1	5.9
5	940.40	12.2	11.8	10.1	3.9

The following parameters are shown:

Table 4-11: Carrier power measurement results

Parameter	Description
Carrier No.	Active carrier number (as defined in Chapter 6.3.2.4, "Carrier Settings", on page 98). Additional labels: • "max": the carrier with the highest power level (If the reference power is determined by a reference measurement (see "Enabling a reference power measurement (Measure)" on page 164), and automatic carrier selection is active, see "Carrier Selection / Carrier" on page 165.) • "ref": selected carrier for reference power (If the reference power is determined by a reference measurement (see "Enabling a reference power measurement (Measure)" on page 164), but the carrier is selected manually, see "Carrier Selection / Carrier" on page 165.) • "man": manually defined reference powers (see "Defining Reference Powers Manually" on page 165)
Carrier frequency	Frequency of the carrier at which power was measured
Power level	Measured power level in dBm
Reference power with RBW 300 kHz	Reference power for measurement with 300 kHz RBW (or manually defined reference value)
Reference power with RBW 100 kHz	Reference power for measurement with 100 kHz RBW (or manually defined reference value)
Reference power with RBW 30 kHz	Reference power for measurement with 30 kHz RBW (or manually defined reference value)

Remote command:
`LAY:ADD? '1',RIGH,WSRP`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:REFerence:POWer[:ALL]?` on page 341

Inner IM Table
Similar to the Outer IM Table, but the measured intermodulation products (up to the order specified in Intermodulation) for the frequencies *in the gap between the GSM carrier blocks* for non-contiguous carrier allocation are displayed. The frequency offsets are defined as offsets from the closest carrier, i.e. the uppermost carrier of the lower sub-block and the lowermost carrier of the upper sub-block.

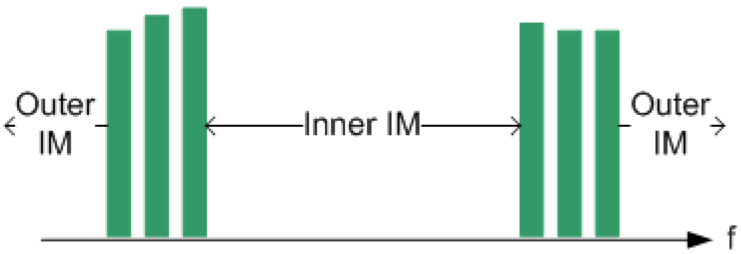


Figure 4-1: Inner and outer intermodulation

The rows are sorted in ascending order of the absolute IM frequency.

For contiguous carrier allocation or if Intermodulation is "off", this table is empty.

Remote command:
`LAY:ADD? '1',RIGH,IIMP`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:IMPRoducts:INNer[:ALL]?` on page 336

Outer IM Table
Displays the measured intermodulation products (up to the order specified in Intermodulation) for the frequencies outside of the sub-blocks (but not in the gap).

3 Outer IM Table

Intermodulation			Power			
Offset MHz	Freq MHz	Order	RBW kHz	dB	dBm	Δ to Limit
-4.80	933.20	5	100	-62.8	-43.7	0.6
-4.20	933.80	5	100	-64.4	-45.3	2.2
-3.60	934.40	5	100	-63.2	-44.2	1.0
-3.00	935.00	5	100	-63.2	-44.2	1.0
-2.40	935.60	3,5	100	-61.6	-42.5	1.6
-1.80	936.20	3,5	100	*-58.0	*-39.0	-2.0
1.80	942.20	3,5	100	*-59.9	*-40.9	-0.1
2.40	942.80	3,5	100	-61.6	-42.5	1.6
3.00	943.40	5	100	*-60.9	*-41.9	-1.3
3.60	944.00	5	100	-63.4	-44.3	1.2
4.20	944.60	5	100	-63.4	-44.3	1.2
4.80	945.20	5	100	-62.3	-43.2	0.1

For each of the following regions the parameters described in Table 4-12 are shown:
- frequencies to the left of the lowermost carrier
- frequencies to the right of the uppermost carrier

The rows are sorted in ascending order of the absolute IM frequency.

The frequency offsets are defined as offsets from the closest carrier, i.e. the lowermost carrier of the lower sub-block and the uppermost carrier of the upper sub-block.

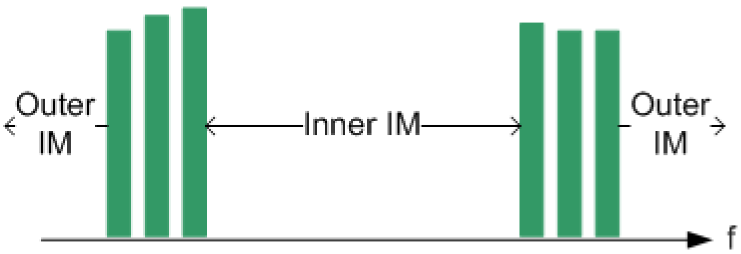


Figure 4-2: Inner and outer intermodulation

The following parameters are shown:

Table 4-12: Intermodulation results

Result	Description
Offset [MHz]	Frequency offsets (from the closest carrier) at which intermodulation power is measured
Freq [MHz]	Absolute frequency of intermodulation product
Order	Order of intermodulation product
RBW [kHz]	Resolution bandwidth used for measurement
dB	relative power level (to reference power) measured at IM frequency

Result	Description
dBm	absolute power level measured at IM frequency
Δ to Limit:	power difference to limit defined in standard (negative values indicate: limit check failed)

If Intermodulation is "off", this table is empty.

Remote command:
`LAY:ADD? '1',RIGH,OIMP`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:IMPRoducts:OUTer[:ALL]?` on page 337

Inner Narrow Band Table

Similar to the Outer Narrowband Table, however the measured distortion products *in the gap between the GSM carrier blocks* are displayed for non-contiguous carrier allocation.

The frequency offsets are defined as offsets from the closest carrier, i.e. the uppermost carrier of the lower sub-block and the lowermost carrier of the upper sub-block. Offsets are lower than 1.8 MHz (400 KHz, 600 KHz, 1200 KHz).

The rows are sorted in ascending order of the absolute measurement frequency.

For contiguous carrier allocation or if narrowband noise measurement is disabled, this table is empty.

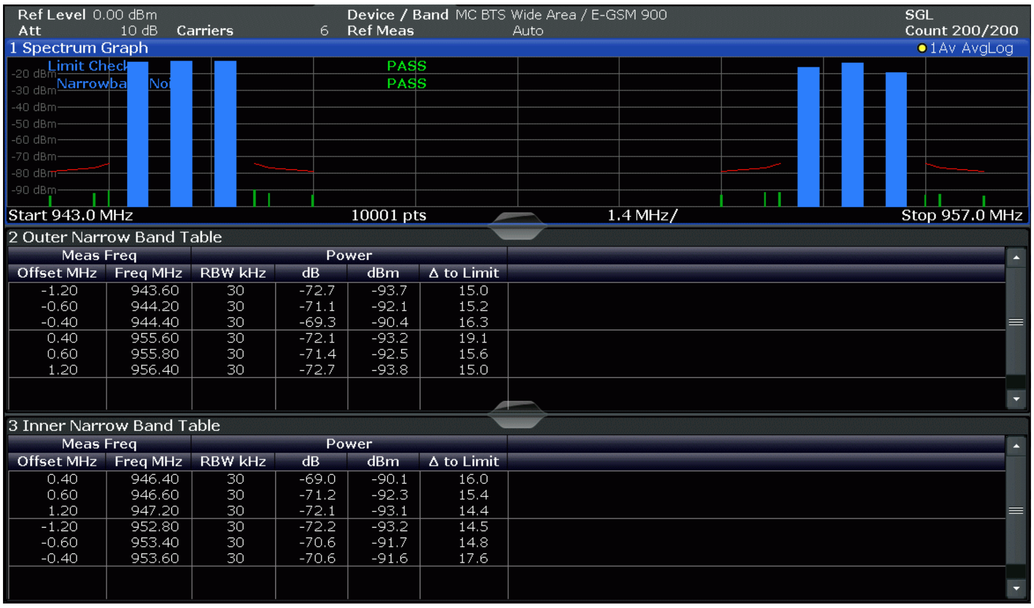
Remote command:
`LAY:ADD? '1',RIGH,INAR`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:NARRow:INNer[:ALL]?` on page 339

Outer Narrowband Table

Displays the measured distortion products for the frequencies outside of the subblocks (but not in the gap) for non-contiguous carrier allocation.

The measurement is gated according to the standard (50 to 90 % of the useful part of the time slot excluding the mid amble, in the outermost carriers). If no bursts are found a warning is issued in the status bar and the measurement results are not valid.

The limits are calculated by cumulating the individual limit lines of each active carrier. Frequencies falling onto theoretical intermodulation products receive an extra relaxation.



For each of the following regions the parameters described in Narrowband noise results are shown:

- frequencies to the left of the lowermost carrier
- frequencies to the right of the uppermost carrier

The rows are sorted in ascending order of the absolute measurement frequency.

The frequency offsets are defined as offsets from the closest carrier, i.e. the lowermost carrier of the lower sub-block and the uppermost carrier of the upper sub-block.

For Narrow Band Noise measurements the frequency offsets are lower than 1.8 MHz (400 kHz, 600 kHz, 1200 kHz).

Outer Narrow Band Noise results are shown for contiguous AND for non-contiguous carrier allocation.

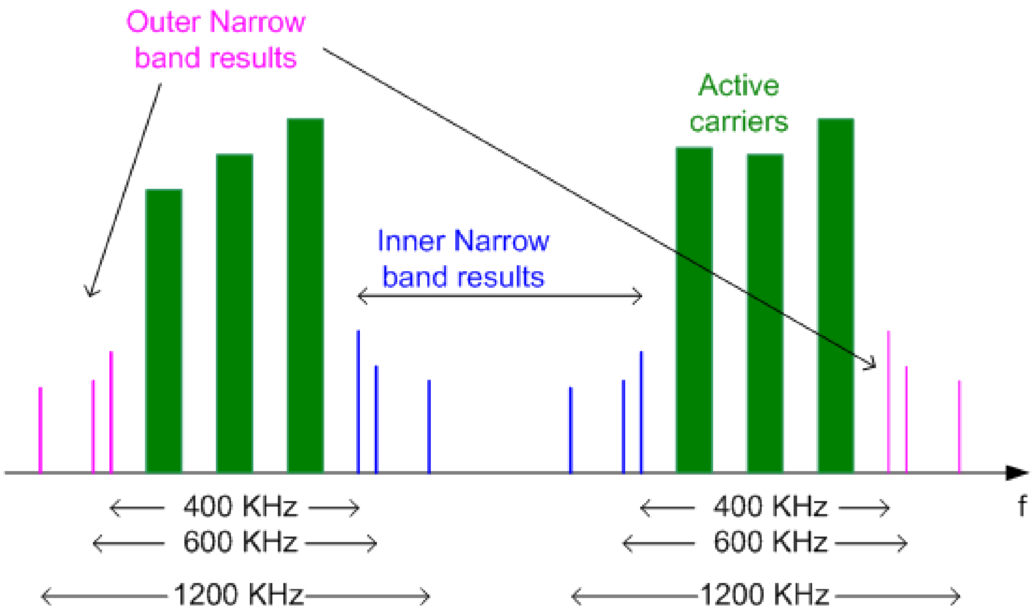


Figure 4-3: Narrowband noise results

The following parameters are shown:

Table 4-13: Narrowband noise results

Result	Description
Offset [MHz]	Frequency offsets (from the closest carrier) at which distortion power is measured
Freq [MHz]	Absolute frequency of distortion product
RBW [kHz]	Resolution bandwidth used for measurement
dB	Relative power level (to reference power) measured at the distortion frequency
dBm	Absolute power level measured at distortion frequency
Δ to Limit:	Power difference to limit defined in standard (negative values indicate: limit check failed)

If narrowband measurement is disabled, this table is empty.

Remote command:
`LAY:ADD? '1',RIGH,ONAR`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:NARRow:OUTer[:ALL]?` on page 340

Inner Wideband Table
Similar to the Outer Wideband Table, but the numeric results of the wideband noise measurement in the gap between the GSM carrier blocks for non-contiguous carrier allocation are displayed. The frequency offsets are defined as offsets from the closest carrier, i.e. the uppermost carrier of the lower sub-block and the lowermost carrier of the upper sub-block.

As for the Outer Wideband Table, the Inner Wideband Table normally has one entry for every limit line segment the GSM standard (3GPP TS 51.021) defines in section 6.5.1. But in this table, the middle of the gap between the 2 sub-blocks is used to split up the results in an upper and lower part (see ranges C and D in Figure 4-4).

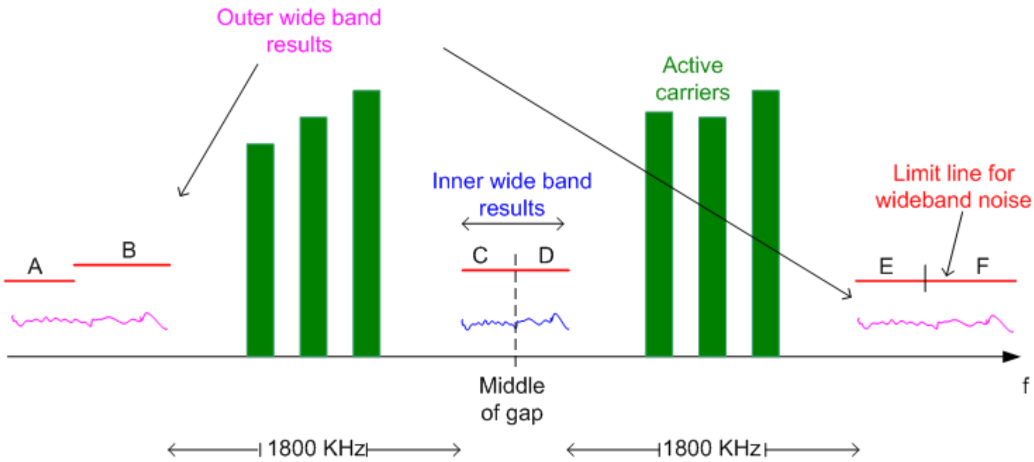


Figure 4-4: Inner and outer wideband noise results

The rows are sorted in ascending order of the absolute frequencies of the wideband noise measurement segments.

For contiguous carrier allocation or if noise measurement is disabled, this table is empty. Furthermore, the table may be empty in the following cases:

- The gap is too small (<3.6 MHz = twice the minimum offset of 1.8 MHz).
- Intermodulation measurement overrides wideband noise measurement: Around every calculated intermodulation product frequency inside or outside the gap, the R&S FSW GSM application places an intermodulation measurement range of a certain bandwidth (regardless whether intermodulation measurement is enabled or not). Due to their more relaxed limits, the IM measurement wins over the wideband noise measurement. Thus, many overlapping IM ranges can narrow down the wideband noise measurement segment until it is eliminated. You can check this by activating only intermodulation (IM order 3 and 5!) OR only wideband measurement and determining where a limit line is drawn and where there are none.

Remote command:
`LAY:ADD? '1',RIGH,IWID`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:WIDeband:INNer[:ALL]?` on page 342

Outer Wideband Table

Displays the numeric results of the wideband noise measurement for the frequencies outside of the sub-blocks (but not in the gap). Measurement offsets relative to outer-most carriers are always greater than 1.8 MHz.

Note: The results for the gap are displayed in the Inner Wideband Table.

For each of the following regions the parameters described in Wideband noise results are shown:

- frequencies to the left of the lowermost carrier
- frequencies to the right of the uppermost carrier

The wideband noise tables divide the total frequency range of the wideband noise measurement (defined by the selected span and the GSM band) in non-overlapping frequency segments. (For details see Chapter 5.15.6, "Wideband Noise Measurement", on page 79.)

The following parameters are shown for wideband noise tables for each segment:

Table 4-14: Wideband noise results

Result	Description
Start [MHz]	Absolute start frequency of segment
Stop [kHz]	Absolute stop frequency of segment
Offset [MHz]	Frequency of the worst measured wideband noise result in that segment. Relative to the nearest active outermost carrier
Freq [MHz]	Absolute frequency of the worst measured wideband noise result in that segment.
dB	Relative power level (to reference power) of the worst measured wideband noise result in that segment
dBm	Absolute power level of the worst measured wideband noise result in that segment
Δ to Limit:	Worst power difference to limit defined in standard in that segment. Defined exceptions are considered. (Negative values indicate: limit check failed)

The rows are sorted in ascending order of the absolute frequencies of the wideband noise measurement segments.

If noise measurement is disabled, this table is empty. Furthermore, the table may be empty in the following cases:

- The span is too small. Wideband noise measurement cannot start closer than 1.8 MHz from the outermost carriers and ends 10 MHz outside the edge of the relevant transmit band. This measurement range may be restricted further by the defined measurement span (see Chapter 6.4.4.2, "Frequency Settings", on page 147). For a measurement according to standard, set the span to the TX band automatically (see "Setting the Span to Specific Values Automatically" on page 149).
- Intermodulation measurement overrides wideband noise measurement: Around every calculated intermodulation product frequency inside or outside the gap, the R&S FSW GSM application places an intermodulation measurement range of a certain bandwidth (regardless whether intermodulation measurement is enabled or not). Due to their more relaxed limits, the IM measurement wins over the wideband noise measurement. Thus, many overlapping IM ranges can narrow down the wideband noise measurement segment until it is eliminated. You can check this by activating only intermodulation (IM order 3 and 5!) OR only wideband measurement and determining where a limit line is drawn and where there are none.

Remote command:
`LAY:ADD? '1',RIGH,OWID`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`FETCh:WSPectrum:WIDeband:OUTer[:ALL]?` on page 343

Marker Table
Displays a table with the current marker values for the active markers.

This table may be displayed automatically if configured accordingly (see "Marker Table Display" on page 174).

4 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
1	M1		1	13.25 GHz	-200.0 dBm
1	D2	M1	1	-600.0 kHz	0.0 dB
1	D3	M1	1	600.0 kHz	0.0 dB
1	D4	M1	1	-2.0 MHz	0.0 dB

Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 275
Results:
`CALCulate<n>:MARKer<m>:X` on page 346
`CALCulate<n>:MARKer<m>:Y?` on page 346

5 Basics on GSM Measurements

Some background knowledge on basic terms and principles used in GSM measurements is provided here for a better understanding of the required configuration settings.

5.1 Relevant Digital Standards

The measurements and the physical layer – the layer of the GSM network on which modulation, transmission of RF signals, reception of RF signals, and demodulation take place – is defined in the standards:

Table 5-1: GSM standards

3GPP TS 45.004	Details on Modulation
3GPP TS 45.005	General measurement specifications and limit values
3GPP TS 45.010	Details on Synchronization and Timing
3GPP TS 51.010	Detailed measurement specifications and limit values for mobile stations (MS)
3GPP TS 51.021	Detailed measurement specifications and limit values for base transceiver stations (BTS)

5.2 Short introduction to GSM (GMSK, EDGE and EDGE Evolution)

The GSM (Global System for Mobile Communication) standard describes the GSM mobile radio network that is in widespread use today. In a first step to enhance this network, 8PSK modulation has been defined in addition to the existing GMSK (Gaussian Minimum Shift Keying) modulation. With 8PSK, the mobile or base station operates in the EDGE mode. While the 8PSK modulation transmits 3 bits within a symbol, GMSK can only transmit 1 bit within a symbol.

In a second step to enhance this network, higher symbol rate (HSR), QPSK, 16QAM, and 32QAM modulation, narrow and wide pulse shapes for the Tx filter have been defined. Here, EDGE Evolution and EGPRS2 are synonyms for this second enhancement.

This means that GSM includes different modes: GMSK, EDGE and EDGE Evolution. The terms EDGE and EDGE Evolution are used here only when there are significant differences between the modes. In all other cases, the term GSM is used.

Time domain vs frequency domain

A TDMA (Time Division Multiple Access) and FDMA (Frequency Division Multiple Access) scheme is used to transfer data in the GSM network. This means that the digital information is transmitted discretely in the time domain (mainly used to distinguish between different users) as well as in the frequency domain (mainly used to distinguish between BTS).

Slots and frames

The time domain is divided into *slots* with a duration of 576.923 µs (exactly: 3/5200 s). 8 slots (numbered 0 to 7) are combined into 1 *frame* with a duration of approximately 4.6154 ms (exactly: 3/650 s).

Multiframes and superframes

Frames can be grouped into a multiframe consisting of either 26 (for support traffic and associated control channels) or 51 (for all other purposes) frames. Multiframes can be grouped to superframes consisting of either 51 26-frame or 26 51-frame multiframes.

Multiframes and superframes are not of relevance for the physical measurements on the GSM system and thus not discussed in detail here.

A mobile phone, therefore, does not communicate continuously with the base station; instead, it communicates discretely in individual slots assigned by the base station during connection and call establishment. In the simplest case, 8 mobiles share the 8 slots of a frame (TDMA).

Frequency bands and channels

The frequency range assigned to GSM is divided into frequency bands, and each band, in turn, is subdivided into channels.

Each frequency channel is identified by its center frequency and a number, known as the ARFCN (Absolute Radio Frequency Channel Number), which identifies the frequency channel within the specific frequency band. The GSM channel spacing is 200 kHz.

Communication between a mobile and a base station can be either frequency-continuous or frequency-discrete – distributed across various frequency channels (FDMA). In the standard, the abbreviation "SFH" (slow frequency hopping) is used to designate the latter mode of communication.

Uplink and downlink

Base stations and mobiles communicate in different frequency ranges; the mobile sends in the "uplink" (UL), and the base station in the "downlink" (DL).

The frequencies specified in the standard plus their channel numbers (ARFCN) are shown in the figure and table below.

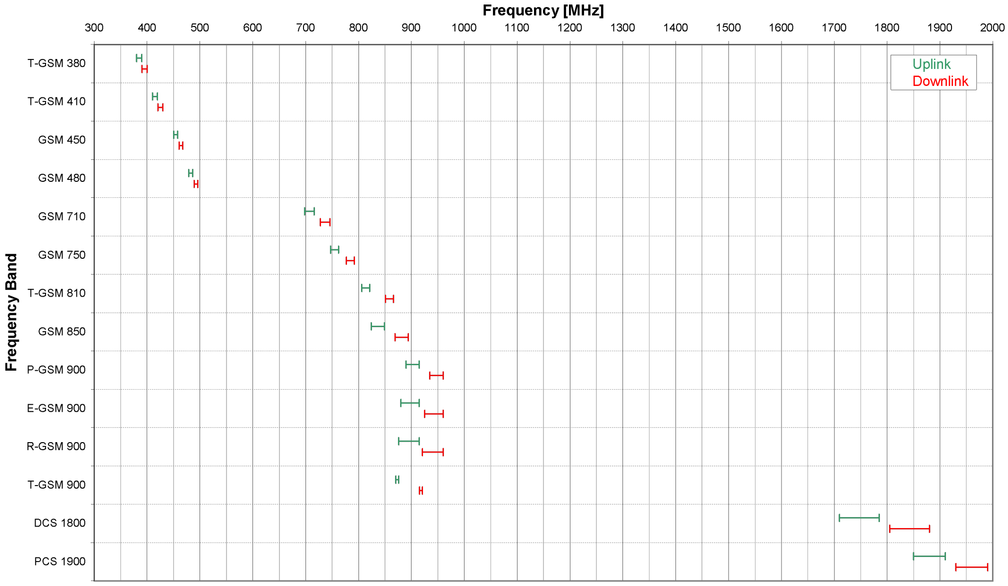


Figure 5-1: The frequencies specified in the GSM standard

Table 5-2: Frequencies and channel numbers (ARFCN) in the GSM standard

Band Class	UL [MHz]	Freq.	DL [MHz]	Freq.	Freq. Middle	Band	UL-DL Shift	ARFCN	
	Lower	Upper	Lower	Upper	UL	DL		Range 1	Range 2
T-GSM 380	380.2	389.8	390.2	399.8	385.0	395.0	10 MHz	0 … 48 [1)]	–
T-GSM 410	410.2	419.8	420.2	429.8	415.0	425.0	10 MHz	0 … 48 [1)]	–
GSM 450	450.4	457.6	460.4	467.6	454.0	464.0	10 MHz	259 … 293	–
GSM 480	478.8	486.0	488.8	496.0	482.4	492.4	10 MHz	306 … 340	–
GSM 710	698.0	716.0	728.0	746.0	707.0	737.0	30 MHz	0 … 90 [1)]	–
GSM 750	747.0	762.0	777.0	792.0	754.5	784.5	30 MHz	438 … 511	–
T-GSM 810	806.0	821.0	851.0	866.0	813.5	858.5	45 MHz	0 … 75 [1)]	–
GSM 850	824.0	849.0	869.0	894.0	836.5	881.5	45 MHz	128 … 251	–
P-GSM 900	890.0	915.0	935.0	960.0	902.5	947.5	45 MHz	1 … 124	–
E-GSM 900	880.0	915.0	925.0	960.0	897.5	942.5	45 MHz	0 … 124	975 … 1023
R-GSM 900	876.0	915.0	921.0	960.0	895.5	940.5	45 MHz	0 … 124	955 … 1023
T-GSM 900	870.4	876.0	915.4	921.0	873.2	918.2	45 MHz	0 … 28 [1)]	–
DCS 1800	1710.0	1785.0	1805.0	1880.0	1747.5	1842.5	95 MHz	512 … 885	–
PCS 1900	1850.0	1910.0	1930.0	1990.0	1880.0	1960.0	80 MHz	512 … 810	–

[1)] For these frequency bands, there is no fixed ARFCN to frequency assignment, instead it is calculated with a formula taking an OFFSET parameter which is signaled by a higher layer of the network. The given ARFCNs assume an OFFSET value of 0.

Modulation modes

Different modulation modes are used in the GSM mobile radio network. The original GSM modulation is GMSK, with the normal symbol rate (NSR) of approximately 270.833 ksymb/s (exactly: 1625/6 ksymb/s). This corresponds to a bit rate of 270.833 kbit/s. The details are specified in chapter 2 of "3GPP TS 45.004" (see Table 5-1).

The 8PSK (Phase Shift Keying) modulation, which is used within EDGE, was introduced to increase the data rate on the physical link. It uses the same symbol rate (the normal symbol rate) as GMSK (270.833 ksymb/s), but has a bit rate of 3 × 270.833 kbit/s (exactly: 812.5 kbit/s).

In this method, three bits represent a symbol. The details are specified in chapter 3 "3GPP TS 45.004" (see Table 5-1).

The 16QAM and 32QAM (Quadrature Amplitude Modulation) modulation, which are used in EDGE Evolution, were introduced to further increase the data rate on the physical link. They use the normal symbol rate (270.833 ksymb/s), but have bit rates of 4 × 270.833 kbit/s or 5 × 270.833 kbit/s, respectively. The details are specified in chapter 4 "3GPP TS 45.004" (see Table 5-1).

The QPSK, 16QAM and 32QAM modulation with a higher symbol rate, which are used in EDGE Evolution, were introduced to further increase the data rate on the physical link. They use a higher symbol rate (325 ksymb/s), but have bit rates of 2 × 325 kbit/s, 4 × 325 kbit/s or 5 × 325 kbit/s, respectively. The details are specified in chapter 5 "3GPP TS 45.004" (see Table 5-1).

The figure below shows the modulation spectrum for both GMSK and 8PSK.

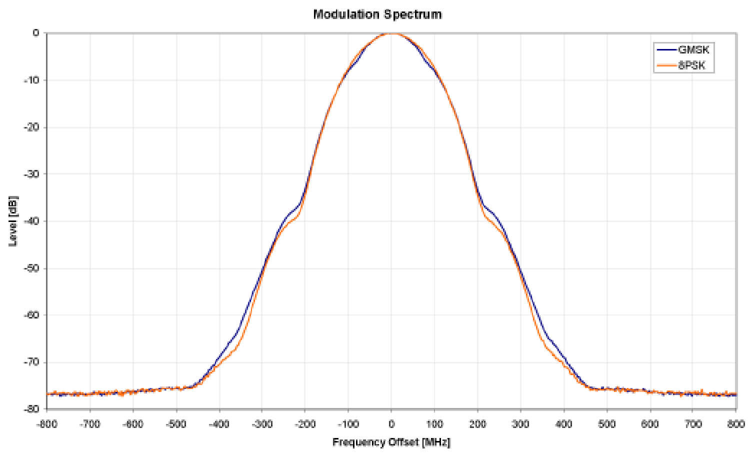


Figure 5-2: GMSK and 8PSK modulation spectrum

Increasing the bandwidth - multiple slots (GPRS, HSCSD)

The customers' demand for higher telecommunication speeds increases the demand for bandwidth. Therefore, the GSM standard has to evolve constantly. An example of this development is the introduction of the EDGE/EDGE Evolution specification and the GPRS/EGPRS2 and HSCSD modes.

Until now, each mobile could use only one slot per frame, but the new HSCSD (High Speed Circuit Switched Data) and GPRS (General Packet Radio Service) methods will allow permanent assignment of more than one slot per mobile, plus dynamic utilization of multiple slots.

The concept behind GPRS is dynamic assignment of up to 8 slots to each mobile for data transmission, depending on demand (and availability in the network).

HSCSD allows permanent assignment of up to 4 slots to a mobile.

Normal and higher symbol rates

The modulation modes GMSK, QPSK, 8PSK, 16QAM and 32QAM can be used with either normal or higher symbol rate and different Tx filters.

What is significant for the R&S FSW GSM application in this respect is that the mobile can send power on a frequency in more than one slot.

5.3 Short Introduction to VAMOS

The "Voice services over Adaptive Multi-user Channels on One Slot" (VAMOS) extension to the GSM standard allows transmission of two GMSK users simultaneously within a single time slot.

Subchannels

The standard specifies the downlink signal using Adaptive QPSK (AQPSK) modulation (see 3GPP TS 45.004), where two "subchannel" binary sequences are multiplexed to form a single QPSK sequence. The ratio of powers for the subchannels is referred to as the "Subchannel Power Imbalance Ratio" (**SCPIR**). One of the subchannels is interpreted as interference. The value of SCPIR affects the shape of the AQPSK constellation. For an SCPIR of 0dB the constellation is square (as in "normal" QSPK), while for other values of the SCPIR the constellation becomes rectangular.

Training sequences (TSCs)

A new set of training sequences (TSCs) has also been proposed (see 3GPP TS 45.002) for GMSK signals. The previous TSCs for GMSK bursts are listed as "Set 1", while the new TSCs are listed as "Set 2". AQPSK signals can be formed using TSCs from Set 1 on the first subchannel and TSCs from either Set 1 or Set 2 on the second subchannel. In case a TSC from Set 2 is used, it should match the TSC from Set 1, i.e. TSC<n> from Set 1 on subchannel 1 should match TSC<n> from Set 2 on subchannel 2, for n = 0..7.

TSC vs "Midamble"

The terms *TSC* and *Midamble* are used synonymously in the standard. In this documentation, we use the term *TSC* to refer to the known symbol sequence in the middle of the slot.

The R&S FSW GSM application supports measurement of the following signals:

- GMSK bursts using the TSCs from Set 1 or Set 2

- AQPSK bursts with combinations of TSCs from Set 1 and 2 on the subchannels
- AQPSK bursts with a user-specified SCPIR

The following measurements of the above signals are supported:

- Power vs Time
- Demod (Modulation Accuracy, EVM vs Time, Phase Error vs Time, Magnitude Error vs Time, Constellation)
- Spectrum (modulation, transient) including limit check
- Automatic trigger offset detection

Restriction for auto frame configuration

Auto Frame configuration only detects AQPSK normal bursts where the subchannels have a TSC according to Table 5-3. The SCPIR value is detected with a resolution of 1 dB. To obtain reliable measurement results on AQPSK normal bursts, compare the auto-detected slot settings with the settings of your device under test.

Table 5-3: Required subchannel - TSC assignment for AQPSK auto frame configuration

AQPSK			**Subchannel 2**															
			TSC j (Set 1)								**TSC j (Set 2)**							
			0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Sub channel 1	**TSC i (Set 1)**	**0**			x	x				x	x							
		1			x	x				x		x						
		2	x	x				x					x					
		3	x	x			x							x				
		4				x			x						x			
		5			x				x							x		
		6					x	x									x	
		7	x	x														x

5.4 AQPSK Modulation

The AQPSK modulation scheme as proposed for use in GSM systems is illustrated in Figure 5-3. First, the bits from two users (subchannels 1 and 2) are interleaved. The combined bit sequence is then mapped to an AQPSK constellation which depends on the SCPIR value. The AQPSK symbols are then modulated using the linearized GMSK pulse (see 3GPP TS 45.004).

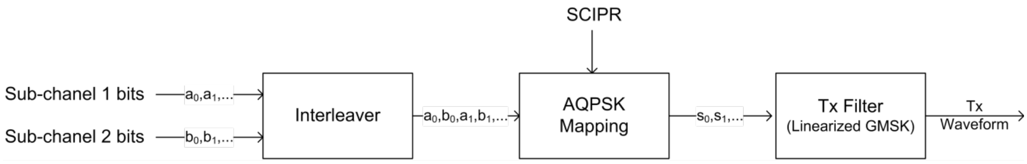


Figure 5-3: AQPSK modulation scheme for GSM systems

The proposed AQPSK mapping (as assumed in the R&S FSW GSM application) is given in Table 5-4 and illustrated in Figure 5-4, where the first (leftmost) bit corresponds to subchannel 1 and the second (rightmost) bit corresponds to subchannel 2.

Table 5-4: AQPSK symbol mappings [reproduced from 3GPP TS 45.004]

Modulating bits for a_i, b_i	AQPSK symbol in polar notation s_i
(0,0)	$e^{j\alpha}$
(0,1)	$e^{-j\alpha}$
(1,0)	$-e^{-j\alpha}$
(1,1)	$-e^{j\alpha}$

The AQPSK modulation constellation diagram is shown in Figure 5-4, where the value α is an angle related to the SCPIR as follows:

$SCPIR_{dB} = 20*\log_{10}[\tan(\alpha)]$ dB

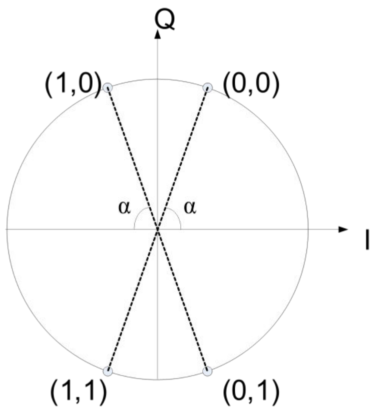


Figure 5-4: AQPSK constellation [reproduced from 3GPP TS 45.004].

5.5 Trigger settings

The GSM measurements can be performed in "Free Run" (untriggered) mode; however, an external trigger or a power trigger can speed up measurements. To perform measurements the R&S FSW GSM application needs the frame start as a time reference. The R&S FSW GSM application searches for a frame start after every I/Q data acquisition. The required search effort depends on the trigger mode.

Consider the following trigger mode settings:

- In "Free Run" mode, i.e. without any trigger, the R&S FSW GSM application totally relies on the frame/slot configuration to find the frame start. The start of a measurement is not triggered. Once a measurement is completed, another is started immediately. For an unambiguous frame configuration, the GSM application searches for the frame start inside the captured I/Q data. This is the slowest frame search mode.
- With a "Power Trigger", the measurement is triggered by the power ramp of the received GSM bursts. Nevertheless the R&S FSW GSM application still relies on the frame/slot configuration to find the frame start inside the captured I/Q data. Once a measurement is completed, the R&S FSW GSM application waits for the next trigger event to start the next measurement. The search for the frame start is as in "Free Run" mode, except that the I/Q data capture is triggered.
- With the "External Trigger", the measurement is triggered by an external signal (connected to the "EXT TRIGGER" input of the R&S FSW). The R&S FSW GSM application assumes that the frame start (i.e. the "active part" in slot 0) directly follows the trigger event. An external trigger requires a correct setting of the trigger offset. The search is faster compared to the free run and power trigger modes. Use an external trigger to maximize the measurement speed or if the frame configuration is ambiguous (i.e. if the slot properties are cyclic with a cycle less than the frame duration).

Trigger source for MSRA Master

Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application. For this purpose, the trigger is considered to be in "Free Run" mode.

Refer to Chapter 6.3.4, "Trigger Settings", on page 116 to learn more about appropriate trigger settings and to Chapter 6.3.2, "Signal Description", on page 89 for information on the frame/slot configuration.

Refer to "Automatic Trigger Offset" on page 138 to learn more about setting the trigger offset automatically.

5.6 Defining the Scope of the Measurement

The R&S FSW GSM application is slot-based. It can measure up to 8 consecutive GSM slots (1 frame) and store the power results for all slots ("Power vs Time" and "Power vs Slot" measurements, see "PvT Full Burst" on page 28 and "Power vs Slot" on page 27).

In previous Rohde & Schwarz signal and spectrum analyzers, the term "burst" was used synonymously for "slot". In this documentation, we use the term "burst" when the signal behaves like a pulse, i.e. power is ramped up and down. The up ramp is referred to as the *rising edge*, the down ramp as the *falling edge*. A burst may occur within one or more slots, which is a measure of time in the captured signal. Thus, a burst may coincide with a slot, but it must not necessarily do so.

Usually only slots in which a burst is expected are of interest. Such slots are defined as *active* slots in the signal description.

Within this slot scope (defined by First Slot to measure and Number of Slots to measure), a single slot (Slot to Measure) is selected for a more detailed analysis (e.g. "Modulation Accuracy" measurement, see "Modulation Accuracy" on page 21). The Slot to Measure is required for the following reasons:

- To provide the reference power and time reference for the "Power vs Time" measurement (see "PvT Full Burst" on page 28). Typically, the masks for all slots are time-aligned according to the timing of the Slot to Measure (see "Limit Line Time Alignment" on page 133).
- All "Modulation Spectrum" results are based on the Slot to Measure (see "Modulation Spectrum Graph" on page 23). (The results of all "Transient Spectrum" diagrams are based on the slot *scope*, i.e. on the interval defined by the First Slot to measure and the Number of Slots to measure, see "Transient Spectrum Graph" on page 29).
- All results that require demodulation of one slot and statistical analysis (e.g. Modulation Accuracy, Phase Error, and EVM) are based on the Slot to Measure.

The slot scope is defined in the "Demodulation Settings" (see Chapter 6.3.6.1, "Slot Scope", on page 127), and it is indicated by a filled green box in the "Frame Configuration" (see Figure 5-6). The Slot to Measure is indicated by a filled blue box.

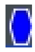
Frame configuration and slot scope in the channel bar

In the channel bar of the R&S FSW GSM application, as well as in the configuration "Overview", the current frame configuration and slot scope are visualized in a miniature graphic. Furthermore, the burst type and modulation of the Slot to Measure are indicated.

Figure 5-5: Frame configuration in GSM application channel bar

The graphic can be interpreted as follows:

Shape/Color	Meaning
	Each slot is represented by a small box
	Active slots are indicated by polygonal symbols

Shape/Color	Meaning
	Slots within the defined slot scope are highlighted green
	The defined Slot to Measure is highlighted blue; the burst type and modulation defined for this slot are indicated to the right of the graphic

Frame configuration in the Frame and Slot Scope dialog boxes

The same graphic is displayed in the "Frame Configuration" of the "Frame" dialog box (see "Frame Configuration: Select Slot to Configure" on page 94) and in the "Slot Scope" tab of the "Demodulation" dialog box (see Chapter 6.3.6.1, "Slot Scope", on page 127).

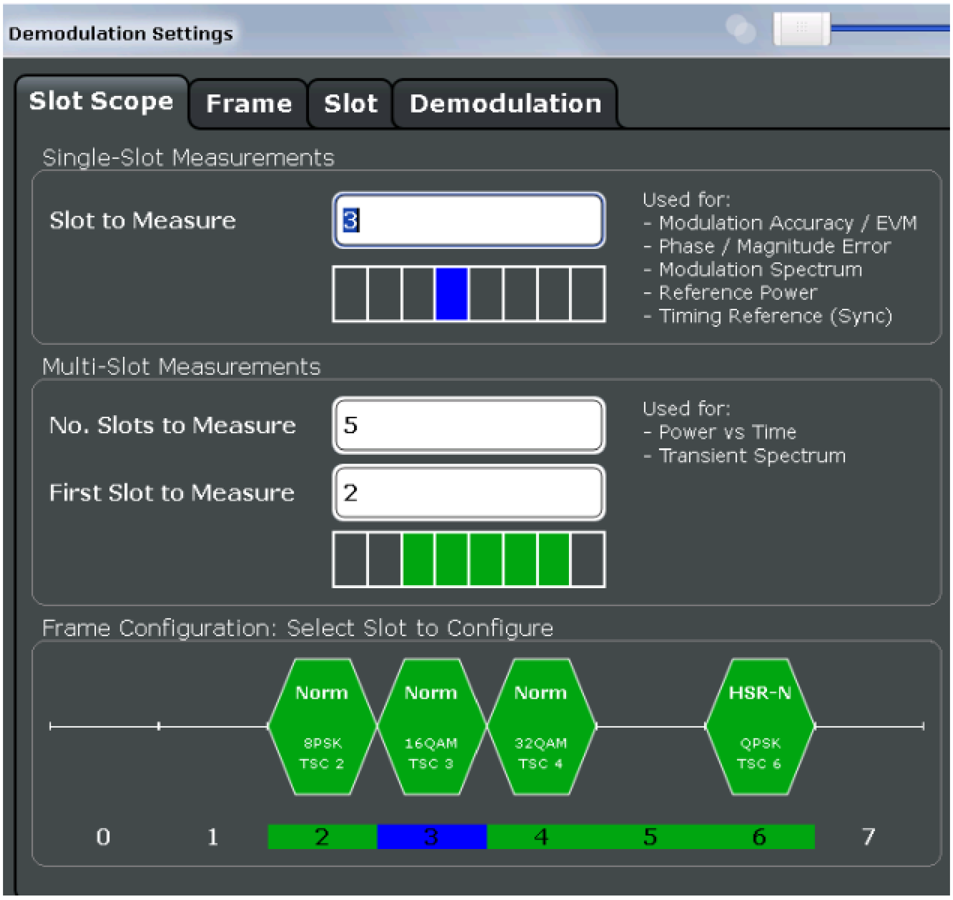


Figure 5-6: Frame configuration in "Slot Scope" settings

This graphic can be interpreted as follows:

- Each slot is represented by its number (0 to 7).
- Slot numbers within the defined slot scope are highlighted green.
- The number of the defined Slot to Measure is highlighted blue.
- Active slots are indicated by polygonal symbols above the number which contain the following information:

– The burst type, e.g. "Norm" for a normal burst
– The modulation, e.g. GMSK
– The training sequence TSC (and Set) or Sync (for access bursts)

5.7 Overview of filters in the R&S FSW GSM application

The R&S FSW GSM application requires a number of filters for different stages of signal processing. These include the "Multicarrier" filter (for multicarrier base station measurements only), the "Power vs Time" filter and the "Measurement" filter. A signal flow diagram is shown in Figure 5-7 to illustrate where the different filters are used.

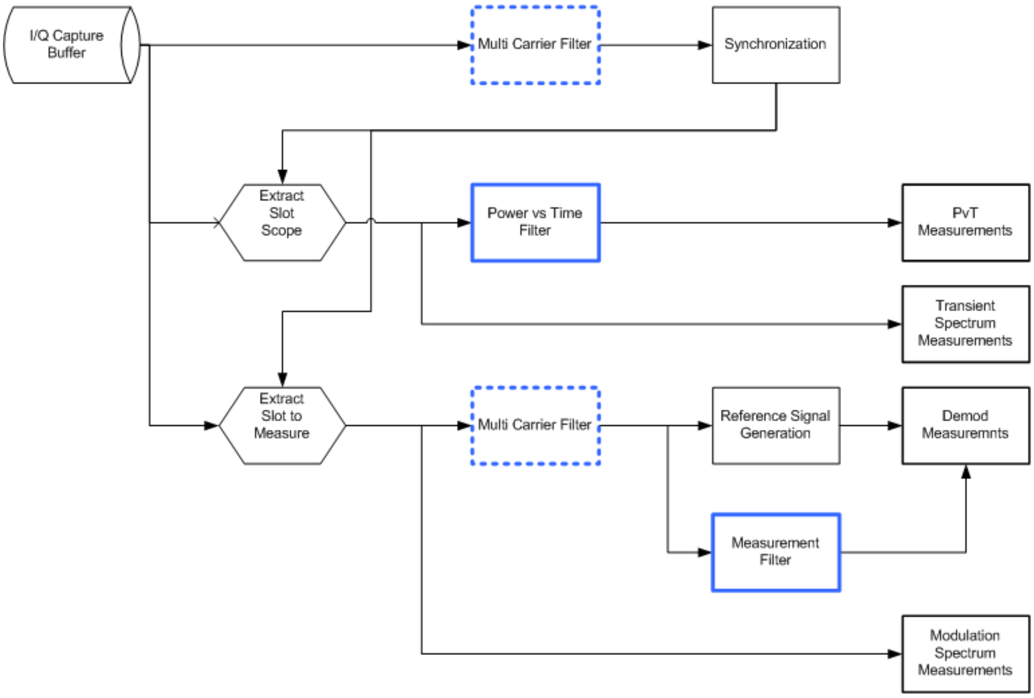


Figure 5-7: Signal flow diagram highlighting filtering operations

5.7.1 Power vs Time Filter

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see "PvT Full Burst" on page 28).

The following filters are available:

Single-carrier filters:

- 1 MHz Gauss
- 500 kHz Gauss
- 600 kHz

Multicarrier filters:

- 400 kHz MC
- 300 kHz MC

The magnitude and step responses of the different "Power vs Time" filters are shown in Figure 5-8 and Figure 5-9, respectively. In general, the smaller the filter bandwidth, the worse the step response becomes (in terms of "ringing" effects) and the better the suppression of interference at higher frequencies. Gaussian type filters are especially useful for signals with "sharp" edges as the step response does not exhibit overshoot.

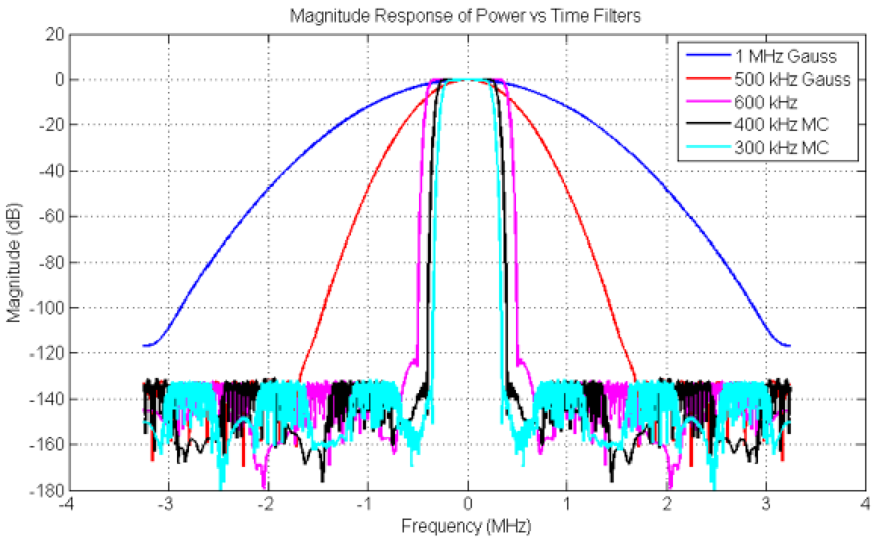


Figure 5-8: Magnitude Response of the Power vs Time Filters

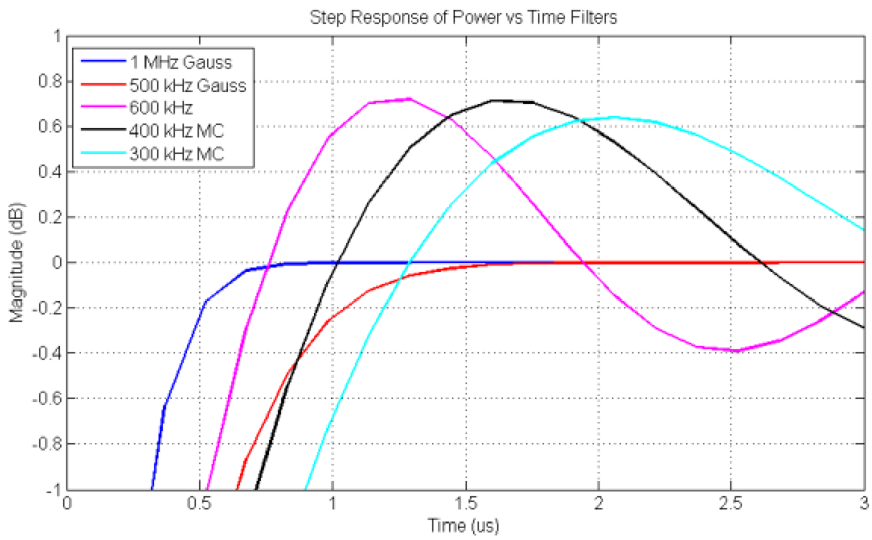


Figure 5-9: Step Response of the Power vs Time Filters

5.7.2 Multicarrier Filter

The "Multicarrier" filter is a special PVT filter that is applied to the captured data if the device is defined as a multicarrier type . This filter is used to suppress neighboring channels which may disturb measurement of the channel of interest. The output from the "Multicarrier" filter is used to perform synchronization and demodulation. The frequency response of the "Multicarrier" filter is shown in Figure 5-10.

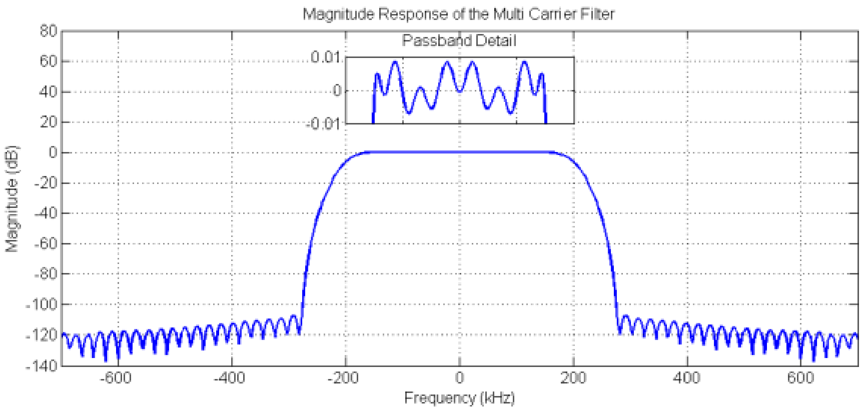


Figure 5-10: Frequency Response of the Multicarrier Filter

5.7.3 Measurement Filter

The "Measurement" filter is used to limit the bandwidth of the demodulation measurements and is described in the 3GPP standard document *TS 45.005* for QPSK, 8PSK, 16QAM and 32QAM as follows:

- *a raised-cosine filter with roll-off 0.25 and single side-band 6 dB bandwidth 90 kHz for normal symbol rate and for higher symbol-rate using narrow bandwidth pulse-shaping filter*
- *a raised-cosine filter with roll-off 0.25 and single side-band 6 dB bandwidth 108 kHz for higher symbol-rate using wide bandwidth pulse-shaping filter*

In addition to these filters, a "Measurement" filter for GMSK is used in the R&S FSW GSM application to limit the effects of out-of-band interference due to the high sample rate of 6.5 MHz which is used. The magnitude responses of all the "Measurement" filters are shown in Figure 5-11.

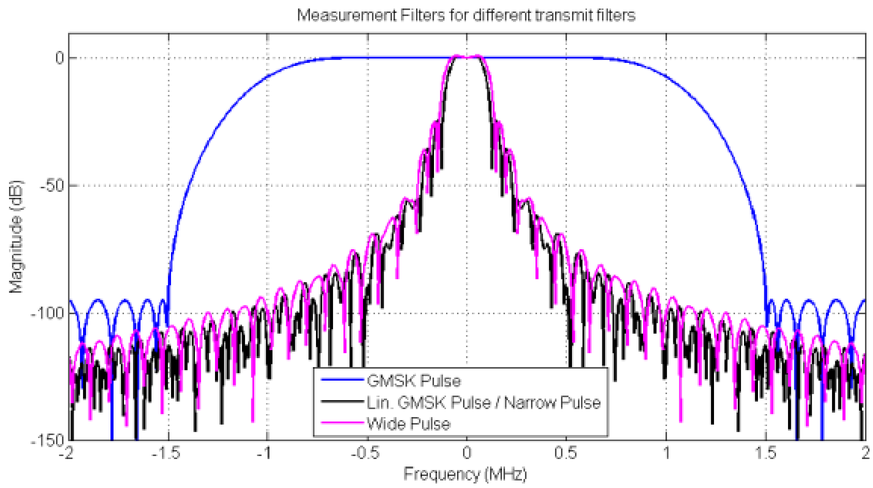


Figure 5-11: Magnitude Responses of Measurement Filters for Demodulation Measurements

5.8 Dependency of Slot Parameters

The parameters that define a slot used for a GSM measurement are dependent on each other, and only the following combinations of these parameters are available in the R&S FSW GSM application (see Chapter 6.3.2.3, "Slot Settings", on page 94).

Table 5-5: Dependency of slot parameters

Burst Type	Modulation	Filter	TSC
AB	GMSK	GMSK Pulse	TS 0, TS 1, TS 2
			User
HSR	QPSK, 16QAM, 32QAM	Narrow Pulse, Wide Pulse	TSC 0, …, TSC 7
			User
NB	8PSK, 16QAM, 32QAM	Linearized GMSK Pulse	TSC 0, …, TSC 7
			User
	AQPSK	Linearized GMSK Pulse	Subchannel 1: TSC 0 (Set 1), …, TSC 7 (Set 1) Subchannel 2: TSC 0 (Set 1), …, TSC 7 (Set 1), TSC 0 (Set 2), …, TSC 7 (Set 2)
			Subchannel 1: User Subchannel 2: User
	GMSK	GMSK Pulse	TSC 0 (Set 1), …, TSC 7 (Set 1), TSC 0 (Set 2), …, TSC 7 (Set 2)
			User

5.9 Definition of the Symbol Period

The following sections define the symbol period for various modulation types.

5.9.1 GMSK Modulation (Normal Symbol Rate)

The GMSK frequency pulse is defined in the standard document "3GPP TS 45.004" as a Gaussian pulse convolved with a rectangular pulse, as illustrated at the top of Figure 5-12. The phase of a GMSK signal due to a sequence of symbols {α} is defined in the standard as:

$$\varphi(t') = \sum_{i} \alpha_i \pi h \int_{-\infty}^{t'-iT} g(u)du$$

Equation 5-1: Phase of a GMSK signal due to a sequence of symbols

where:

- **g(t)**: the frequency pulse
- **T**: the normal symbol period

The modulating index is chosen such that the maximum phase change of π/2 radians per data interval is achieved.

Note that the standard 3GPP TS 45.004 specifies in chapter "2.5 Output phase" for Normal Burst GMSK:

"*The time reference t' = 0 is the start of the active part of the burst as shown in figure 1. This is also the start of the bit period of bit number 0 (the first tail bit) as defined in 3GPP TS 45.002.*"

The phase change due to the first tail symbol is illustrated at the bottom of Figure 5-12, where you can see that the "decision instant" corresponding to the center of the frequency pulse occurs at the beginning of the first symbol period, i.e. at t' = 0."

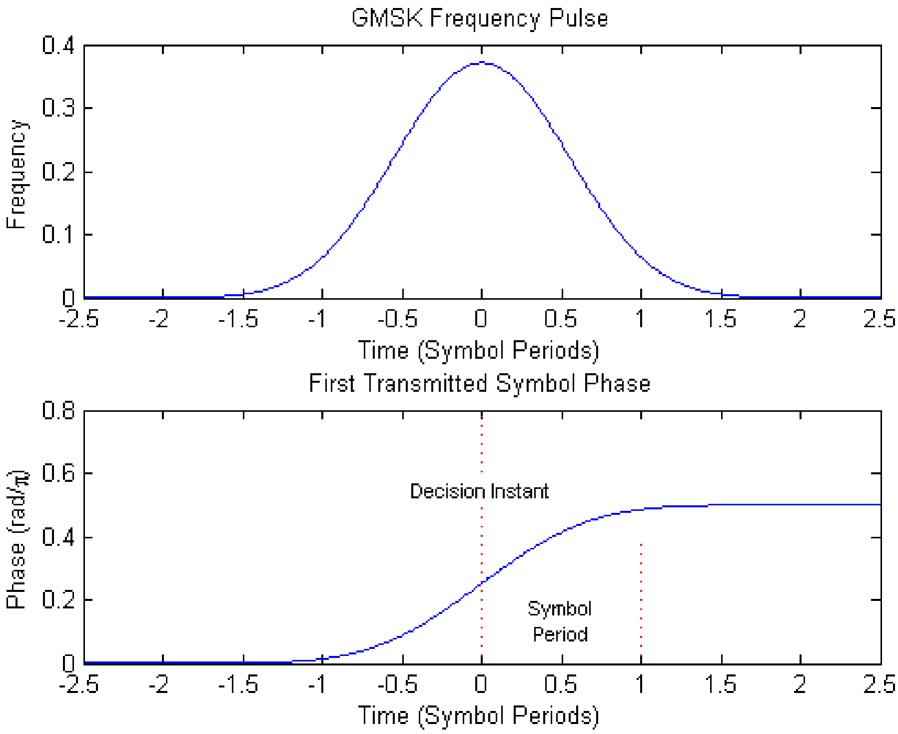


Figure 5-12: GMSK Frequency Pulse (top) and phase of the first tail symbol (bottom)

5.9.2 8PSK, 16QAM, 32QAM, AQPSK Modulation (Normal Symbol Rate)

The EDGE transmit pulse is defined in the standard document "3GPP TS 45.004" as a linearized GMSK pulse, as illustrated at the top of Figure 5-13. Note that according to the definition in the standard, the center of the pulse occurs at 2.5 T, where T is the normal symbol period (NSP). The baseband signal due to a sequence of symbols $\{\hat{s}_i\}$ is defined in the standard as:

$$y(t') = \sum_i \hat{s}_i \cdot c_0(t' - iT + 2T)$$

Equation 5-2: Baseband signal due to a sequence of symbols

where:

c_0(t): the transmit pulse

Note that the standard 3GPP TS 45.004 specifies in chapter "3.5 Pulse shaping" for normal burst 8PSK, 16QAM and 32QAM:

"*The time reference t' = 0 is the start of the active part of the burst as shown in figure 3. This is also the start of the symbol period of symbol number 0 (containing the first tail bit) as defined in 3GPP TS 45.002.*"

For normal burst AQPSK, the standard 3GPP TS 45.004 specifies in chapter "6.5 Pulse shaping":

"*The time reference t' = 0 is the start of the active part of the burst as shown in figure 6. This is also the start of the symbol period of symbol number 0 (containing the first tail bit) as defined in 3GPP TS 45.002.*"

The transmitted pulse for the first tail symbol is illustrated in the lower part of Figure 5-13, where it can be seen that the "decision instant" corresponding to the center of the transmit pulse occurs in the center of the first symbol period, i.e. at t'=0.5T.

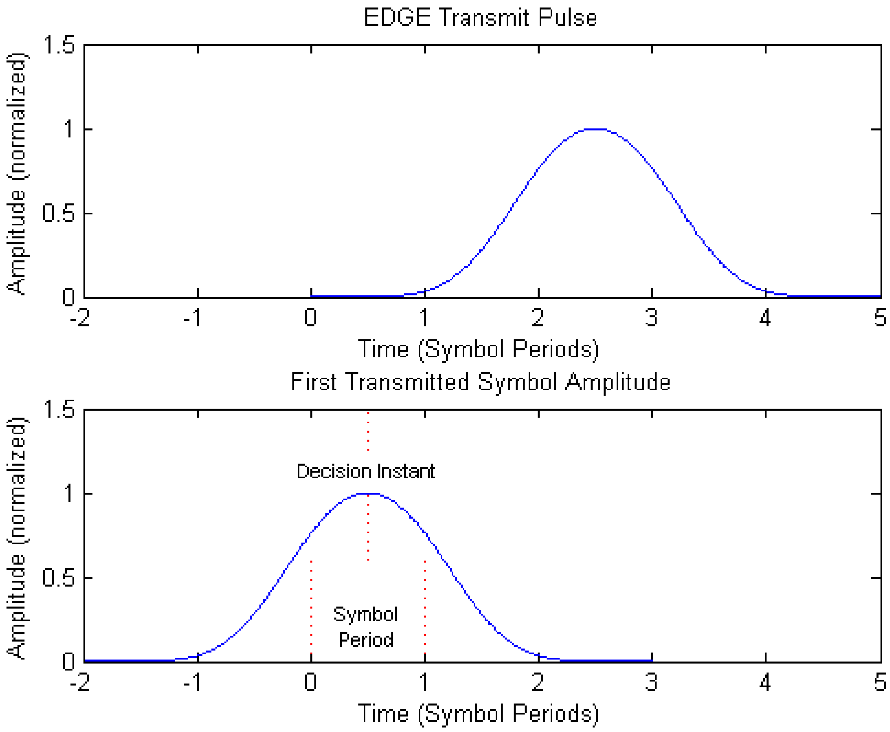


Figure 5-13: EDGE transmit pulse (top) and the first transmitted symbol (bottom)

The description above also applies to the 16QAM and 32QAM modulations defined for EDGE Evolution, using the "normal" symbol rate.

5.9.3 QPSK, 16QAM and 32QAM Modulation (Higher Symbol Rate)

For the newer "reduced" symbol period (higher symbol rate) the standard document "3GPP TS 45.004" defines two transmit pulse shapes; the so-called "narrow" and "wide" pulses. The narrow pulse is the same linearized GMSK pulse as described in Chapter 5.9.2, "8PSK, 16QAM, 32QAM, AQPSK Modulation (Normal Symbol Rate)", on page 60, while the wide pulse was designed based on a numerically optimized set of discrete filter coefficients. Both narrow and wide pulse shapes are illustrated at the top of Figure 5-14, where you can see that the center of the pulse occurs at 3T, with T being the reduced symbol period. For a sequence of symbols $\{\hat{s}_i\}$, the transmitted signal is defined in the standard as:

$$y(t') = \sum_{i} \hat{s}_i \cdot c(t' - iT + 2.5T)$$

Equation 5-3: The transmitted signal for a sequence of symbols

where:

c(t): the transmit pulse(which may be either the narrow or wide pulse)

Note that the standard 3GPP TS 45.004 specifies in chapter "5.5 Pulse shaping" for higher symbol rate burst QPSK, 16QAM and 32QAM:

"*The time reference t' = 0 is the start of the active part of the burst as shown in figure 3. This is also the start of the symbol period of symbol number 0 (containing the first tail bit) as defined in 3GPP TS 45.002.*"

The transmitted pulse for the first tail symbol is illustrated at the bottom of Figure 5-14, where you can see that the "decision instant" corresponding to the center of the transmit pulse occurs in the center of the first symbol period, i.e. at t'=0.5T.

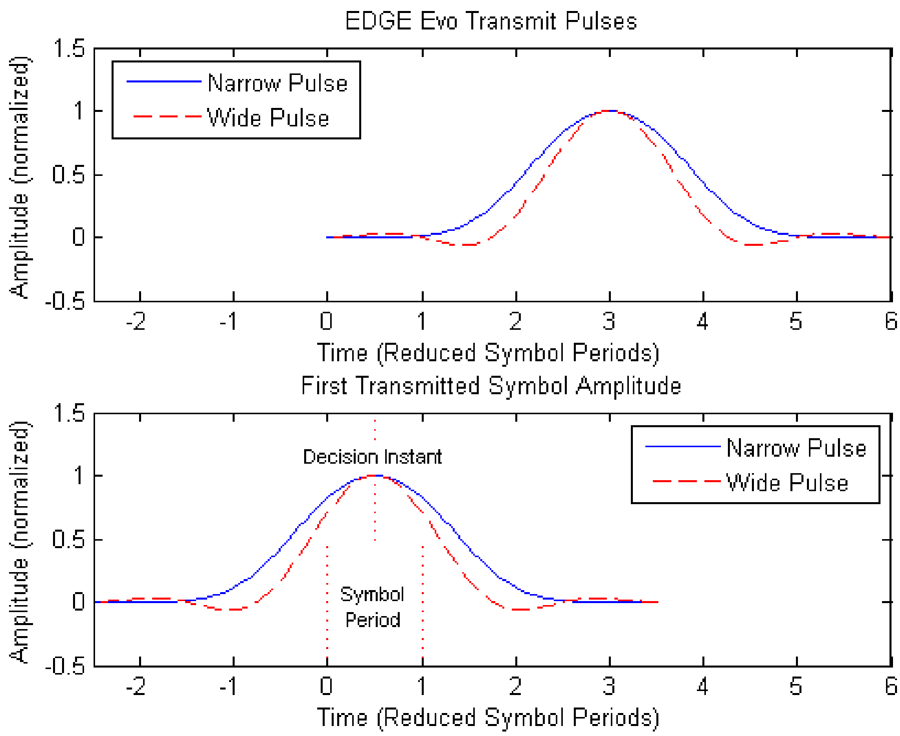


Figure 5-14: EDGE Evolution transmit pulses (top) and the first transmitted symbols (bottom)

5.10 Synchronization

In order to detect and distinguish the individual slots and frames in the measured signal, the known signal sequence (Sync or TSC) must be found in each frame.

The synchronization process in the R&S FSW GSM application depends on how or if the measurement is triggered.

Synchronization process for power trigger or free run mode

If a power trigger or no trigger is used (free run mode), the synchronization process consists of the following steps:

1. Beginning at the start of a capture, the application searches for the synchronization pattern (or TSC) of the Slot to Measure within one GSM frame length. This search must be performed over the entire area, as the time of occurrence of the TSC within the signal is not known. Thus, it is referred to as a "wide" search.
2. Once the synchronization point has been found, the application checks whether enough samples remain in the capture buffer in order to analyze another frame. If so, the process continues with the next step.
   Otherwise, a new capture is started and the process begins with step 1 again.
3. Assuming the signal is periodic, the synchronization point in the signal is moved by exactly one GSM frame length. From there, a "narrow" search for the next TSC is performed within only a small search area.
   Thus, the remaining frames in the capture buffer can be synchronized quickly after the initial "wide" search.
   Steps 2 and 3 are repeated until all frames have been detected.

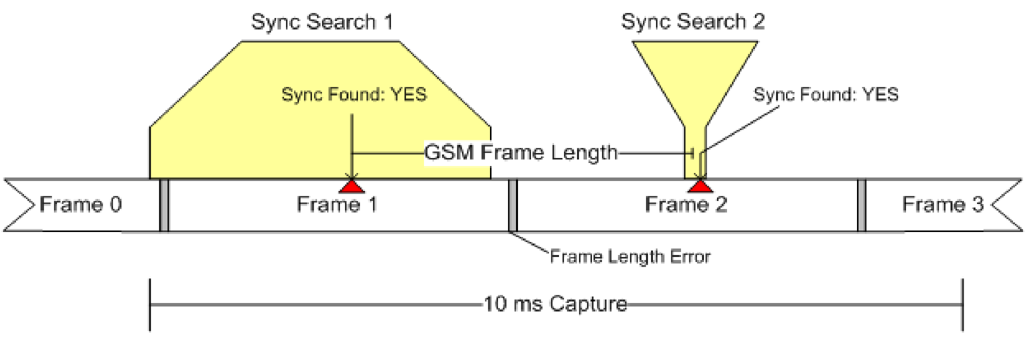


Figure 5-15: Synchronization using "wide" and "narrow" searches

Synchronization errors

The process described above assumes the GSM frame length in the signal is periodic (within a given tolerance: "frame length error"). If this is not the case, however, for example if a frame is too short, the application cannot synchronize to further frames after the initial search.

Frequency hopping can lead to the same problem, as successive frames may not be detected on the measured frequency channel.

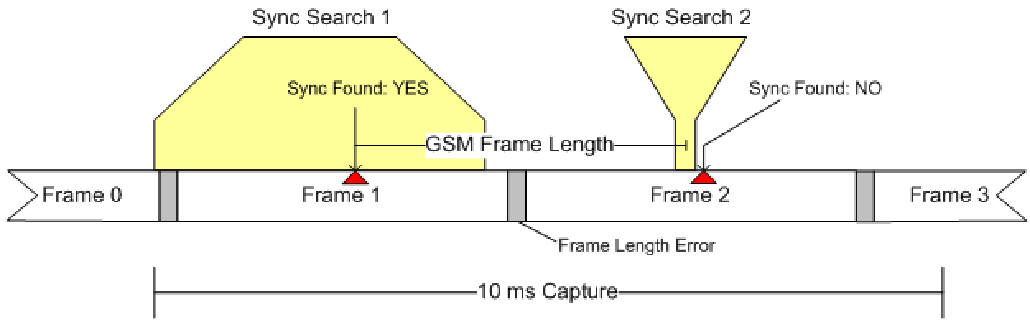


Figure 5-16: Failed synchronization due to frame length error and resulting false search area

A special **"Measure only on sync"** option ensures that only those sections of the captured signal are processed further for which synchronization was possible, thus improving performance.

For **frequency-hopping** signals, it is recommended that you use a power trigger to ensure capture starts with an active frame.

External trigger

When using an external trigger source, the application assumes that the trigger offset is set such that the GSM frame start is aligned with the start of a capture. Therefore only "narrow" searches are performed from the beginning of the Synchronization process for power trigger or free run mode.

5.11 Timeslot Alignment

Reference Time

The definition of a "reference time" is necessary for the following description of timeslot alignment. In the standard document "3GPP TS 45.010", in Section 5.7 it is stated that:

"Irrespective of the symbol duration used, the center of the training sequence shall occur at the same point in time. "

This is illustrated in Figure 5.7.3 of the standard document "3GPP TS 45.010" which is reproduced below for convenience (Figure 5-17). Due to this requirement, the "middle of TSC" or "center of Active Part" shall be used as the reference time when specifying timeslot alignment. Additionally, the "middle of TSC" is used for the alignment of the Power vs Time limit masks (see also "Limit Line Time Alignment" on page 133).

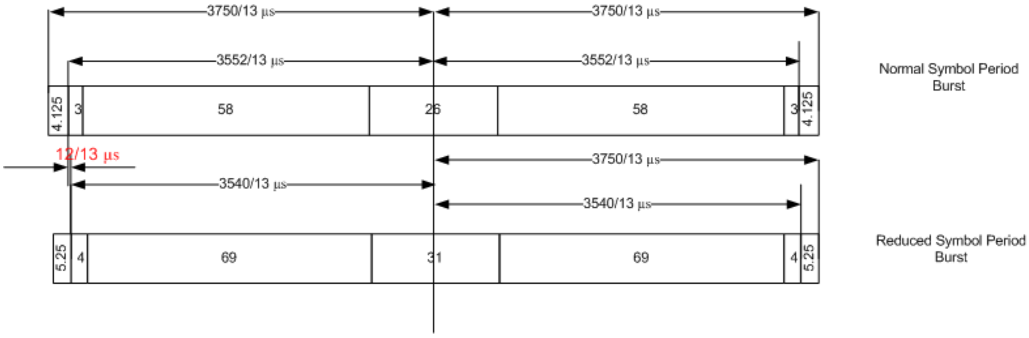


Figure 5-17: Timing alignment between normal symbol period and reduced symbol period bursts

As described in Chapter 5.9, "Definition of the Symbol Period", on page 59, the middle of TSC can be defined with respect to symbol periods and symbol decision instants. This is illustrated in Figure 5-18. You can see that for normal symbol period bursts (Normal bursts), the middle of TSC for GMSK occurs exactly at the decision instant of symbol 74. However, for EDGE it occurs between the decision instants of symbols 73 and 74, while for reduced symbol period bursts (Higher Symbol Rate bursts), it occurs exactly at the decision instant of symbol 88.

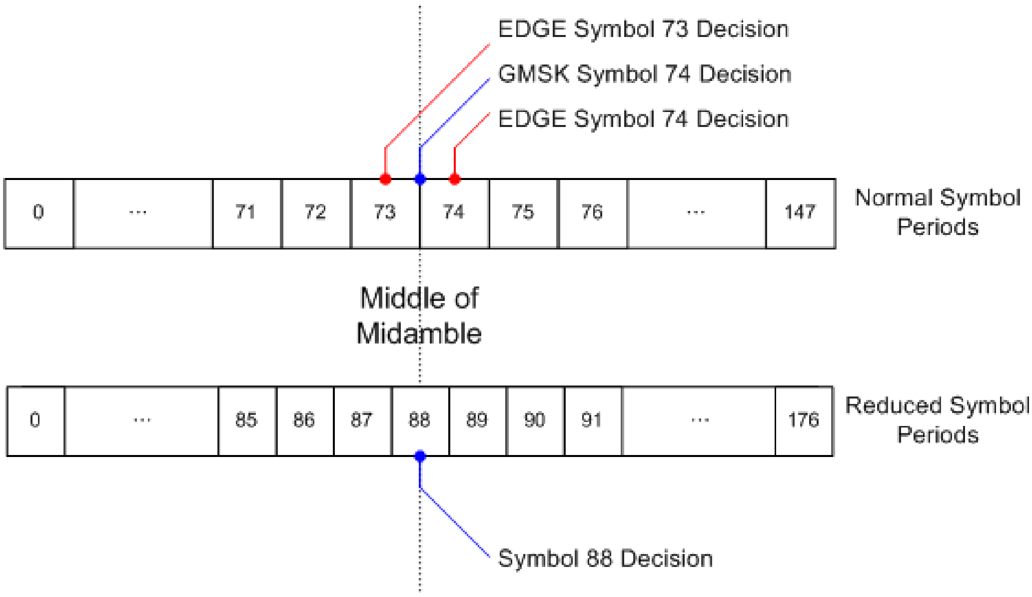


Figure 5-18: Middle of TSC for normal and reduced symbol period bursts.

Timeslot alignment within the frame

The standard document "3GPP TS 45.010" provides details on the alignment of slots within the GSM frame:

"Optionally, the BTS may use a timeslot length of 157 normal symbol periods on time-slots with TN = 0 and 4, and 156 normal symbol periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156.25 normal symbol periods on all timeslots"

The alignment of slots therefore falls under the "Not Equal Timeslot Length" (Equal Timeslot Length = off) or the "Equal Timeslot Length" (Equal Timeslot Length = on) criterion (see also "Equal Timeslot Length" on page 93), which are illustrated in Figure 5-19.

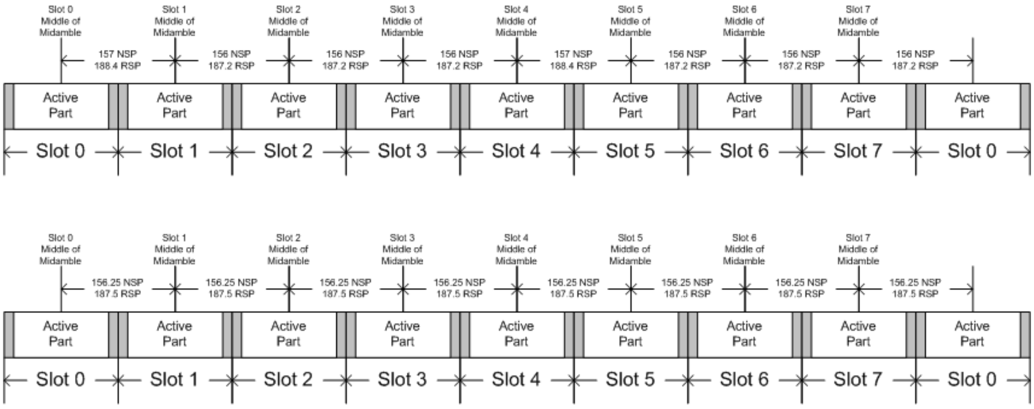


Figure 5-19: "Not equal"(top) and "equal" (bottom) timeslot length criteria

Note that, since the reference point at the "middle of TSC" of each slot must coincide, the length of the guard interval between successive bursts will depend on both the timeslot length and the symbol rate of bursts in successive slots. As stated in the standard "3GPP TS 45.010", for the "Equal Timeslot Length" case:

"… if there is a pair of different symbol period bursts on adjacent timeslots, then the guard period between the two bursts shall be 8.5 normal symbol periods which equals 10.2 reduced symbol periods."

For the "Not Equal Timeslot Length" case, deriving the guard period length is somewhat more complicated, and the possible values are summarized in Table 5.7.2 of "3GPP TS 45.010", reproduced below as Guard period lengths between different timeslots, for convenience:

Table 5-6: Guard period lengths between different timeslots

Burst Transition	Guard Period Between Timeslots (In terms of normal symbol periods)		Guard Period Between Timeslots (In terms of reduced symbol periods)	
	TS0 and TS1 or TS4 and TS5	**Any other timeslot pair**	**TS0 and TS1 or TS4 and TS5**	**Any other timeslot pair**
normal symbol period to normal symbol period	9	8	10.8	9.6
normal symbol period to reduced symbol period	9.25	8.25	11.1	9.9

Burst Transition	Guard Period Between Timeslots (In terms of normal symbol periods)		Guard Period Between Timeslots (In terms of reduced symbol periods)	
	TS0 and TS1 or TS4 and TS5	Any other time-slot pair	TS0 and TS1 or TS4 and TS5	Any other timeslot pair
reduced symbol period to normal symbol period	9.25	8.25	11.1	9.9
reduced symbol period to reduced symbol period	9.5	8.5	11.4	10.2

5.12 Delta to Sync Values

The "Delta to Sync" value is defined as the distance between the mid of the TSC and the TSC of the Slot to Measure.

The results are provided in the unit NSP, which stands for Normal Symbol Period, i.e. the duration of one symbol using a normal symbol rate (approx. 3.69µs). The measured "Delta to Sync" values have a resolution of 0.02 NSP.

These values are either assumed to be constant (according to the 3GPP standard) or measured, depending on the setting of the Limit Line Time Alignment parameter ("Slot to measure" or "Per Slot").

According to the standard (see "Timeslot length" in 3GPP TS 45.010), there are either eight slots of equal length (156.25 NSP), or slot 0 and slot 4 have a length of 157 NSP while all other slots have a length of 156 NSP. For details see Chapter 5.11, "Timeslot Alignment", on page 64.

The timeslot length is defined as the distance between the centers of the TSCs in successive slots. By setting the "Limit Time Alignment" parameter to "Per Slot", the "Delta to Sync" values can be measured and used in order to verify the timeslot lengths.

Setting the Limit Line Time Alignment to "Slot to measure" displays the expected values (according to the standard and depending on the value of Equal Timeslot Length). These values are summarized in Expected "Delta to Sync" values in normal symbol periods (Slot to measure = 0, No. of slots = 8 and First slot to measure = 0).

Table 5-7: Expected "Delta to Sync" values in normal symbol periods

Slot Number	**0 = Slot to measure**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Equal Timeslot Length = On	0	156.25	312.50	468.75	625.00	781.25	937.50	1093.75
Equal Timeslot Length = Off	0	157	313	469	625	782	938	1094

5.13 Limit Checks

5.13.1 Limit Check for Modulation Spectrum

The determined "Modulation Spectrum" values in the average (Avg) trace can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Modulation Spectrum" diagram (see "Modulation Spectrum Graph" on page 23).

The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *both* limits are exceeded.

The limits depend on the following parameters:

- Frequency band
- Device Type (only BTS type, not MS type)
- Burst Type / Modulation / Filter - limits are different for Higher Symbol Rate and Wide Pulse Filter (case 2) and others (case 1), see 3GPP TS 45.005, chapter 4.2.1.3
- The measured reference power (30 kHz bandwidth)
- The measured burst power (power level)
- Number of active carriers for multicarrier BTS. The limit is relaxed by 10*log10(N) dB for offset frequencies ≥1.8 MHz, see 3GPP TS 45.005 chapter 4.2.1.2

5.13.2 Limit Check for Transient Spectrum

The determined "Transient Spectrum Accuracy" values can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Transient Spectrum" diagram (see "Transient Spectrum Graph" on page 29).

The limits depend on the following parameters:

- Graph: Limit check of maximum (Max) trace
- Table: Limit check of absolute and relative scalar values
- The limit masks are generated adaptively from the measured signal.
- The limits depend on the following parameters:
  – Frequency band (not for MS)
  – Burst Type / Modulation / Filter (not for MS)
  – The measured reference (slot) power

5.13.3 Limit Check for Power vs Time Results

The determined "Power vs Time" values can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Power vs Time" diagram (see "PvT Full Burst" on page 28) and in the "Power vs Slot" table (see "Power vs Slot" on page 27).

The limits depend on the following parameters:

- The maximum (Max) trace is checked against the upper limit.
- The minimum (Min) trace is checked against the lower limit.
- The limit masks are generated adaptively from the measured signal according to the following parameters:
  – Frequency band (special masks for PCS1900 and DCS1800 BTS with GMSK)
  – Burst type
  – Modulation
  – Filter
  – The reference burst power is measured and the "0 dB line" of the limit mask is assigned to it.
  – For MS, the "-6 dB line" of the limit mask depends on the PCL. The PCL is derived from the measured burst power.

5.14 Impact of the "Statistic Count"

Generally, the "Statistic Count" defines how many measurements (or: analysis steps) are performed - equivalent to the "Sweep Count" in applications that perform sweeps.

In particular, the "Statistic Count" defines the number of frames to be included in statistical evaluations. For measurements on the Slot to Measure, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count", for statistical evaluations.

For Trigger to Sync measurements, where only one result is calculated per data acquisition, the "Statistic Count" determines how many values are considered for averaging.

Statistic count for Trigger to Sync vs other measurements

As mentioned above, the "Statistic Count" for Trigger to Sync measurements refers to the number of data acquisitions, whereas for all other measurements, the value refers to the number of frames. Since usually more than one frame is captured per data acquisition, the number of data acquisitions required to obtain the required number of results (the "Statistic Count") may vary considerably. If both Trigger to Sync and other result types are active at the same time, the latter are finished first and the traces (in particular the current measurement trace) remains unchanged until the Trigger to Sync measurement has also finished. The counter in the channel bar counts the "slower" of the two events, i.e. the number of measurements if a Trigger to Sync result display is active.

In **MSRA mode**, only a single data acquisition is performed (by the MSRA Master) and the R&S FSW GSM application analyzes this data repeatedly. Thus, the Trigger to Sync measurement will only count one data acquisition and can never reach a larger "Statistic Count" value.

Tip: You can query the current value of the counter for both Trigger to Sync and other measurements in remote control, as well. See `[SENSe:]SWEep:COUNt:TRGS:CURRent?` on page 253.

Obviously, the "Statistic Count" has an impact on all results and values that are re-calculated after each measurement. The higher the count, the more values are taken into consideration, and the more likely the result of the calculation will converge to a stable value. On the other hand, the fewer measurements are considered, the higher the variance of the individual results, and the less reliable the calculation result will be.

For instance, if the "Statistic Count" is set to values smaller than 5, the measured reference power for Modulation Spectrum Table (see "Modulation Spectrum Table" on page 24) and Transient Spectrum Table (see "Transient Spectrum Table" on page 30) measurements increases. This leads to a higher variance of the measured relative powers at the offset frequencies, and thus to a reduced measurement dynamic.

For the Power vs Time (see "PvT Full Burst" on page 28) and Power vs Slot (see "Power vs Slot" on page 27) measurements, a small "Statistic Count" increases the variance of the measured slot powers. The slot power is required to calculate the PVT limit lines.

5.15 Multicarrier and Wideband Noise

For multicarrier measurements, the GSM standard defines limits for some parameters concerning noise and intermodulation products. Thus, a new separate measurement is provided by the R&S FSW GSM application: the *Multicarrier Wideband Noise Measurement* (MCWN). This measurement comprises:

- I/Q based measurements on the carriers to determine their power levels and reference powers
- Frequency sweeps with RBWs of 100 kHz (to measure wideband noise) and 300 kHz (to measure intermodulation products)
- Gated zero span measurements with an RBW of 30 kHz to measure narrowband noise

5.15.1 MCWN Measurement Process

The MCWN measurement consists of several sub-measurements, and may include averaging processes.

Reference measurement

Optionally, a reference measurement is carried out to obtain suitable reference power values for the actual noise measurement. The reference measurement can determine the reference powers of the active carrier with the maximum power level, or optionally, measure just one selected carrier. Several reference measurements can be performed subsequently to calculate an average, thus ensuring stable reference values. Usually, a small average count (10-12) is sufficient to obtain suitable results for the reference measurement.

If this reference measurement is disabled, user-defined reference values are used for relative results in the final measurement.

Narrowband noise measurement

If enabled, the narrowband noise is measured next. Narrowband noise measurement is only available for multicarrier device types (see "Device Type" on page 90) for which at least 2 carriers are configured (see Chapter 6.3.2.4, "Carrier Settings", on page 98).

This measurement consists of zero span sweeps at a number of defined offset frequencies for each active carrier. That means I/Q data is captured at all relevant outermost carriers (i.e. 2 carriers for contiguous, 4 for non-contiguous carrier allocation), one after another. From this I/Q data, all slots and timing information are determined.

At each determined slot, a gated zero span measurement with an RBW and VBW of 30 kHz is performed, using the same I/Q data. Measurement time is from 50 to 90 % of the useful part of the time slot excluding the mid amble. Measurement offsets are 400 kHz, 600 kHz and 1200 kHz, either below or above the outermost carrier.

If no slots are found, the results are invalid due to an invalid measurement setup, and a warning is displayed in the status bar.

Several narrowband noise measurements can be performed subsequently to calculate an average. Typically, a much larger average count than for the reference measurement is required to obtain suitable results for noise measurements, thus a separate average count is available for reference and noise measurements.

Wideband noise and intermodulation sweeps

After the narrowband noise measurement, if either wideband noise or intermodulation, or both, are enabled, frequency sweeps are performed in the defined span. Since the standard requires different RBWs depending on the distance from the outermost carriers, several sweeps are required to obtain results for the complete span. The first sweep measurement is performed using an RBW of 100 kHz. The second sweep measurement is performed using an RBW of 300 kHz.

For more details on how intermodulation is calculated see Chapter 5.15.5, "Intermodulation Calculation", on page 77.

For more details on how wideband noise results are determined, see Chapter 5.15.6, "Wideband Noise Measurement", on page 79.

Evaluating the results for display

After all the reference and noise measurements have been performed, the measured data is evaluated for the final result display. This includes the following procedures:

- Averaging the results from several measurements
- Putting the results in relation to the reference power values
- Merging the traces according to the distance from the carriers and the position of the intermodulation products
- Performing limit checks (see Chapter 5.15.4, "Limit Check for MCWN Results", on page 75)

(The details of evaluation are described for the individual evaluation methods in Chapter 4.2.1, "Multicarrier Evaluation Methods", on page 34.)

Continuous measurement mode

If continuous sweep mode is selected, the measurement process described above is repeated continuously, i.e. after the average count number of noise measurements, the results are evaluated and displayed, a new reference sub-measurement is performed, the noise measurements are repeated, and so on.

5.15.2 Contiguous vs Non-Contiguous Multicarrier Allocation

In a standard GSM measurement scenario, multiple carriers are positioned with a fixed spacing in one block. This setup is referred to as *contiguous carrier allocation*.

Carrier frequencies are allocated in a grid with a spacing of 200 kHz. The minimum carrier spacing is 600 kHz.

Multi-standard radio (MSR) signals

Modern base stations may process multiple signals for different communication standards, for example two GSM subblocks with an LTE subblock in-between. In this case, if you consider only the GSM carriers, the carriers are spaced regularly within the GSM subblocks, but there is a gap between the two subblocks. Such a carrier setup is referred to as *non-contiguous carrier allocation*.

According to the 3GPP standard TS 51.021, a subblock is defined as *"one contiguous allocated block of spectrum for use by the same base station. There may be multiple instances of subblocks within an RF bandwidth"*.

A gap is defined as *"A frequency gap between two consecutive sub-blocks within an RF bandwidth, where the RF requirements in the gap are based on co-existence for uncoordinated operation."*

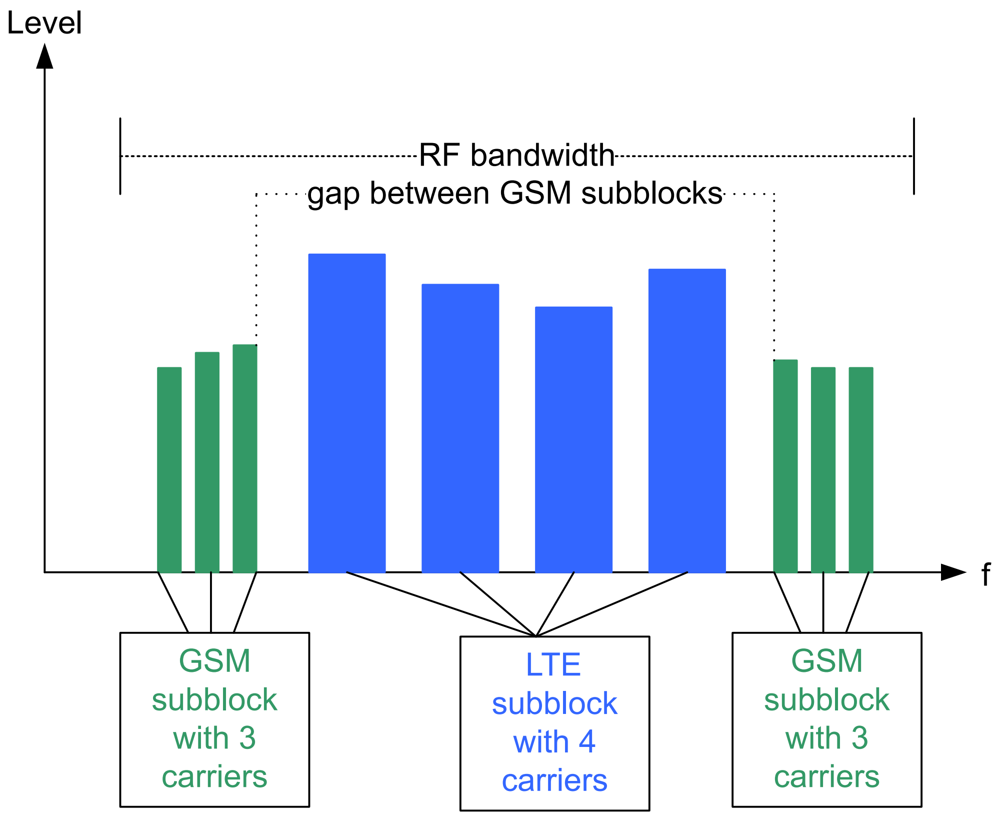


Figure 5-20: Non-contiguous carrier allocation

Non-contiguous carrier allocation

The R&S FSW GSM application now allows you to measure such non-contiguous carrier setups containing up to 16 carriers and a single gap (two subblocks). The position of the individual carriers is defined as absolute frequency values. In addition, the position of the gap between the GSM subblocks is defined explicitly by the number of the carrier after which it begins. The burst type and modulation can be defined individually for each carrier to reflect different GSM configurations.

Limit checks for non-contiguous carrier allocation

In order to perform useful limit checks for such non-contiguous carrier allocation, the limit lines are automatically adapted to the gap, so that other signals do not distort the GSM limit check.

5.15.3 Manual Reference Power Definition for MCWN Measurements

For MCWN measurements, reference powers are required to calculate relative results in the final measurement. These power levels can either be determined by a reference measurement or they can be defined manually by the user. In the latter case, a power level is defined, as well as three reference power levels for an RBW of 30 kHz, 100 kHz, and 300 kHz.

The reference powers depend on the modulation characteristics. Some typical values for various modulation types are provided in Table 5-8. The table indicates the reference powers for the three RBWs, relative to a defined power level. Since all reference powers are measured with a smaller bandwidth than the power level, all values are negative.

To define reference powers manually, define a power level and then subtract the values indicated in Reference powers relative to power level for various modulation types for the used modulation to determine the reference power levels.

Table 5-8: Reference powers relative to power level for various modulation types

Modulation	RBW = 300 kHz	RBW = 100 kHz	RBW = 30 kHz
NB GMSK	-0.3 dB	-2.2 dB	-7.8 dB
NB 8PSK	-1.7 dB	-3.8 dB	-7.7 dB
NB 16QAM	-2.8 dB	-4.5 dB	-8.6 dB
NB 32QAM	-2.9 dB	-5.0 dB	-9.3 dB
NB AQPSK (SCPIR = 0 dB)	-2.5 dB	-4.0 dB	-8.5 dB
HSR-N QPSK	-1.9 dB	-3.9 dB	-8.2 dB
HSR-N 16QAM	-3.0 dB	-4.7 dB	-8.7 dB
HSR-N 32QAM	-3.5 dB	-5.5 dB	-10.0 dB
HSR-W QPSK	-1.6 dB	-5.0 dB	-10.0 dB

Modulation	RBW = 300 kHz	RBW = 100 kHz	RBW = 30 kHz
HSR-W 16QAM	-3.1 dB	-5.5 dB	-10.3 dB
HSR-W 32QAM	-3.1 dB	-6.1 dB	-11.3 dB

Example:

For a normal burst 8PSK signal, for example, and a power level of 35 dBm, the reference values according to Table 5-8 would be:

RBW	Reference power
300 kHz	35 dBm - 1.7 dB = 33.3 dBm
100 kHz	35 dBm - 3.8 dB = 31.2 dBm
30 kHz	35 dBm - 7.7 dB = 27.3 dBm

5.15.4 Limit Check for MCWN Results

For MCWN measurements, various limit lines are calculated:

- Wideband noise limits
- Limits for intermodulation products that have to be measured with an RBW of 100 kHz
- Limits for intermodulation products that have to be measured with an RBW of 300 kHz
- Limits for narrowband measurements that have to be measured with an RBW of 30 kHz. The limit is defined at 3 distinct measurement offsets each, then connected by straight lines.

For each of these limit lines, a limit check is performed and the results can be queried. They are also indicated in the Spectrum Graph display (see "Spectrum Graph" on page 35.

Exceptions

For measurements using an RBW of 100 kHz (wideband noise, certain intermodulation products), the standard allows for the signal to exceed the specified limits in exceptional cases. Thus, you can define whether the limit check for MCWN measurements considers these exceptions or not.

If exceptions are considered, the R&S FSW GSM application divides the measurement range into 200 kHz bands. If the limit line in one of these bands is exceeded, a new, higher limit line (with an exceptional level) is applied to the band. Only if this exceptional limit line is also exceeded, the limit check fails.

Maximum number of exceptions

The number of bands for which exceptional limits may be applied is restricted by the standard (3GPP TS 45.005 (chapter 6.2.1.4.1) for single carrier, 3GPP 51.021 (chapter 6.12.3) for multicarrier BTS devices). Thus, the maximum number of bands that may use exceptional limits is indicated for each measurement, as well as the number of bands for which exceptions actually were used. The limit check compares the number of employed exceptions with the number of maximum allowed exceptions.

Note that the maximum number of exceptional bands is based on the total number of bands included in the following Exception ranges.

However, if the defined measurement span does not comprise all the bands in these ranges, the maximum is not valid. In this case, the measurement may pass the limit check although too many exceptions occurred for the restricted span.

To ensure the correct span is used, select "FREQ > Frequency Config > TX band" (see "Setting the Span to Specific Values Automatically" on page 149).

Exception ranges

Exceptions are defined for two frequency ranges:

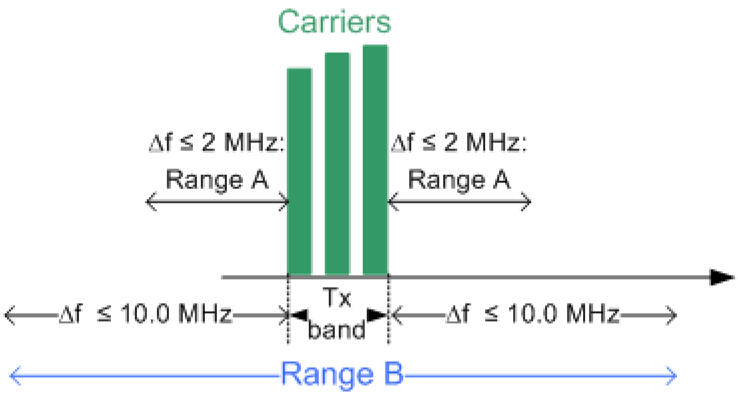


Figure 5-21: Exception ranges for multicarrier BTS limit checks

Range A

- **For multicarrier BTS device types:**
  Bands with an offset of 0 Hz to 2 MHz from the Tx band edges are counted. Bands containing third order IM products and adjacent bands are ignored. For the exact details see 3GPP TS 51.021, chapter 6.12.3.
- **For other device types**
  Bands in a distance of 600 kHz to 6 MHz above and below the outermost carrier are counted. For the exact details see 3GPP TS 45.005, chapter 6.2.1.4.1.

The suffix required to query the number of exceptions in range A using remote commands (<k>) is 5.

Range B

- **For multicarrier BTS device types:**
  Bands inside the Tx band +/- 10 MHz are counted. Bands containing third order IM products and adjacent bands are ignored. These are the (only) exceptions allowed by the standard. Note that this range includes range A. The number of exceptions thus includes the results from range A.
  For the exact details see 3GPP TS 51.021, chapter 6.12.3.

- **For other device types**
  Bands in a distance over 6 MHz from the outermost carriers are counted. For the exact details see 3GPP TS 45.005, chapter 6.2.1.4.1.

The suffix required to query the number of exceptions in range B using remote commands (<k>) is 6.

5.15.5 Intermodulation Calculation

If intermodulation measurement is activated, the following calculations are performed.

If there are N active carriers with frequencies f_1, f_2, f_3, ... f_N, find all possible combinations of integer coefficients c_1, c_2, c_3, ... c_N for which the following equation is true:

$$\sum_{k=1}^{N} |c_k| = M$$

with M = intermodulation order

Use all those combinations of coefficients c_k to calculate all possible intermodulation frequencies of the given order M:

$$f_{IM} = \sum_{k=1}^{N} c_k \cdot f_k$$

Example: Calculating intermodulation

For 3 carriers and IM order 3 these are all the theoretical combinations of c_k:

Table 5-9: Intermodulation coefficients depending on number of carriers involved

1 carrier	2 carriers				3 carriers
0 0 3	0 1 2	0 2 1	1 0 2	2 0 1	1 1 1
0 3 0	1 2 0	2 1 0	1 0 -2	-2 0 1	1 1 -1
3 0 0	0 1 -2	0 2 -1	-1 0 2	2 0 -1	1 -1 1
0 0 -3	1 -2 0	**2 -1 0 *)**	-1 0 -2	-2 0 -1	-1 1 1
0 -3 0	0 -1 2	0 -2 1			1 -1 -1
-3 0 0	-1 2 0	-2 1 0			-1 -1 1
	0 -1 -2	0 -2 -1			-1 -1 -1
	-1 -2 0	-2 -1 0			
*) critical intermodulation					

Critical intermodulations

For critical intermodulations, the sum of all c_k equals 1. For example $2*f_1 – 1*f_2$, indicated in Table 5-9. They are critical because they are close to active carriers.

Note that for some combinations the following may apply:

- Results are much too far away from the active carriers to be of relevance
- Results are negative

- Results have an identical IM frequency

Therefore the R&S FSW GSM application always checks the list of theoretical IM frequencies for the following aspects:

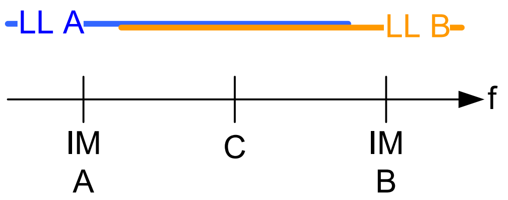
- Intermodulation frequencies are ignored if they are outside the set frequency span or the range defined by the standard (typically the Tx band +/- 2 MHz or 10 MHz).
- For some measurements the GSM standard distinguishes how many carriers were involved in generating the intermodulation. This means checking how many $c_k \neq 0$.

Overlapping intermodulation limit lines

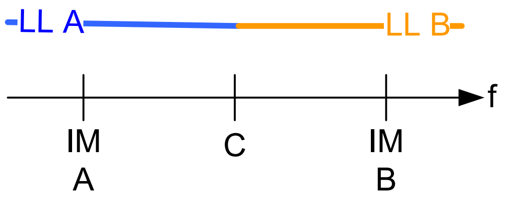
Intermodulations with different orders (for example 3 and 5) might fall on the exact same frequency or so close that the corresponding limit line ranges overlap. In this case, the R&S FSW GSM application checks which IM's limit value or relaxation value applies according to the GSM standard.

The following cases may occur:

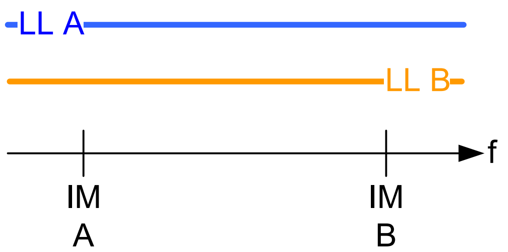
- The overlapping limit lines have the same level.



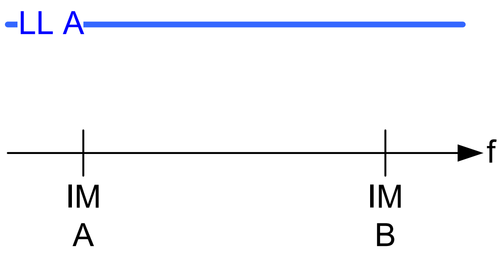
In this case, the point in the middle of both IM frequencies is determined and each limit line is restricted to the area up to or starting from this point.



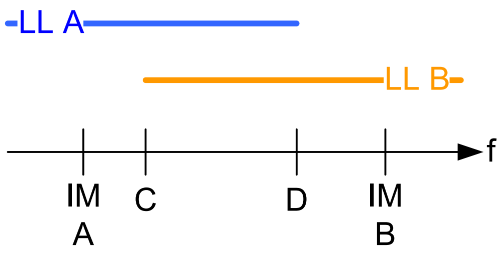
- The limit lines have different values and overlap over the entire span



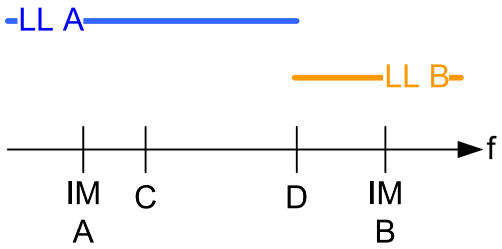
The less stringent limit line is applied.



- The limit lines have different values and overlap over a partial span



The less stringent limit line is applied in the overlapping area; the distinct limit lines are reduced to the remaining area(s).



5.15.6 Wideband Noise Measurement

If wideband noise measurement is activated, the total frequency range of the measurement (defined by the selected span and the GSM band) is divided in non-overlapping frequency segments according to the following rules:

- Basically the segments are those defined in the tables in section 6.5.1. (and following) of the 3GPP TS 51.021 standard. The frequency offsets defined there are applied relative to all outermost carriers, i.e. below the lowest carrier and above the highest carrier. For non-contiguous mode the same principle is applied in the gap.
- The resulting segments can be limited further by the defined span (see Chapter 6.4.4.2, "Frequency Settings", on page 147).
  Note: If the span is too small, no wideband noise results can be calculated. For a measurement according to standard, set the span to the TX band automatically (see "Setting the Span to Specific Values Automatically" on page 149).
- The segments are also limited by the maximum range demanded by the GSM standard ("*…10 MHz outside the edge of the relevant transmit band…*")
- Adjacent segments are not merged to one large segment even if their limit values happen to be identical.

- The R&S FSW GSM application calculates where the standard demands intermodulation measurements instead of wideband noise measurement. It does not matter whether the intermodulation measurement is actually enabled or disabled in the Noise Measurement Settings! All determined IM ranges override a wideband measurement and replace it. This can make the wideband noise measurement segment start later, end earlier, or even vanish completely, or be separated in several segments.
- The middle of the gap is always a boundary (in case a wideband noise measurement segment exists there).
- The gaps between 2 wideband noise limit line segments in the R&S FSW GSM application are 1 Hz wide. These exact values can be output via remote commands. However, in the result display, some start and stop frequencies may appear to be equal due to rounding effects.

In the wideband noise tables, the results are then displayed for each segment (see "Outer Wideband Table" on page 42).

Limit checks in wideband noise tables

For the wideband noise table results, which indicate the distance of the measured value to the limit, limit exceptions do not cause the wideband noise segment to be split into two or more segments. The wideband noise table segments are constant and do not vary from sweep to sweep depending on whether exceptions are set or not (as opposed to the overall limits, see Chapter 5.15.4, "Limit Check for MCWN Results", on page 75).

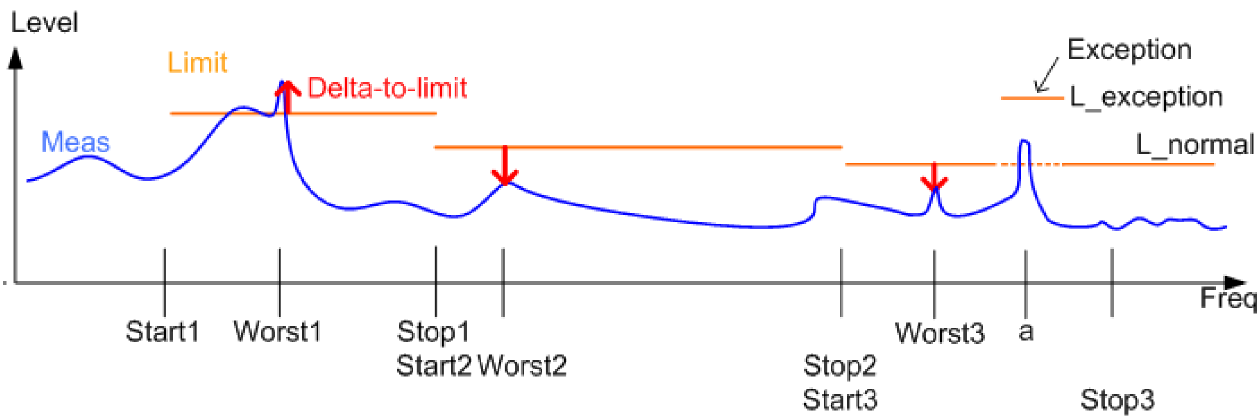


Figure 5-22: Wideband noise table: exceptions and delta to limit values

Example: Determining the "delta to limit" values for wideband noise tables

In Wideband noise table: exceptions and delta to limit values you see how the "delta to limit" values are calculated. The measured wideband noise trace is blue. The limit line (taking exceptions into account) is orange.

In each segment (StartX to StopX) the red arrow shows the worst delta to limit result.

- The first segment fails, assuming no exception is allowed here.
- The second segment passes.
- In the third segment, the normal limit line (dotted line) fails at frequency "a". However, an exception is allowed and raises the limit for a certain range. Thus, the R&S FSW GSM application recalculates the internal "delta to limit" trace (solid orange line). The new worst result is determined at position "Worst3". This position is then used to determine the noise power and limit line values for the wideband noise table.

5.16 Automatic Carrier Detection

An automatic carrier detection function is now available (Adjusting the Center Frequency Automatically (Auto Freq)). For multi-carrier measurements this function detects the available carriers in the input signal within a frequency range of approximately 25 MHz to 2 GHz.

The "Auto Frequency" function is sensitive to overload conditions. Thus, before using this function, make sure the reference level is not lower than the input signal's peak power. On the other hand, avoid reference level settings that are much too high, as they make very low carriers (approx. 50 dB under the reference level) disappear in the noise floor and they will not be detected.

Optionally, use the Setting the Reference Level Automatically (Auto Level) function to fine-tune the attenuators and the pre-amplifier *AFTER* the correct carrier frequencies have been determined.

For MCWN measurements, make sure all detected carriers are in the measurement span, for example using the "Carriers +/- 1.8 MHz" or "Carriers +/- 6 MHz" settings (see "Setting the Span to Specific Values Automatically" on page 149).

5.17 GSM in MSRA Operating Mode

The GSM application can also be used to analyze data in MSRA operating mode. In MSRA operating mode, only the MSRA Master actually captures data; the MSRA applications receive an extract of the captured data for analysis, referred to as the **application data**. For the R&S FSW GSM application in MSRA operating mode, the application data range is defined by the same settings used to define the signal capture in Signal and Spectrum Analyzer mode (see "Capture Time" on page 123). In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the application data for GSM measurements. The "Magnitude Capture" display shows the application data of the R&S FSW GSM application in MSRA mode.

MCWN measurements and MSRA mode

Only the default GSM I/Q measurement (Modulation Accuracy...) is available in MSRA mode, not the new MCWN measurement (see Chapter 4.2, "Multicarrier Wideband Noise Measurements", on page 34).

Data coverage for each active application

Generally, if a signal contains multiple data channels for multiple standards, separate applications are used to analyze each data channel. Thus, it is of interest to know which application is analyzing which data channel. The MSRA Master display indicates the data covered by each application, restricted to the channel bandwidth used by the corresponding standard (for GSM: 200 kHz), by vertical blue lines labeled with the application name.

Analysis interval

However, the individual result displays of the application need not analyze the complete data range. The data range that is actually analyzed by the individual result display is referred to as the **analysis interval**.

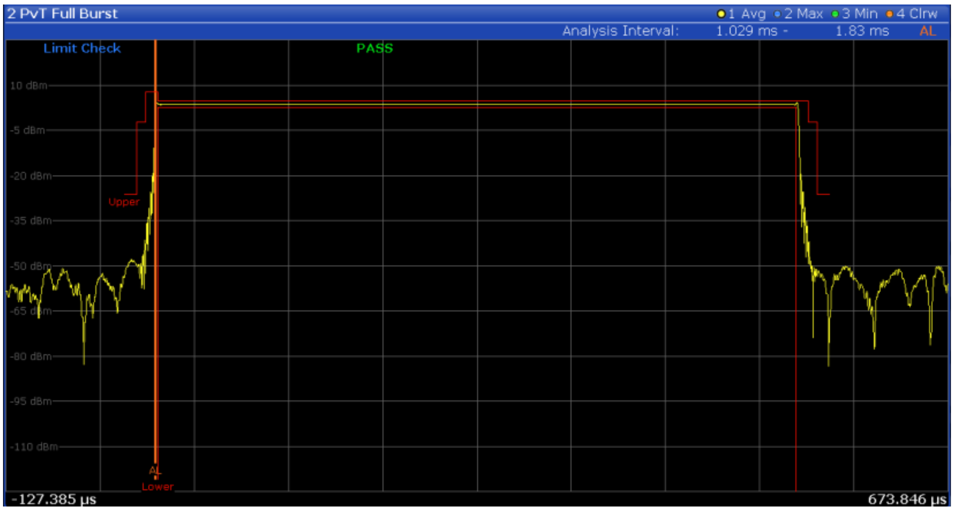
In the R&S FSW GSM application the analysis interval is automatically determined according to the basis of evaluation, for example the Slot to Measure or the slot scope. The currently used analysis interval (in seconds, related to capture buffer start) is indicated in the window header for each result display.

Analysis line

A frequent question when analyzing multi-standard signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced. The analysis line is a common time marker for all MSRA slave applications. It can be positioned in any MSRA slave application or the MSRA Master and is then adjusted in all other slave applications. Thus, you can easily analyze the results at a specific time in the measurement in all slave applications and determine correlations.

If the marked point in time is contained in the analysis interval of the slave application, the line is indicated in all time-based result displays, such as time, symbol, slot or bit diagrams. By default, the analysis line is displayed, however, it can be hidden from view manually. In all result displays, the "AL" label in the window title bar indicates whether the analysis line lies within the analysis interval or not:

- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval



Trigger source for MSRA Master

Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application (see Chapter 5.5, "Trigger settings", on page 51).

In the default state in MSRA operating mode, the Sequencer is active in continuous mode. Thus, the MSRA Master performs a data acquisition and then the active applications evaluate the data in turn, after which the MSRA Master performs a data acquisition and so on. As opposed to some other R&S FSW applications in MSRA mode, statistical evaluation of the traces (averaging, MinHold, MaxHold) is not reset after each evaluation in the R&S FSW GSM application.

You can take advantage of this feature in the R&S FSW GSM application by performing continuous data acquisition in MSRA operating mode over a longer period (e.g. over night), and then checking the average or MinHold/MaxHold trace to detect any irregularities in the captured data.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

6 Configuration

The default GSM I/Q measurement captures the I/Q data from the GSM signal and determines various characteristic signal parameters such as the modulation accuracy, transient spectrum, trigger to sync, etc. in just one measurement (see Chapter 4.1, "GSM I/Q Measurement Results", on page 17).

For multicarrier wideband noise (MCWN) measurements, a different configuration is required (see Chapter 6.4, "Multicarrier Wideband Noise (MCWN) Measurements", on page 138).

The settings required to configure each of these measurements are described here.

Selecting the measurement type

► To select a different measurement type, do one of the following:
  - Select the "Overview" softkey. In the "Overview", select the "Select Measurement" button. Select the required measurement.
  - Press the MEAS key. In the "Select Measurement" dialog box, select the required measurement.

Remote command:

`CONFigure:MEASurement` on page 202

6.1 Multiple Measurement Channels and Sequencer Function

When you activate an application, a new measurement channel is created which determines the measurement settings for that application. These settings include the input source, the type of data to be processed (I/Q or RF data), frequency and level settings, measurement functions etc. If you want to perform the same measurement but with different center frequencies, for instance, or process the same input data with different measurement functions, there are two ways to do so:

- Change the settings in the measurement channel for each measurement scenario.
  In this case the results of each measurement are updated each time you change the settings and you cannot compare them or analyze them together without storing them on an external medium.
- Activate a new measurement channel for the same application.
  In the latter case, the two measurement scenarios with their different settings are displayed simultaneously in separate tabs, and you can switch between the tabs to compare the results.

For example, you can activate one GSM measurement channel to perform a GSM modulation accuracy measurement for an unknown signal, and a second channel to perform a multicarrier measurement using the same GSM input source. Then you can monitor all results at the same time in the "MultiView" tab.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

Only one measurement can be performed on the R&S FSW at any time. If one measurement is running and you start another, or switch to another channel, the first measurement is stopped. In order to perform the different measurements you configured in multiple channels, you must switch from one tab to another.

However, you can enable a Sequencer function that automatically calls up each activated measurement channel in turn. This means the measurements configured in the channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a ⚙ symbol in the tab label. The result displays of the individual channels are updated in the corresponding tab (as well as the "MultiView") as the measurements are performed. Sequencer operation is independent of the currently *displayed* tab; for example, you can analyze the SEM measurement while the modulation accuracy measurement is being performed by the Sequencer.

For details on the Sequencer function see the R&S FSW User Manual.

The Sequencer functions are only available in the "MultiView" tab.

Sequencer State

Activates or deactivates the Sequencer. If activated, sequential operation according to the selected Sequencer mode is started immediately.

Remote command:
`SYSTem:SEQuencer` on page 201
`INITiate<n>:SEQuencer:IMMediate` on page 250
`INITiate<n>:SEQuencer:ABORt` on page 250

Sequencer Mode

Defines how often which measurements are performed. The currently selected mode softkey is highlighted blue. During an active Sequencer process, the selected mode softkey is highlighted orange.

"Single Sequence"
Each measurement is performed once, until all measurements in all active channels have been performed.

"Continuous Sequence"
The measurements in each active channel are performed one after the other, repeatedly, in the same order, until sequential operation is stopped.
This is the default Sequencer mode.

Remote command:
`INITiate<n>:SEQuencer:MODE` on page 251

6.2 Display Configuration

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the selected measurement are displayed in the evaluation bar in SmartGrid mode when you do one of the following:

- Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the "Overview".
- Press the MEAS key.
- Select the "Display Config" softkey in any GSM menu.

Up to 16 evaluation methods can be displayed simultaneously in separate windows. The GSM evaluation methods are described in Chapter 4.1, "GSM I/Q Measurement Results", on page 17 and Chapter 4.2.1, "Multicarrier Evaluation Methods", on page 34.

For details on working with the SmartGrid see the R&S FSW Getting Started manual.

6.3 Modulation Accuracy Measurement Configuration

GSM measurements require a special application on the R&S FSW, which you activate using the MODE key.

When you switch a measurement channel to the GSM application the first time, a set of parameters is passed on from the currently active application. After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

When you activate a measurement channel in the GSM application, a GSM modulation accuracy measurement for the input signal is started automatically with the default configuration. The "GSM" menu is displayed and provides access to the most important configuration functions.

The MARKER FUNCT and LINES menus are currently not used.

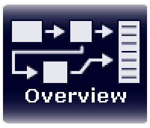
Importing and Exporting I/Q Data

The I/Q data to be evaluated in the GSM application (Modulation Accuracy measurement only) can not only be captured by the GSM application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the GSM application can be exported for further analysis in external applications.

The import and export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar.

For details on importing and exporting I/Q data see the R&S FSW I/Q Analyzer User Manual.

6.3.1 Configuration Overview



Access: MEAS CONFIG > "Overview"

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview".

Note that the configuration "Overview" depends on the selected measurement type. Configuration for multicarrier measurements is described in Chapter 6.4, "Multicarrier Wideband Noise (MCWN) Measurements", on page 138.

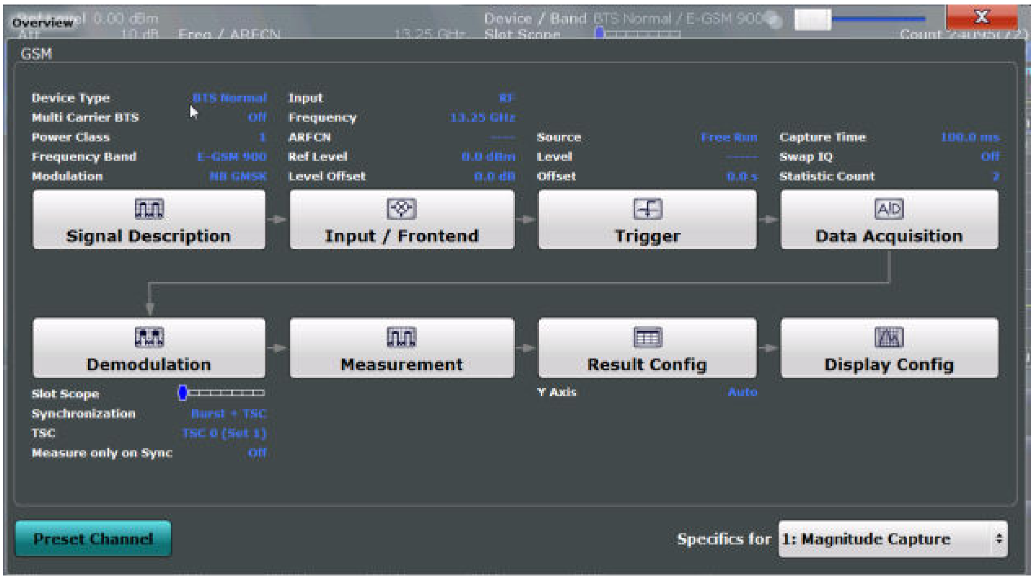


Figure 6-1: Configuration "Overview" for Modulation Accuracy measurement

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See Chapter 6.3.2, "Signal Description", on page 89
2. Input and Frontend Settings
   See Chapter 6.3.3, "Input, Output and Frontend Settings", on page 100
3. Triggering
   See Chapter 6.3.4, "Trigger Settings", on page 116
4. Data Acquisition
   See Chapter 6.3.5, "Data Acquisition", on page 122
5. Demodulation Settings
   See Chapter 6.3.6, "Demodulation", on page 126
6. Measurement Settings
   See Chapter 6.3.7, "Measurement Settings", on page 132
7. Result Configuration
   See Chapter 7.1, "Result Configuration", on page 169
8. Display Configuration
   See Chapter 6.2, "Display Configuration", on page 86

To configure settings

► Select any button to open the corresponding dialog box. The corresponding dialog box is opened with the focus on the selected setting.

For step-by-step instructions on configuring GSM measurements, see Chapter 9, "How to Perform Measurements in the GSM Application", on page 181.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FSW (except for the default Spectrum application channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 201

Select Measurement
Selects a measurement to be performed.

See Chapter 4, "Measurements and Result Displays", on page 17.

Specifics for
The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

6.3.2 Signal Description

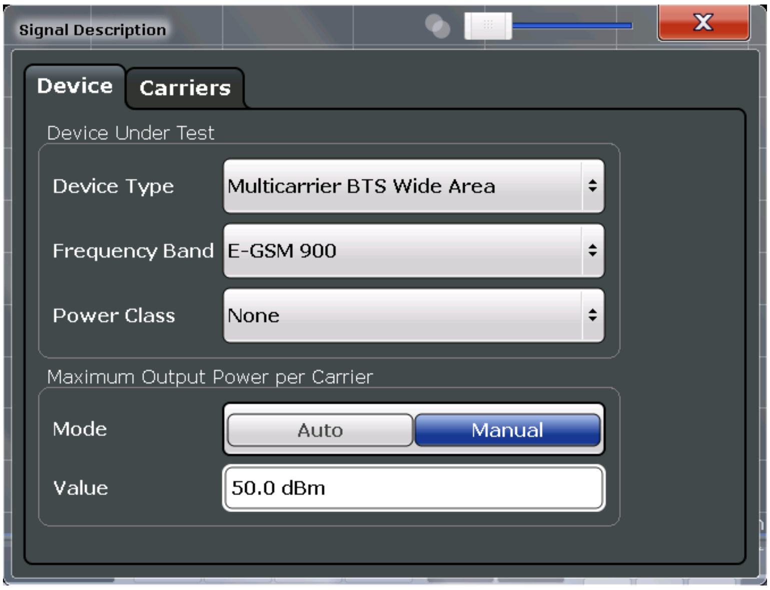
Access: "Overview" > "Signal Description"

The signal description provides information on the expected input signal, which optimizes frame detection and measurement.

6.3.2.1 Device Under Test Settings

Access: "Overview" > "Signal Description" > "Device"

The type of device to be tested provides additional information on the signal to be expected.



Device Type

Defines the type of device under test (DUT). The following types are available:

- BTS Normal
- BTS Micro
- BTS Pico
- MS Normal
- MS Small
- Multicarrier BTS Wide Area
- Multicarrier BTS Medium Range
- Multicarrier BTS Local Area

The default device type is "BTS Normal".

Remote command:

`CONFigure[:MS]:DEVice:TYPE` on page 203

Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 46.

The following frequency bands are supported:

- DCS 1800
- E-GSM 900
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- GSM 850

- PCS 1900
- P-GSM 900
- R-GSM 900
- T-GSM 380
- T-GSM 410
- T-GSM 810
- T-GSM 900

The default frequency band is "E-GSM 900".

Remote command:
CONFigure[:MS]:NETWork[:TYPE] on page 204
CONFigure[:MS]:NETWork:FREQuency:BAND on page 205

Power Class
The following power classes are supported:

(For MCWN measurements no power class is used: "NONE".)

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
CONFigure[:MS]:POWer:CLASs on page 206

Maximum Output Power per Carrier (multicarrier measurements only)
Defines the maximum output power per carrier, which determines the limit lines for the modulation spectrum (I/Q measurements) and MCWN measurement.

In "Auto" mode, the maximum measured power level for the carriers is used.

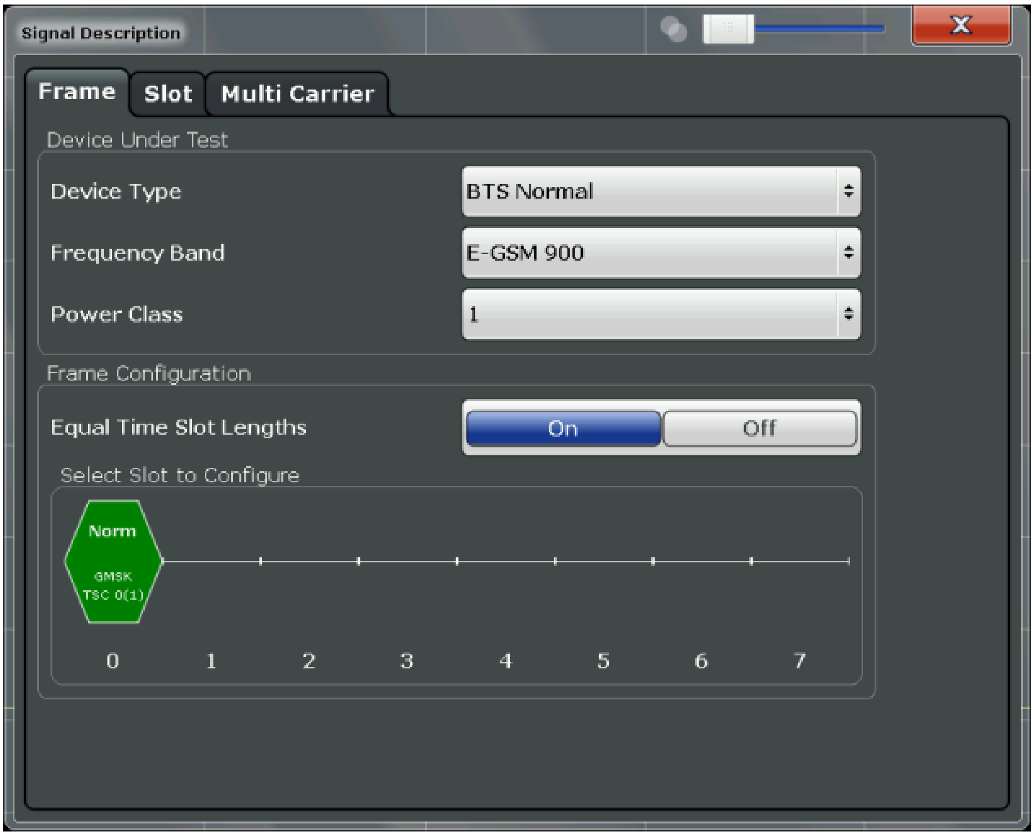
This setting is only available for multicarrier measurements.

Remote command:
CONFigure[:MS]:POWer:PCARrier:AUTO? on page 208
CONFigure[:MS]:POWer:PCARrier? on page 208

6.3.2.2 Frame

Access: "Overview" > "Signal Description" > "Frames"

Frame settings determine the frame configuration used by the device under test.



Device Type

Defines the type of device under test (DUT). The following types are available:

- BTS Normal
- BTS Micro
- BTS Pico
- MS Normal
- MS Small
- Multicarrier BTS Wide Area
- Multicarrier BTS Medium Range
- Multicarrier BTS Local Area

The default device type is "BTS Normal".

Remote command:
`CONFigure[:MS]:DEVice:TYPE` on page 203

Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 46.

The following frequency bands are supported:

- DCS 1800
- E-GSM 900
- GSM 450
- GSM 480

- GSM 710
- GSM 750
- GSM 850
- PCS 1900
- P-GSM 900
- R-GSM 900
- T-GSM 380
- T-GSM 410
- T-GSM 810
- T-GSM 900

The default frequency band is "E-GSM 900".

Remote command:
`CONFigure[:MS]:NETWork[:TYPE]` on page 204
`CONFigure[:MS]:NETWork:FREQuency:BAND` on page 205

Power Class
The following power classes are supported:

(For MCWN measurements no power class is used: "NONE".)

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
`CONFigure[:MS]:POWer:CLASs` on page 206

Equal Timeslot Length
This parameter is only taken into account if "Limit Time Alignment" is set to "Slot to measure" (see "Limit Line Time Alignment" on page 133).

If activated, all slots of a frame are considered to have the same length (8 x 156.26 normal symbol periods).

In this case, the limit line for each slot (required for the "Power vs Time" spectrum masks) is aligned by measuring the TSC of the Slot to Measure only, and using this value to align the limit line for all slots in the frame (see also "PvT Full Burst" on page 28).

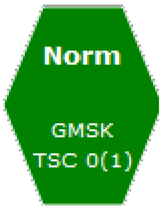
If deactivated, slots number 0 and 4 of a frame have a longer duration, all others have a shorter duration compared to the "Equal Timeslot Length" (157, 156, 156, 156, 157, 156, 156, 156 normal symbol periods).

See GPP TS 51.021 and 3GPP TS 45.010 chapter "6.7 Timeslot length" for further details.

Remote command:
`CONFigure[:MS]:CHANnel:FRAMe:EQUal` on page 208

Frame Configuration: Select Slot to Configure

This area shows a graphical representation of the configuration of each slot. Select a slot to display its "Slot" dialog box (see Chapter 6.3.2.3, "Slot Settings", on page 94).



For active slots the following information is shown:

- The burst type, e.g. "Normal (NB)" for a normal burst.
- The modulation, e.g. GMSK.
- The training sequence TSC (and Set)

For details on how to interpret the graphic, see "Frame configuration and slot scope in the channel bar" on page 53.

6.3.2.3 Slot Settings

Access: "Overview" > "Signal Description" > "Slot"> "Slot1"/.../"Slot7"

The individual slots are configured on separate tabs. The dialog box for the selected slot is displayed directly when you select a slot in the "Frame Configuration" graphic on the "Frame" tab (see "Frame Configuration: Select Slot to Configure" on page 94).

Slot structure display

The basic slot structure according to the selected Frequency Band and Power Class is displayed graphically for reference.

White fields indicate unknown data; colored fields indicate known symbol sequences.

The slot settings vary slightly for different burst types.

Figure 6-2: Slot configuration for normal and higher symbol rate bursts

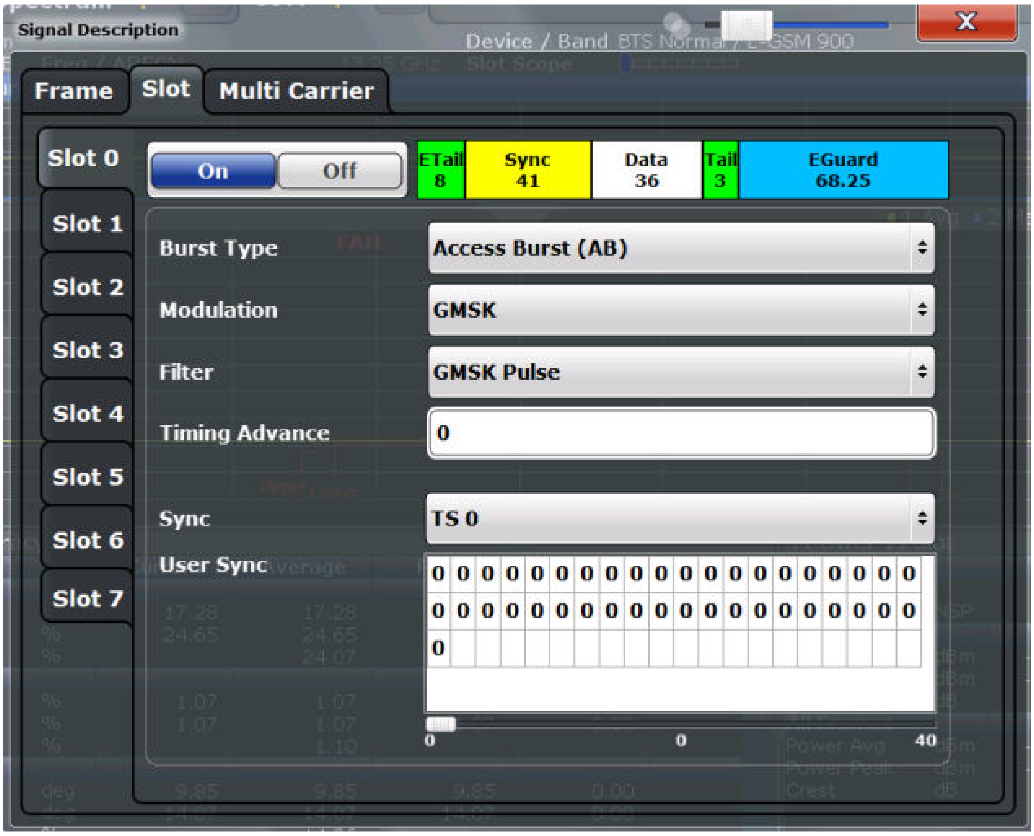


Figure 6-3: Slot configuration for access burst

The "Slot" settings are dependant on each other, and only specific combinations of these parameters are available in this dialog box (see Chapter 5.8, "Dependency of Slot Parameters", on page 58).

Slot State (On/Off)

Activates or deactivates the selected slot. The R&S FSW GSM application expects an input signal within the active slots only.

At least the Slot to Measure must be active in order to evaluate it.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>[:STATe]` on page 210

Burst Type

Assigns a burst type to the selected slot.

The following burst types are supported:
- Normal (NB)
- Higher Symbol Rate (HB)
- Access (AB)

The graphical slot structure is adapted according to the selected burst type.

Note: The "Slot" settings are dependant on each other, and only specific combinations of these parameters are available in this dialog box (see Chapter 5.8, "Dependency of Slot Parameters", on page 58).

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE` on page 215

Modulation
Defines the modulation used in the slot.

The possible modulations depend on the set burst type (see Chapter 5.8, "Dependency of Slot Parameters", on page 58).

The graphical slot structure is adapted according to the selected modulation.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:MTYPe` on page 210

SCPIR
This parameter is only available for **AQPSK** modulation.

It specifies the Subchannel Power Imbalance Ratio (SCPIR). The value of SCPIR affects the shape of the AQPSK constellation (see Chapter 5.4, "AQPSK Modulation", on page 50). For an SCPIR of 0 dB the constellation is square (as in "normal" QPSK), while for other values of SCPIR the constellation becomes rectangular.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:SCPir` on page 211

Filter
Specifies the pulse shape of the modulator on the DUT and thus the measurement filter in the R&S FSW GSM application.

(For details see Chapter 5.7.3, "Measurement Filter", on page 57).

The following filter types are supported for normal and higher symbol rate bursts:
- GMSK Pulse
- Linearized GMSK Pulse
- Narrow Pulse
- Wide Pulse

For access bursts, only a GMSK Pulse filter is supported.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:FILTer` on page 209

Timing Advance (Access Burst only)
Specifies the position of an access burst within a single slot as an offset in symbols from the slot start.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:TADVance` on page 213

Training Sequence TSC / Sync
(Note: for Access bursts, this setting is labeled "Sync", but the functionality is the same.)

The "Training Sequence TSC" or "Sync" values are known symbol sequences used to synchronize the measured signal with the expected input signal in a single slot.

The available values depend on the modulation as indicated in the table below.

For user-defined TSCs, select "User" and define the training sequence in the User TSC / User Sync table.

For more information on TSCs see "Training sequences (TSCs)" on page 49.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:TSC` on page 213
AQPSK:
`CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC` on page 212

User TSC / User Sync
(Note: for Access bursts, this setting is labeled "User Sync", but the functionality is the same.)

Defines the bits of the user-defined TSC or Sync. The number of bits depend on the burst type and the modulation and is indicated in Table 6-1.

For AQPSK modulation, the training sequence is defined for each subchannel, see Chapter 5.4, "AQPSK Modulation", on page 50.

Note:
As the "User TSC" table in the dialog box only displays 25 bits at a time, a scrollbar beneath the table allows you to display the remaining bits. The currently selected bit number is indicated in the center of the scrollbar.

Table 6-1: Number of TSC bits depending on burst type and modulation

Burst Type	Modulation	Number of Bits
Normal	GMSK	26
Normal	8PSK	78
Normal	16QAM	104
Normal	32QAM	130
Higher Symbol Rate	QPSK	62
Higher Symbol Rate	16QAM	124
Higher Symbol Rate	32QAM	155
Access	GMSK	41

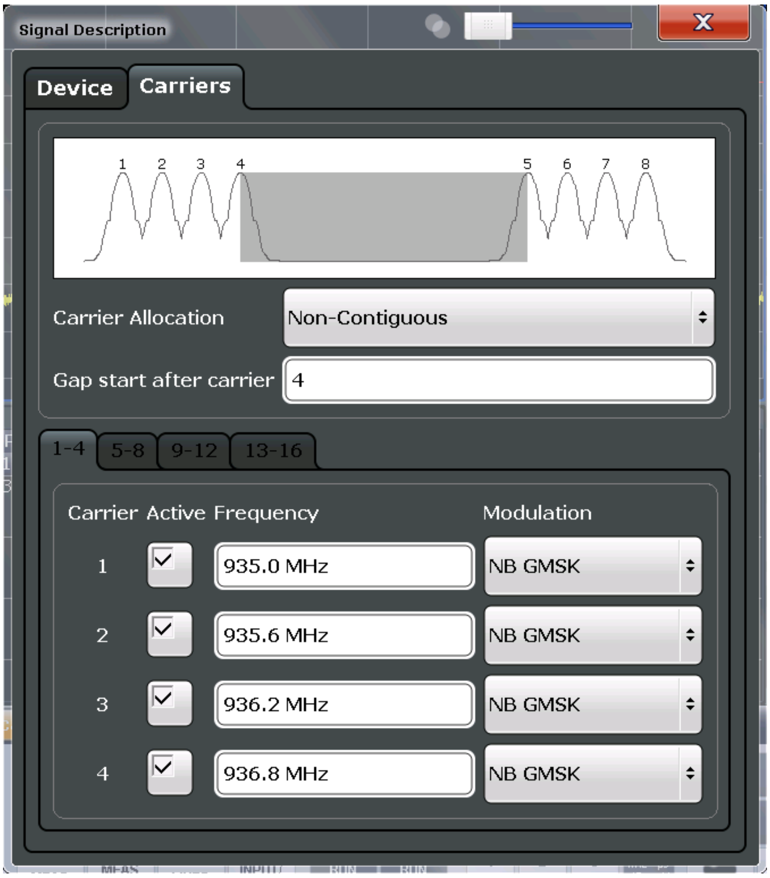
Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER` on page 214
AQPSK:
`CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER` on page 212

6.3.2.4 Carrier Settings

Access: "Overview" > "Signal Description" > "Carriers"

The "Carrier" settings define whether the expected signal contains a single or multiple carriers. Multiple carriers can only be defined if a multicarrier Device Type is selected (see Chapter 6.3.2.1, "Device Under Test Settings", on page 89.

Up to 16 carriers can be configured for a single MCWN measurement.



The carriers can also be configured automatically, see "Adjusting the Center Frequency Automatically (Auto Freq)" on page 137.

Carrier Allocation

Defines whether a multicarrier measurement setup contains one subblock of regularly spaced carriers only (contiguous), or two subblocks of carriers with a gap in-between (non-contiguous).

For details see Chapter 5.15.2, "Contiguous vs Non-Contiguous Multicarrier Allocation", on page 72.

Remote command:
`CONFigure[:MS]:MCARrier:FALLocation` on page 218

Gap start after carrier (Non-contiguous carriers only)
For non-contiguous setups (see Carrier Allocation) the position of the gap must be defined as the number of the active carrier after which the gap starts.

Remote command:
`CONFigure[:MS]:MCARrier:FALLocation:NCONtiguous:GSACarrier` on page 218

Active carriers
Defines which of the defined carriers are active for the current measurement.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>[:STATe]?` on page 216

Frequency
Defines the absolute frequency of each (active) carrier.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>:FREQuency` on page 216

Modulation
Defines the burst type, modulation and pulse shape filter of each (active) carrier.

For possible combinations see Chapter 5.8, "Dependency of Slot Parameters", on page 58.

Note: This setting determines the appropriate limits from the 3GPP standard.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>:MTYPe` on page 217

6.3.3 Input, Output and Frontend Settings

Access: "Overview" > "Input/Frontend"

The R&S FSW can evaluate signals from different input sources and provide various types of output (such as noise or trigger signals).

6.3.3.1 Input Source Settings

Access: "Overview" > "Input/Frontend" > "Input Source"

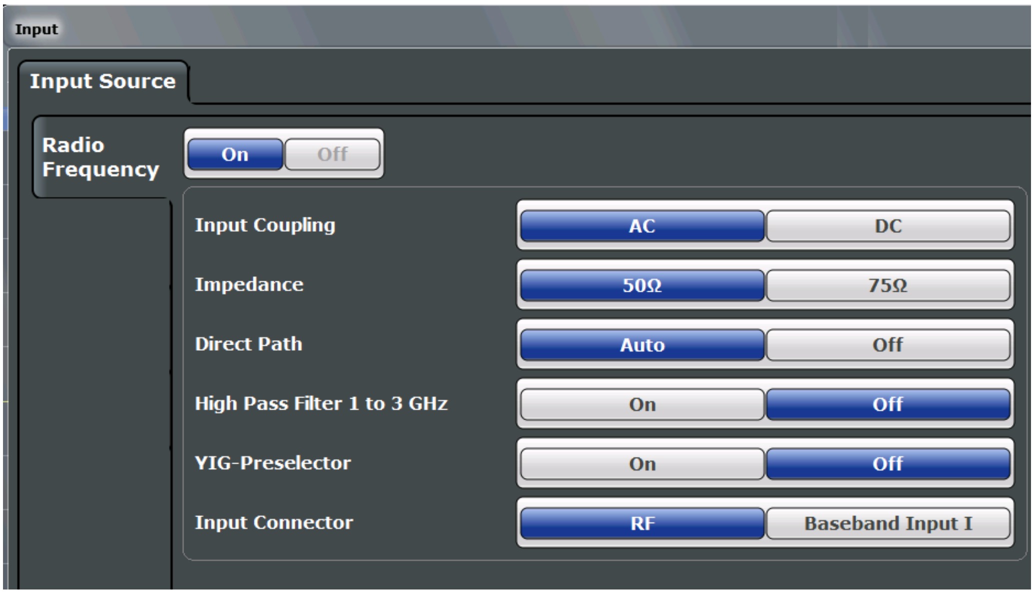
The input source determines which data the R&S FSW will analyze.

The default input source for the R&S FSW is "Radio Frequency", i.e. the signal at the RF INPUT connector of the R&S FSW. If no additional options are installed, this is the only available input source.

Since the Digital I/Q input and the Analog Baseband input use the same digital signal path, both cannot be used simultaneously. When one is activated, established connections for the other are disconnected. When the second input is deactivated, connections to the first are re-established. This may cause a short delay in data transfer after switching the input source.

Radio Frequency Input

Access: "Overview" > "Input/Frontend" > "Input Source" > "Radio Frequency"



Radio Frequency State

Activates input from the RF INPUT connector.

Remote command:

`INPut:SELect` on page 221

Input Coupling

The RF input of the R&S FSW can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 219

Impedance

For some measurements, the reference impedance for the measured levels of the R&S FSW can be set to 50 Ω or 75 Ω.

Select 75 Ω if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type. (That corresponds to 25Ω in series to the input impedance of the instrument.) The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Remote command:
`INPut:IMPedance` on page 221

Direct Path

Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be deactivated. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

"Auto"	(Default) The direct path is used automatically for frequencies close to zero.
"Off"	The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 220

High-Pass Filter 1...3 GHz

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Remote command:
INPut:FILTer:HPASs[:STATe] on page 220

YIG-Preselector
Activates or deactivates the YIG-preselector, if available on the R&S FSW.

An internal YIG-preselector at the input of the R&S FSW ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. To use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSW, which can lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Note:
For the following measurements, the YIG-Preselector is off by default (if available).

- I/Q Analyzer (and thus in all slave applications in MSRA operating mode)
- Multi-Carrier Group Delay
- GSM
- VSA

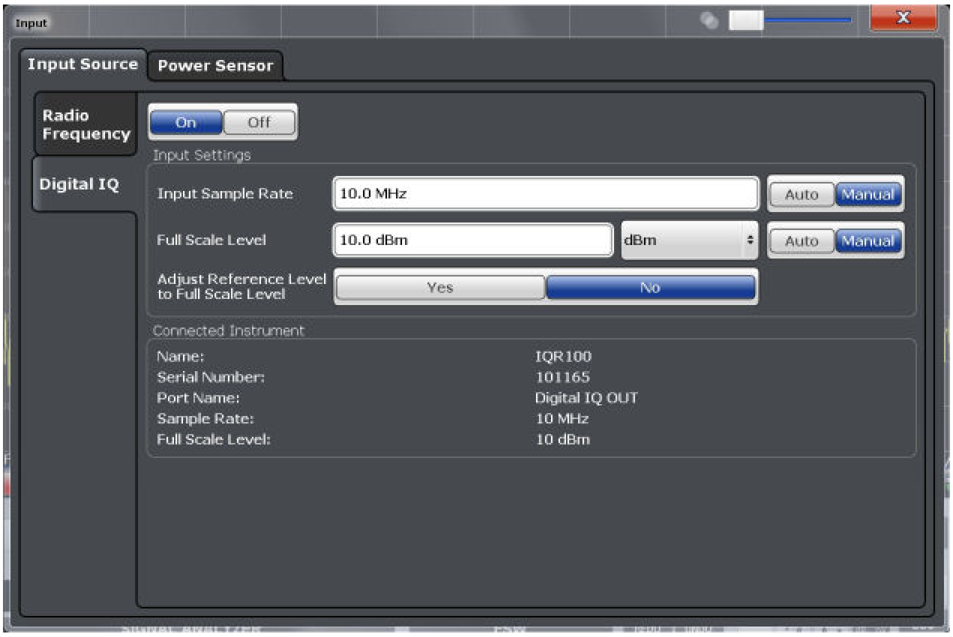
Remote command:
INPut:FILTer:YIG[:STATe] on page 221

Digital I/Q Input Settings

Access: INPUT/OUTPUT > "Input Source Config" > "Digital I/Q" tab

The following settings and functions are available to provide input via the optional Digital Baseband Interface in the applications that support it.

These settings are only available if the Digital Baseband Interface option is installed on the R&S FSW.



For more information, see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Digital I/Q Input State

Enables or disable the use of the "Digital IQ" input source for measurements.

"Digital IQ" is only available if the optional Digital Baseband Interface is installed.

Remote command:
`INPut:SELect` on page 221

Input Sample Rate

Defines the sample rate of the digital I/Q signal source. This sample rate must correspond with the sample rate provided by the connected device, e.g. a generator.

If "Auto" is selected, the sample rate is adjusted automatically by the connected device.

The allowed range is from 100 Hz to 10 GHz.

Remote command:
`INPut:DIQ:SRATe` on page 225
`INPut:DIQ:SRATe:AUTO` on page 225

Full Scale Level

The "Full Scale Level" defines the level and unit that should correspond to an I/Q sample with the magnitude "1".

If "Auto" is selected, the level is automatically set to the value provided by the connected device.

Remote command:
INPut:DIQ:RANGe[:UPPer] on page 225
INPut:DIQ:RANGe[:UPPer]:UNIT on page 225
INPut:DIQ:RANGe[:UPPer]:AUTO on page 224

Adjust Reference Level to Full Scale Level
If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

Remote command:
INPut:DIQ:RANGe:COUPling on page 224

Connected Instrument
Displays the status of the Digital Baseband Interface connection.

If an instrument is connected, the following information is displayed:

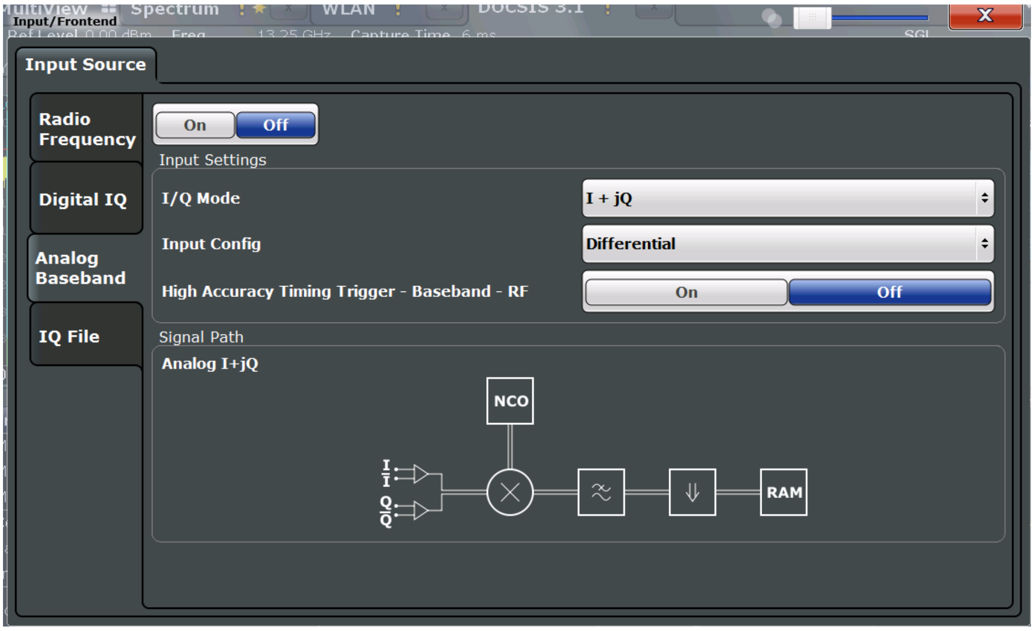
- Name and serial number of the instrument connected to the Digital Baseband Interface
- Used port
- Sample rate of the data currently being transferred via the Digital Baseband Interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1" (Full Scale Level), if provided by connected instrument

Remote command:
INPut:DIQ:CDEVice on page 223

Analog Baseband Input Settings

Access: INPUT/OUTPUT > "Input Source Config" > "Analog Baseband" tab

The following settings and functions are available to provide input via the optional Analog Baseband Interface in the applications that support it.



For more information on the optional Analog Baseband Interface, see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Analog Baseband Input State

Enables or disable the use of the "Analog Baseband" input source for measurements. "Analog Baseband" is only available if the optional Analog Baseband Interface is installed.

Remote command:
`INPut:SELect` on page 221

I/Q Mode

Defines the format of the input signal.

"I + jQ" The input signal is filtered and resampled to the sample rate of the application.
Two inputs are required for a complex signal, one for the in-phase component, and one for the quadrature component.

"I Only / Low IF I"
The input signal at the BASEBAND INPUT I connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband I**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF I**).

"Q Only / Low IF Q"
The input signal at the BASEBAND INPUT Q connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband Q**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF Q**).

Remote command:
`INPut:IQ:TYPE` on page 227

Input Configuration

Defines whether the input is provided as a differential signal via all four Analog Baseband connectors or as a plain I/Q signal via two simple-ended lines.

Note: Both single-ended and differential probes are supported as input; however, since only one connector is occupied by a probe, the "Single-ended" setting must be used for all probes.

"Single Ended" I, Q data only

"Differential" I, Q and inverse I,Q data
(Not available for R&S FSW85)

Remote command:
INPut:IQ:BALanced[:STATe] on page 226

High Accuracy Timing Trigger - Baseband - RF
Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

Note: Prerequisites for previous models of R&S FSW.
For R&S FSW models with a serial number lower than 103000, special prerequisites and restrictions apply for high accuracy timing:

- To obtain this high timing precision, trigger port 1 and port 2 must be connected via the Cable for High Accuracy Timing (order number 1325.3777.00).
- As trigger port 1 and port 2 are connected via the cable, only trigger port 3 can be used to trigger a measurement.
- Trigger port 2 is configured as output if the high accuracy timing option is active. Make sure not to activate this option if you use trigger port 2 in your measurement setup.
- When you first enable this setting, you are prompted to connect the cable for high accuracy timing to trigger ports 1 and 2. If you cancel this prompt, the setting remains disabled. As soon as you confirm this prompt, the cable must be in place - the firmware does not check the connection. (In remote operation, the setting is activated without a prompt.)

For more information, see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:
CALibration:AIQ:HATiming[:STATe] on page 227

Center Frequency
Defines the center frequency for analog baseband input.

For real-type baseband input (I or Q only), the center frequency is always 0 Hz.

Note: If the analysis bandwidth to either side of the defined center frequency exceeds the minimum frequency (0 Hz) or the maximum frequency (40 MHz/80 MHz), an error is displayed. In this case, adjust the center frequency or the analysis bandwidth.

Remote command:
[SENSe:]FREQuency:CENTer on page 232

Probe Settings

Probes are configured in a separate tab on the "Input" dialog box which is displayed when you select the INPUT/OUTPUT key and then "Input Source Config".

For each possible probe connector (Baseband Input I, Baseband Input Q), the detected type of probe, if any, is displayed. The following information is provided for each connected probe:

- Probe name
- Serial number
- R&S part number
- Type of probe ("Differential", "Single Ended")

For general information on the R&S®RTO probes, see the device manuals.

Common Mode Offset

Sets the common mode offset. The setting is only available if a differential probe is connected to the R&S FSW.

If the probe is disconnected, the common mode offset of the probe is reset to 0.0 V.

Remote command:
`[SENSe:]PROBe<p>:SETup:CMOFfset` on page 228

Microbutton Action

Active R&S probes (except for RT-ZS10E) have a configurable microbutton on the probe head. By pressing this button, you can perform an action on the instrument directly from the probe.

Select the action that you want to start from the probe:

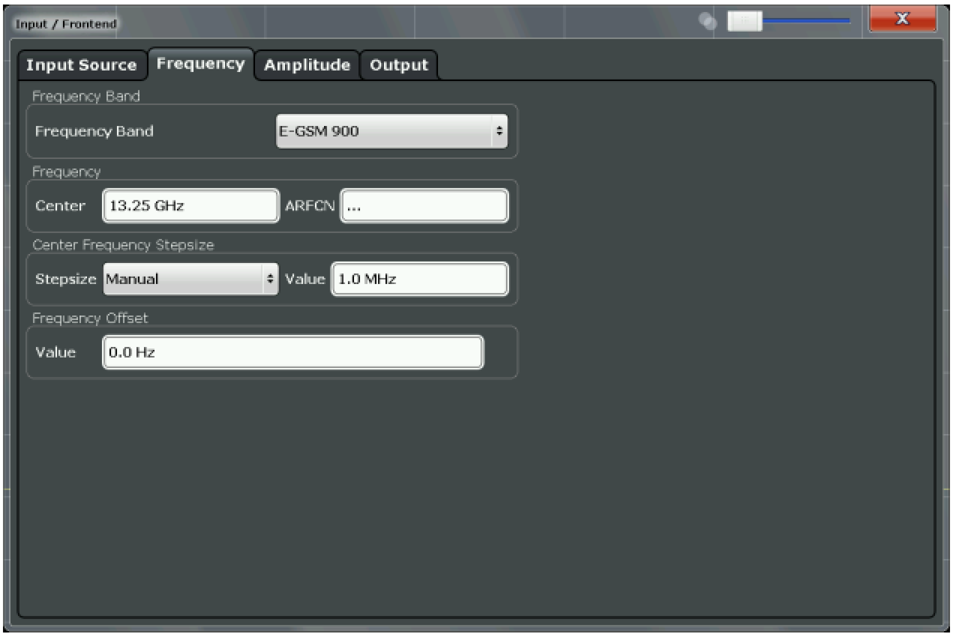
"Run single" Starts one data acquisition.

"No action" Prevents unwanted actions due to unintended usage of the microbutton.

Remote command:
`[SENSe:]PROBe<p>:SETup:MODE` on page 229

6.3.3.2 Frequency Settings

Access: "Overview" > "Input/Frontend" > "Frequency"



Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 46.

The following frequency bands are supported:

- DCS 1800
- E-GSM 900
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- GSM 850
- PCS 1900
- P-GSM 900
- R-GSM 900
- T-GSM 380
- T-GSM 410
- T-GSM 810
- T-GSM 900

The default frequency band is "E-GSM 900".

Remote command:

`CONFigure[:MS]:NETWork[:TYPE]` on page 204

`CONFigure[:MS]:NETWork:FREQuency:BAND` on page 205

Center Frequency

Specifies the center frequency of the signal to be measured (typically the center of the Tx band).

If the frequency is modified, the "ARFCN" is updated accordingly (for I/Q measurements, see ARFCN).

Remote command:
`[SENSe:]FREQuency:CENTer` on page 232

ARFCN

Defines the Absolute Radio Frequency Channel Number (ARFCN). The "Center Frequency" on page 110 is adapted accordingly.

Possible values are in the range from 0 to 1023; however, some values may not be allowed depending on the selected Frequency Band.

Remote command:
`CONFigure[:MS]:ARFCn` on page 232

Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased using the arrow keys.

When you use the rotary knob the center frequency changes in steps of only 1/10 of the span.

The step size can be coupled to another value or it can be manually set to a fixed value.

"X * Span"	Sets the step size for the center frequency to a defined factor of the span. The "X-Factor" defines the percentage of the span. Values between 1 % and 100 % in steps of 1 % are allowed. The default setting is 10 %. This setting is only available for MCWN measurements.
"= Center"	Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.
"Manual"	Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP` on page 233

Frequency Offset

Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, or on the captured data or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies, but not if it shows frequencies relative to the signal's center frequency.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

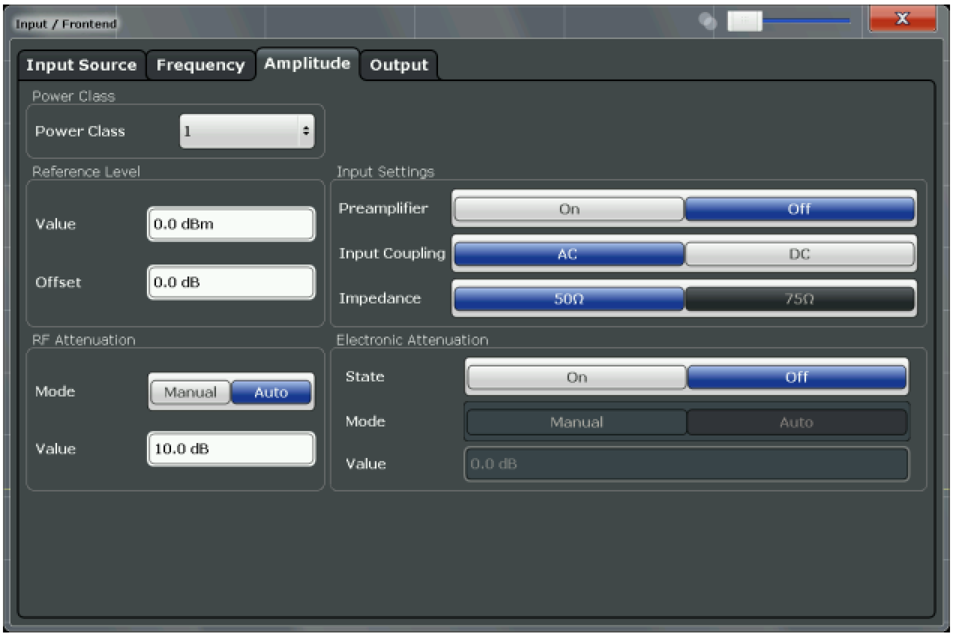
Note: In MSRA/MSRT mode, this function is only available for the MSRA/MSRT Master.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 233

6.3.3.3 Amplitude Settings

Access: "Overview" > "Input/Frontend" > "Amplitude"

Amplitude settings affect the y-axis values.



Power Class

The following power classes are supported:

(For MCWN measurements no power class is used: "NONE".)

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
`CONFigure[:MS]:POWer:CLASs` on page 206

Reference Level
Defines the expected maximum input signal level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

The reference level can also be used to scale power diagrams; the reference level is then used as the maximum on the y-axis.

Since the hardware of the R&S FSW is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level. Thus you ensure an optimum measurement (no compression, good signal-to-noise ratio).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 234

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the R&S FSW so the application shows correct power results. All displayed power level results are shifted by this value.

The setting range is ±200 dB in 0.01 dB steps.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S FSW must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 235

Mechanical Attenuation
Defines the mechanical attenuation for RF input.

Attenuation Mode / Value ← Mechanical Attenuation
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that no overload occurs at the RF INPUT connector for the current reference level. It is the default setting.

By default and when no (optional) electronic attenuation is available, mechanical attenuation is applied.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload may lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 236
`INPut:ATTenuation:AUTO` on page 236

Using Electronic Attenuation
If the (optional) Electronic Attenuation hardware is installed on the R&S FSW, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) > 13.6 GHz.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation may provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation can be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

Both the electronic and the mechanical attenuation can be varied in 1 dB steps. Other entries are rounded to the next lower integer value.

For the R&S FSW85, the mechanical attenuation can be varied only in 10 dB steps.

If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed in the status bar.

Remote command:
`INPut:EATT:STATe` on page 237
`INPut:EATT:AUTO` on page 237
`INPut:EATT` on page 237

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

For details see Chapter 6.3.3.1, "Input Source Settings", on page 100.

Preamplifier ← Input Settings
If the (optional) Preamplifier hardware is installed, a preamplifier can be activated for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low output power.

For R&S FSW26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW8 or 13 models, the following settings are available:

"Off"	Deactivates the preamplifier.
"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 235
`INPut:GAIN[:VALue]` on page 235

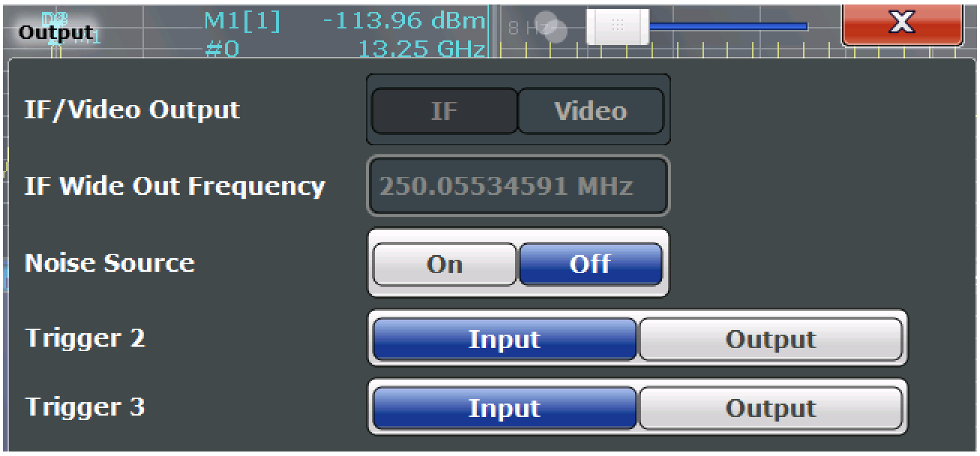
6.3.3.4 Output Settings

Access: INPUT/OUTPUT > "Output"

The R&S FSW can provide output to special connectors for other devices.

For details on connectors, refer to the R&S FSW Getting Started manual, "Front / Rear Panel View" chapters.

How to provide trigger signals as output is described in detail in the R&S FSW User Manual.



IF/VIDEO/DEMOD Output
This function is not available for the R&S FSW GSM application.

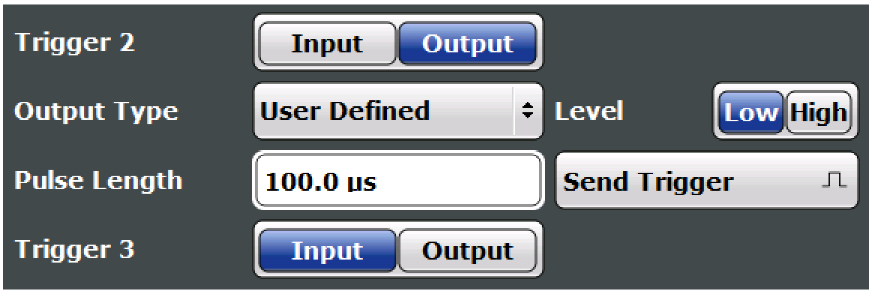
IF Out Frequency
This function is not available for the R&S FSW GSM application.

Noise Source
This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSW on and off.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSW itself, for example when measuring the noise level of a DUT.

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 231

Trigger 2/3



Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSW sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:DIRection` on page 243

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSW triggers.

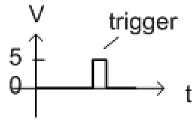
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when you select the "Send Trigger" button.
In this case, further parameters are available for the output signal.

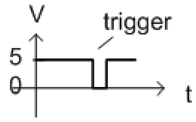
Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 244

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level = High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



low-level constant,
high-level trigger



high-level constant,
low-level trigger

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 243

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 245

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

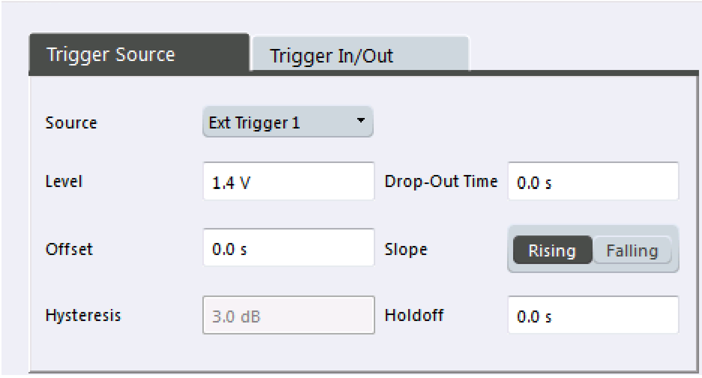
Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 244

6.3.4 Trigger Settings

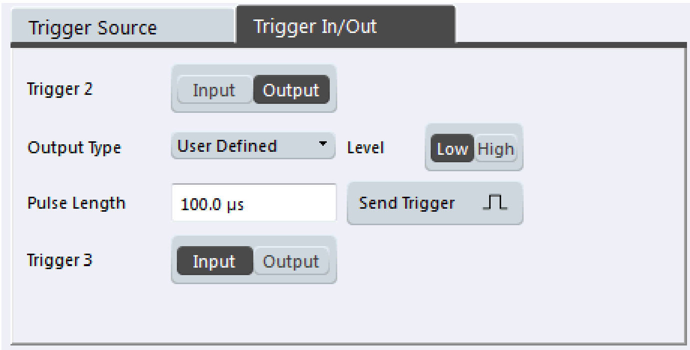
Access: "Overview" > "Trigger"

or: TRIG > "Trigger Config"

Trigger settings determine when the input signal is measured. Which settings are available depends on the R&S FSW.



External triggers from one of the TRIGGER INPUT/OUTPUT connectors on the R&S FSW are configured in a separate tab of the dialog box.



Trigger Source

Selects the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

For gated measurements, this setting also selects the gating source.

Remote command:
TRIGger[:SEQuence]:SOURce on page 242

Free Run ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
TRIG:SOUR IMM, see TRIGger[:SEQuence]:SOURce on page 242

External Trigger 1/2/3 ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

(See "Trigger Level" on page 119).

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT connector on the front panel.

For details, see the "Instrument Tour" chapter in the R&S FSW Getting Started manual.

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT connector.

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 115).

"External Trigger 3"
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector on the rear panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 115).

Remote command:
TRIG:SOUR EXT, TRIG:SOUR EXT2
TRIG:SOUR EXT3
See TRIGger[:SEQuence]:SOURce on page 242

I/Q Power ← Trigger Source
This trigger source is not available if the optional Digital Baseband Interface or optional Analog Baseband Interface is used for input. It is also not available for analysis bandwidths ≥ 160 MHz.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

Remote command:
TRIG:SOUR IQP, see TRIGger[:SEQuence]:SOURce on page 242

RF Power ← Trigger Source
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose, the instrument uses a level detector at the first intermediate frequency.

The input signal must be in the frequency range between 500 MHz and 8 GHz.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels, see the instrument's data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement may be aborted. A message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 242

Power Sensor ← Trigger Source
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

Note: For R&S power sensors, the "Gate Mode" *Lvl* is not supported. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed.

Remote command:
`TRIG:SOUR PSE`, see `TRIGger[:SEQuence]:SOURce` on page 242

Time ← Trigger Source
Triggers in a specified repetition interval.

Remote command:
`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 242

Trigger Level
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the data sheet.

Remote command:
`TRIGger[:SEQuence]:LEVel:IFPower` on page 240
`TRIGger[:SEQuence]:LEVel:IQPower` on page 241
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 240
`TRIGger[:SEQuence]:LEVel:RFPower` on page 241

Drop-Out Time
Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 239

Trigger Offset
Defines the time offset between the trigger event and the start of the measurement.

Note: When using an external trigger, the trigger offset is particularly important to detect the frame start correctly! (See Chapter 5.5, "Trigger settings", on page 51.) The R&S FSW GSM application expects the trigger event to be the start of the "active part" in slot 0.

Offset > 0:	Start of the measurement is delayed
Offset < 0:	Measurement starts earlier (pretrigger)

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 239

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

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

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 239

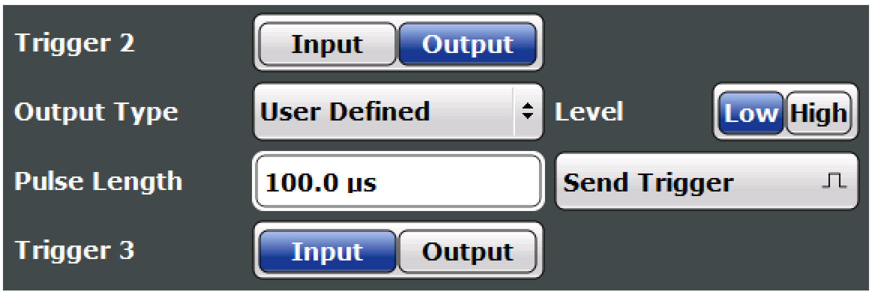
Trigger Holdoff
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 239

Slope
For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 242

Trigger 2/3



Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSW sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:DIRection` on page 243

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSW triggers.

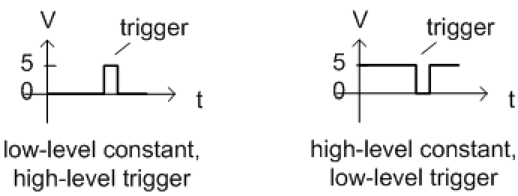
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when you select the "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 244

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level = High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 243

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 245

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 244

6.3.5 Data Acquisition

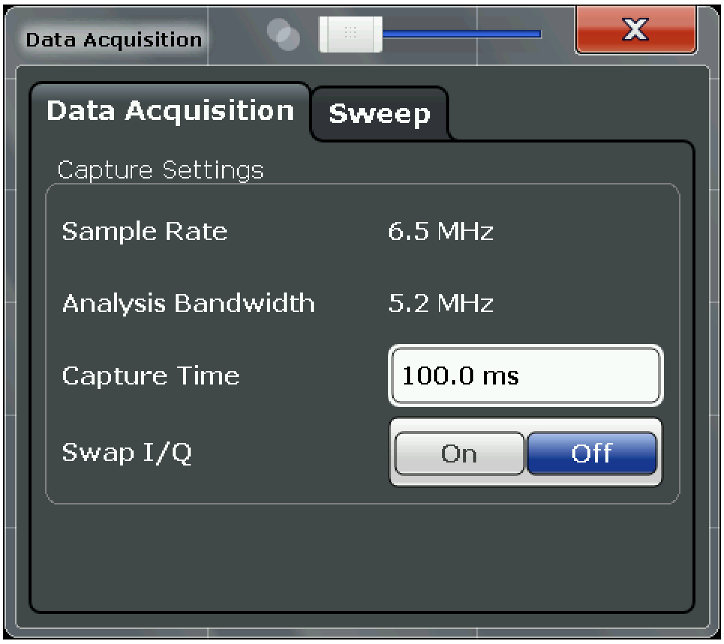
Access: "Overview" > "Data Acquisition"

You must define how much and how often data is captured from the input signal.

6.3.5.1 Data Acquisition

Access: "Overview" > "Data Acquisition" > "Data Acquisition"

The "Data Acquisition" settings define how long data is captured from the input signal by the R&S FSW GSM application.



Sample rate

The sample rate for I/Q data acquisition is indicated for reference only. It is a fixed value, depending on the frequency range to be measured (see also Chapter 6.3.7.2, "Spectrum", on page 133).

Remote command:
`TRACe:IQ:SRATe?` on page 247

Analysis Bandwidth

The analysis bandwidth is indicated for reference only. It defines the flat, usable bandwidth of the final I/Q data. This value is dependent on the Frequency list and the defined signal source.

The following rule applies:

*analysis bandwidth = 0.8 * sample rate*

Note: MSRA operating mode. In MSRA operating mode, the MSRA Master is restricted to an input sample rate of 200 MHz.

Remote command:
`TRACe:IQ:BWIDth?` on page 247

Capture Time

Specifies the duration (and therefore the amount of data) to be captured in the capture buffer.

The capture time can be defined automatically or manually.

If **Auto mode** is enabled, the optimal capture time is determined according to the Sample rate and Analysis Bandwidth.

In **Manual mode** be sure to define a sufficiently long capture time. If the capture time is too short, demodulation will fail.

Note: The duration of one GSM slot equals 15/26 ms = 0.576923 ms. The duration of one GSM frame (8 slots) equals 60/13 ms = 4.615384 ms.

Tip: In order to improve the measurement speed further by using short capture times, consider the following:

- Use an external trigger which indicates the frame start. In this case, the minimum allowed capture time is reduced from 10 ms to 866 us (see Chapter 5.5, "Trigger settings", on page 51)
- Measure only slots at the beginning of the frame, directly after the trigger (see Chapter 6.3.6.1, "Slot Scope", on page 127)
- Use a small statistic count (see "Statistic Count" on page 125)

Note: MSRA operating mode.

In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The "Capture Time" for the R&S FSW GSM application in MSRA mode defines the length of the **application data extract** (see also Chapter 5.17, "GSM in MSRA Operating Mode", on page 81).

For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

The "Capture Time" can also be defined using the softkey which is available from the SPAN, BW or SWEEP menus.

Remote command:
`[SENSe:]SWEep:TIME` on page 246
`[SENSe:]SWEep:TIME:AUTO` on page 246

Capture Offset

This setting is only available for slave applications in **MSRA/MSRT operating mode**. It has a similar effect as the trigger offset in other measurements: it defines the time offset between the capture buffer start and the start of the extracted slave application data.

In MSRA mode, the offset must be a positive value, as the capture buffer starts at the trigger time = 0.

For details on the MSRA operating mode, see the R&S FSW MSRA User Manual.

For details on the MSRT operating mode, see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

Remote command:
`[SENSe:]MSRA:CAPTure:OFFSet` on page 294

Swap I/Q

Activates or deactivates the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the R&S FSW can do the same to compensate for it.

Tip: Try this function if the TSC cannot be found.

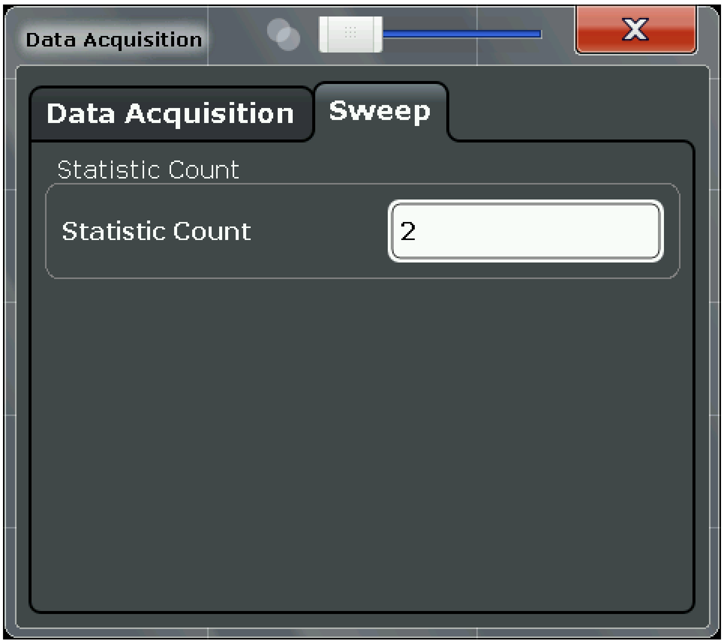
On	I and Q signals are interchanged Inverted sideband, Q+j*I
Off	I and Q signals are not interchanged Normal sideband, I+j*Q

Remote command:
`[SENSe:]SWAPiq` on page 245

6.3.5.2 Sweep

Access: SWEEP

The "Sweep" settings define how often data is captured from the input signal by the R&S FSW GSM application.



Statistic Count

Defines the number of frames to be included in statistical evaluations. For measurements on the Slot to Measure, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count", for statistical evaluations.

The default value is 200 in accordance with the GSM standard.

For details on the impact of this value, see Chapter 5.14, "Impact of the "Statistic Count"", on page 69.

Remote command:
`[SENSe:]SWEep:COUNt` on page 252

Continuous Sweep/RUN CONT

While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 249

Single Sweep/ RUN SINGLE
While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

Remote command:
`INITiate<n>[:IMMediate]` on page 250

Continue Single Sweep
While the measurement is running, the "Continue Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
`INITiate<n>:CONMeas` on page 248

Refresh (MSRA/MSRT only)
This function is only available if the Sequencer is deactivated and only for **MSRA/ MSRT slave applications**.

The data in the capture buffer is re-evaluated by the currently active slave application only. The results for any other slave applications remain unchanged.

This is useful, for example, after evaluation changes have been made or if a new sweep was performed from another slave application; in this case, only that slave application is updated automatically after data acquisition.

Note: To update all active slave applications at once, use the "Refresh all" function in the "Sequencer" menu.

Remote command:
`INITiate<n>:REFResh` on page 294

6.3.6 Demodulation

Access: "Overview" > "Demodulation"

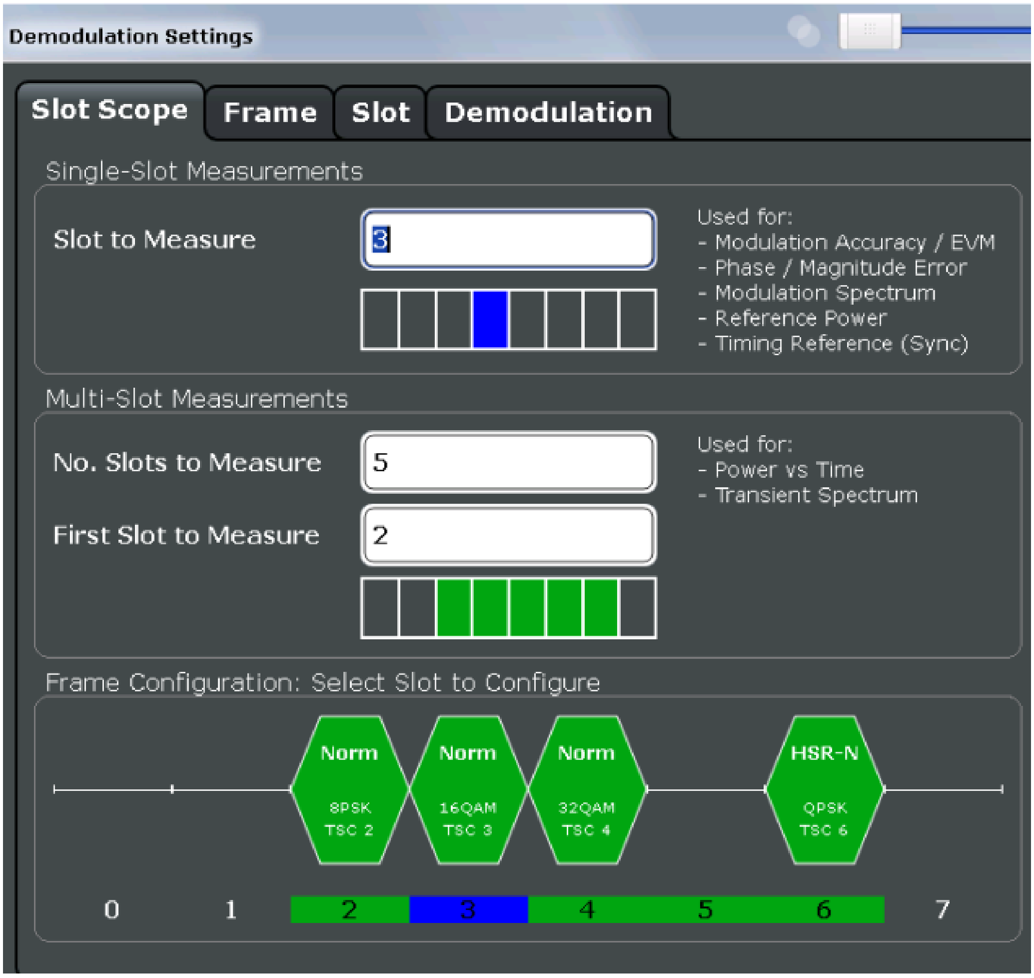
Demodulation settings determine how frames and slots are detected in the input signal and which slots are to be evaluated.

The "Frame" and "Slot" settings are identical to those in the "Signal Description" dialog box, see Chapter 6.3.2.2, "Frame", on page 91 and Chapter 6.3.2.3, "Slot Settings", on page 94.

6.3.6.1 Slot Scope

Access: "Overview" > "Demodulation" > "Slot Scope"

The slot scope defines which slots are to be evaluated (see also Chapter 5.6, "Defining the Scope of the Measurement", on page 52).



Slot to Measure

This parameter specifies the slot to be measured in single-slot measurements relative to the GSM frame boundary. The following rule applies:

0 ≤ Slot to Measure ≤ 7

The "Slot to Measure" is used as the (only) slot to measure in the following measurements: (see "First Slot to measure" on page 128)

- Modulation Accuracy
- EVM
- Phase Error
- Magnitude Error
- Modulation Spectrum
- Constellation

Furthermore, the "Slot to Measure" is used to measure the reference power for the following measurements:

- Power vs Time
- Modulation Spectrum
- Transient Spectrum

Finally, the "Slot to Measure" is used to measure the position of its TSC, which represents the timing reference for the Power vs Time mask (limit lines) of all slots.

See also Chapter 5.6, "Defining the Scope of the Measurement", on page 52. For details on the measurement types see Chapter 4.1, "GSM I/Q Measurement Results", on page 17.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:MEASure` on page 253

Number of Slots to measure

This parameter specifies the "Number of Slots to measure" for the measurement interval of multi-slot measurements, i.e. the Power vs Time and Transient Spectrum measurements. Between 1 and 8 consecutive slots can be measured.

See also Chapter 5.6, "Defining the Scope of the Measurement", on page 52.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:NOFSlots` on page 254

First Slot to measure

This parameter specifies the start of the measurement interval for multi-slot measurements, i.e. Power vs Time and Transient Spectrum measurements, relative to the GSM frame boundary. The following conditions apply:

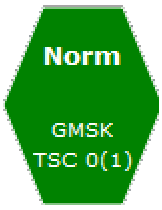
- First Slot to measure ≤ Slot to Measure
- Slot to Measure ≤ First Slot to measure + Number of Slots to measure -1

See also Chapter 5.6, "Defining the Scope of the Measurement", on page 52.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:OFFSet` on page 254

Frame Configuration: Select Slot to Configure

This area shows a graphical representation of the configuration of each slot. Select a slot to display its "Slot" dialog box (see Chapter 6.3.2.3, "Slot Settings", on page 94).



For active slots the following information is shown:

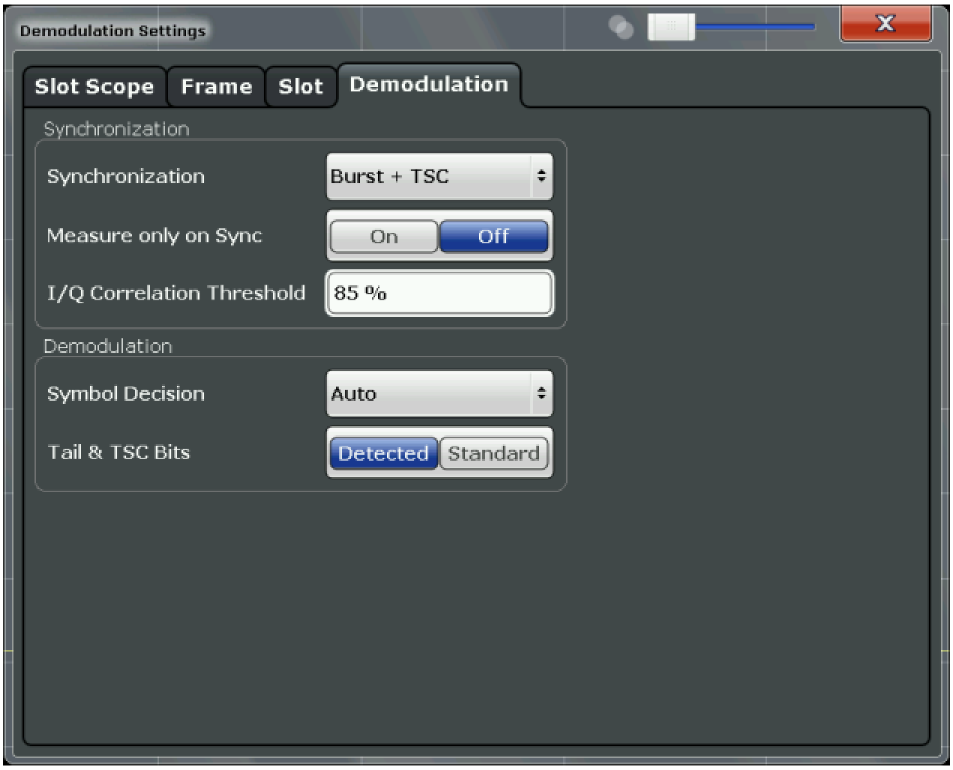
- The burst type, e.g. "Normal (NB)" for a normal burst.
- The modulation, e.g. GMSK.
- The training sequence TSC (and Set)

For details on how to interpret the graphic, see "Frame configuration and slot scope in the channel bar" on page 53.

6.3.6.2 Demodulation Settings

Access: "Overview" > "Demodulation" > "Demodulation"

The demodulation settings provide additional information to optimize frame, slot and symbol detection.



Synchronization

Sets the synchronization mode of the R&S FSW GSM application.

"Burst+TSC" First search for the power profile (burst search) according to the frame configuration in the capture buffer. Second, inside the found bursts search for the TSC of the Slot to Measure as given in the frame configuration. "Burst +TSC" is usually faster than "TSC" for bursted signals.

"TSC" Search the capture buffer for the TSC of the Slot to Measure as given in the frame configuration. This mode corresponds to a correlation with the given TSC. This mode can be used for continuous (but framed) signals or bursted signals.

"Burst" Search for the power profile (burst search) according to the frame configuration in the capture buffer.
Note: For "Burst" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

"None" Do not synchronize at all. If an external or power trigger is chosen, the trigger instant corresponds to the frame start.
Tip: Manually adjust the trigger offset to move the burst to be analyzed under the mask in the "Power vs Time" measurement.
Note: For "None" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

Remote command:
`CONFigure[:MS]:SYNC:MODE` on page 254

Measure only on Sync

If activated (default), only results from frames (slots) where the Slot to Measure was found are displayed and taken into account in the averaging of the results. The behavior of this option depends on the value of the Synchronization parameter.

Remote command:
`CONFigure[:MS]:SYNC:ONLY` on page 255

I/Q Correlation Threshold

This threshold determines whether a burst is accepted if Measure only on Sync is activated. If the correlation value between the ideal I/Q signal of the given TSC and the measured TSC is below the I/Q correlation threshold, then the application reports "Sync not found" in the status bar. Additionally, such bursts are ignored if "Measure only on Sync" is activated.

Note: If the R&S FSW GSM application is configured to measure GMSK normal bursts, a threshold below 97% will also accept 8PSK normal bursts (with the same TSC) for analysis. In this case, activate Measure only on Sync and set the "I/Q Correlation Threshold" to 97%. This will exclude the 8PSK normal bursts from the analysis.

Remote command:
`CONFigure[:MS]:SYNC:IQCThreshold` on page 256

Symbol Decision

The symbol decision determines how the symbols are detected in the demodulator. Setting this parameter does not affect the demodulation of normal bursts with GMSK modulator. For normal bursts with 8PSK, 16QAM, 32QAM or AQPSK modulation, or higher symbol rate bursts with QPSK, 16QAM or 32QAM modulation, use this parameter to get a trade-off between performance (symbol error rate of the R&S FSW GSM application) and measurement speed.

"Auto" Automatically selects the symbol decision method.

"Linear" Linear symbol decision: Uses inverse filtering (a kind of zero-forcing filter) and a symbol-wise decision method. This method is recommended for high symbol to noise ratios, but not for higher symbol rate bursts with a narrow pulse. The inverse filter colors the noise inside the signal bandwidth and therefore is not recommended for narrowband signals or signals with a low signal to noise ratio. Peaks in the "EVM vs Time" measurement (see "EVM" on page 18) may occur if the "Linear" symbol decision algorithm fails. In that case use the "Sequence" method. Linear is the fastest option.

"Sequence" Symbol decision via sequence estimation. This method uses an algorithm that minimizes the symbol errors of the entire burst. It requires that the tail bits in the analyzed signal are correct. It has a better performance (lower symbol error rate) compared to the "Linear" method, especially at low signal to noise ratios, but with a loss of measurement speed. This method is recommended for normal bursts with 16QAM or 32QAM modulation and for Higher Symbol Rate bursts with a narrow pulse.
Tip: Use this setting if it reduces the EVM RMS measurement result.

Remote command:
`CONFigure[:MS]:DEMod:DECision` on page 256

Tail & TSC Bits

The demodulator in the R&S FSW GSM application requires the bits of the burst (tail, data, TSC, data, tail) to provide an ideal version of the measured signal. The "data" bits can be random and are typically not known inside the demodulator of the R&S FSW GSM application. "tail" and "TSC" bits are specified in the "Slot" dialog box (see "Training Sequence TSC / Sync" on page 97).

"Detected" The detected Tail and TSC bits are used to construct the ideal signal.

"Standard" The standard tail and TSC bits (as set in the "Slot" dialog box) are used to construct the ideal signal.
Using the standard bits can be advantageous to verify whether the device under test sends the correct tail and TSC bits. Incorrect bits would lead to peaks in the "EVM vs Time" trace (see "EVM" on page 18) at the positions of the incorrect bits.

Remote command:
`CONFigure[:MS]:DEMod:STDBits` on page 257

6.3.7 Measurement Settings

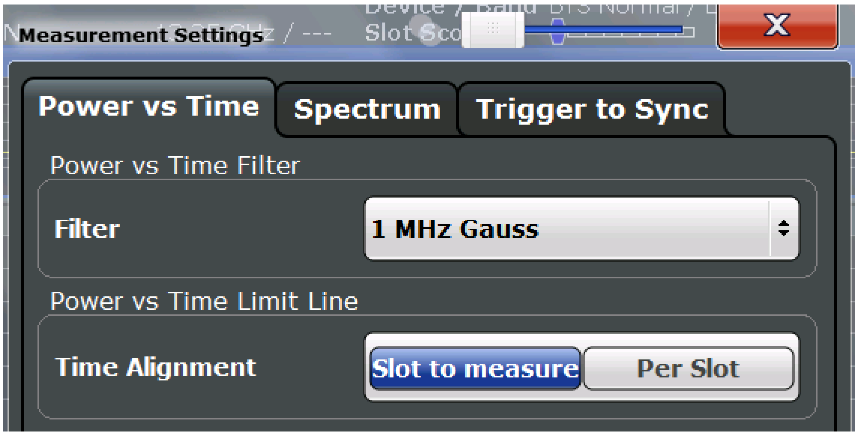
Access: "Overview" > "Measurement"

Measurement settings define how power or spectrum measurements are performed.

6.3.7.1 Power vs Time

Access: "Overview" > "Measurement" > "Power vs Time"

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see Chapter 5.7.1, "Power vs Time Filter", on page 55). A limit line is available to determine if the power exceeds the limits defined by the standard in each slot.



Power vs Time Filter
The PvT filter controls the filter used to reduced the measurement bandwidth in "Power vs Time" measurements.

Note: The PvT filter is optimized to get smooth edges after filtering burst signals and to suppress adjacent, active channels.

Depending on the Device Type (single carrier or multicarrier), different PvT filters are supported:

"1 MHz Gauss"
default for single carrier device

"600 kHz"
(single carrier only) for backwards compatibility to FS-K5

"500 kHz Gauss"
(single carrier only) for backwards compatibility to FS-K5

"400 kHz (multicarrier)"
(default for multicarrier device) Recommended for measurements with multi channels of equal power.

"300 kHz (multicarrier)"
Recommended for multicarrier measurement scenarios where a total of six channels is active and the channel to be measured has a reduced power (e.g. 30 dB) compared to its adjacent channels.

Remote command:
`CONFigure:BURSt:PTEMplate:FILTer` on page 258

Limit Line Time Alignment
Controls how the limit lines are aligned in a "Power vs Time" measurement graph (see "PvT Full Burst" on page 28). Limit lines are defined for each slot. The limit lines are time-aligned in each slot, based on the position of the TSC (the center of the TSC is the reference point). This parameter affects how the center of the TSC is determined for each slot:

- **Slot to measure** (default): For each slot the center of the TSC is derived from the measured center of the TSC of the Slot to Measure and the timeslot lengths specified in the standard (see "Timeslot length" in 3GPP TS 45.010 and "Equal Timeslot Length" on page 93).
- **Per Slot**: For each slot the center of the TSC is measured. This provides reasonable time-alignment if the slot lengths are not according to standard. Note that in this case the "Power vs Time" limit check may show "pass" even if the timeslot lengths are not correct according to the standard.

Note: The "Limit Time Alignment" also decides whether the "Delta to sync" values of the "Power vs Time" list result are measured (for "Limit Time Alignment" = "Per Slot") or if they are constant as defined by the 3PP standard (for "Limit Time Alignment" = "Slot to measure").

The R&S FSW GSM application offers a strictly standard-conformant, multiple-slot PvT limit line check. This is based on time alignment to a single specified slot (the "Slot to Measure") and allows the user to check for correct BTS timeslot alignment in the DUT, according to the GSM standard. In addition, a less stringent test which performs PvT limit line alignment on a per-slot basis ("Per Slot") is also available.

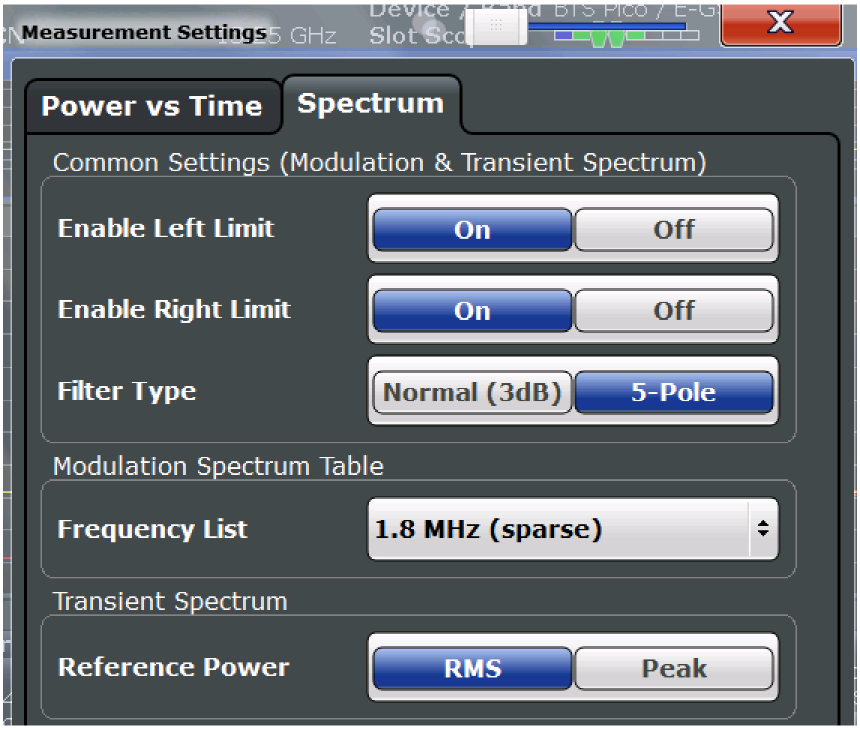
Note:
When measuring access bursts the parameter "Limit Time Alignment" should be set to "Per Slot", since the position of an access burst within a slot depends on the set timing advance of the DUT.

Remote command:
`CONFigure:BURSt:PTEMplate:TALign` on page 259

6.3.7.2 Spectrum

Access: "Overview" > "Measurement" > "Spectrum"

The modulation and transient spectrum measurements allow for further configuration.



Enable Left Limit/ Enable Right Limit

Controls whether the results for the frequencies to the left or to the right of the center frequency, or both, are considered in the limit check of the spectrum trace (spectrum graph measurement). This parameter affects the "Modulation Spectrum Graph" on page 23 and "Transient Spectrum Graph" on page 29 measurements.

Note: For measurements on multicarrier signals, using either the check on the left or right side only allows you to measure the spectrum of the left or right-most channel while ignoring the side where adjacent channels are located.

Remote command:

`CONFigure:SPECtrum:LIMit:LEFT` on page 260

`CONFigure:SPECtrum:LIMit:RIGHt` on page 260

Filter Type

Defines the filter type for the resolution filter for the "Modulation Spectrum" and "Transient Spectrum" measurements.

"Normal" 3 dB Gauss filter

"5-pole" according to the GSM standard

Remote command:

`[SENSe:]BANDwidth[:RESolution]:TYPE` on page 262

Modulation Spectrum Table: Frequency List

This setting is only required by the "Modulation Spectrum Table" evaluation (see "Modulation Spectrum Table" on page 24). In this evaluation, the spectrum of the signal at fixed frequency offsets is determined. The list of frequencies to be measured is defined by the standard. Additionally, sparse versions of the specified frequency lists with fewer intermediate frequencies are provided for quicker preliminary tests.

Note: Modulation RBW at 1800 kHz.
As opposed to previous R&S signal and spectrum analyzers, in which the modulation RBW at 1800 kHz was configurable, the R&S FSW configures the RBW (and VBW) internally according to the selected frequency list (see "Modulation Spectrum Table: Frequency List" on page 135). For the "Modulation Spectrum Graph" both the RBW and VBW are set to 30 kHz. For the "Modulation Spectrum Table", they are set according to Table 4-6.

The frequency list also determines the used sample rate, see "Sample rate" on page 123).

"1.8 MHz"	The frequency list comprises offset frequencies up to 1.8 MHz from the carrier. The sample rate is 6.5 MHz. In previous R&S signal and spectrum analyzers, this setting was referred to as "narrow".
"1.8 MHz (sparse)"	More compact version of "1.8 MHz". The sample rate is 6.5 MHz.
"6 MHz"	The frequency list comprises offset frequencies up to 6 MHz from the carrier. The sample rate is 19.5 MHz. In previous R&S signal and spectrum analyzers, this setting was referred to as "wide".
"6 MHz (sparse)"	More compact version of "6 MHz". The sample rate is 19.5 MHz.

Remote command:
`CONFigure:WSPectrum:MODulation:LIST:SELect` on page 262

Transient Spectrum: Reference Power

This setting is only required by the "Transient Spectrum" evaluation (see Transient Spectrum Graph).

In this evaluation, the power vs spectrum for all slots in the slot scope is evaluated and checked against a spectrum mask. To determine the relative limit values, a reference power is required. In order to detect irregularities, it is useful to define the peak power as a reference. However, the standard requires the reference power to be calculated from the RMS power.

To perform the measurement according to the 3GPP standard set the reference power to RMS and the Slot to Measure to the slot with the highest power (see also "Transient Spectrum Table" on page 30).

"RMS"	(Default:) The reference power is the RMS power level measured over the useful part of the Slot to Measure and averaged according to the defined Statistic Count.

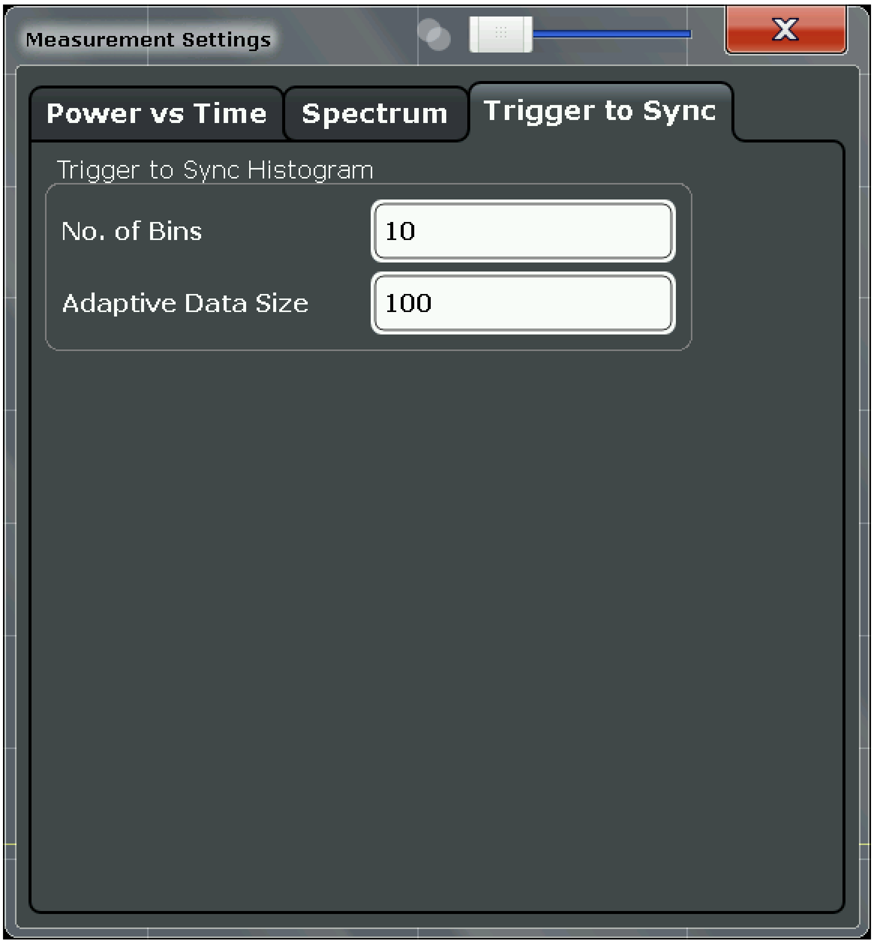
"Peak" The reference power is the peak power level measured over the selected slot scope (see Chapter 6.3.6.1, "Slot Scope", on page 127) and its peak taken over Statistic Count measurements (GSM frames).

Remote command:
`CONFigure:SPECtrum:SWITching:TYPE` on page 261

6.3.7.3 Trigger to Sync

Access: "Overview" > "Measurement" > "Trigger to Sync"

The Trigger to Sync measurement allows for further configuration.



No. of Bins
Specifies the number of bins for the histogram of the "Trigger to Sync" measurement.

For details see "Trigger to Sync Graph" on page 32.

Remote command:
`CONFigure:TRGS:NOFBins` on page 263

Adaptive Data Size
Specifies the number of measurements (I/Q captures) after which the x-axis of the "Trigger to Sync" histogram is adapted to the measured values and fixed for subsequent measurements.

Up to the defined number of measurements, the Trigger to Sync value is stored. When enough measurements have been performed, the x-axis is adapted to the value range of the stored results. For subsequent measurements, the result is no longer stored and the x-axis (and thus the dimensions of the bins) is maintained at the set range.

The higher the "Adaptive Data Size", the more precise the x-axis scaling.

For details see "Trigger to Sync Graph" on page 32.

Remote command:
`CONFigure:TRGS:ADPSize` on page 264

6.3.8 Adjusting Settings Automatically

Access: AUTO SET

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

Adjusting the Center Frequency Automatically (Auto Freq)
This function adjusts the center frequency and ARFCN (I/Q mode only) automatically.

For multicarrier measurements, all carrier settings are automatically adjusted (see Chapter 6.3.2.4, "Carrier Settings", on page 98).

This command is not available when using the Digital Baseband Interface (R&S FSW-B17) or the Analog Baseband Interface (R&S FSW-B71).

Carriers are only detected in a range of approximately 25 MHz to 2 GHz. For further details see Chapter 5.16, "Automatic Carrier Detection", on page 81.

Remote command:
`[SENSe:]ADJust:FREQuency` on page 265

Setting the Reference Level Automatically (Auto Level)
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

This function is **not** available in **MSRA** mode.

Remote command:
`CONFigure[:MS]:AUTO:LEVel ONCE` on page 265

Automatic Frame Configuration
When activated, a single auto frame configuration measurement is performed.

Note: This function is **not** available in **MSRA** mode if the **Sequencer** is active.

The auto frame configuration measurement may take a long time, therefore it is deactivated by default. The following parameters are detected and automatically measured:

- Active slots
- Slot configuration (burst type, modulation, filter, TSC)
- Equal time slot length
- For VAMOS normal burst and GMSK: TSCs of set 1 and set 2
- For VAMOS normal burst and AQPSK: TSCs of both subchannels (restrictions see "Restriction for auto frame configuration" on page 50) and SCPIR

Remote command:
`CONF:AUTO:FRAM ONCE`, see `CONFigure[:MS]:AUTO:FRAMe ONCE` on page 264

Automatic Trigger Offset
If activated, the trigger offset (for external and IF power triggers) are detected and automatically measured.

This function is **not** available in **MSRA** mode.

For details on the trigger offset refer to "Trigger Offset" on page 119.

Remote command:
`CONF:AUTO:TRIG ONCE`, see `CONFigure[:MS]:AUTO:TRIGger ONCE`
on page 265

6.4 Multicarrier Wideband Noise (MCWN) Measurements

For multicarrier measurements, some parameters defined by the GSM standard require a swept measurement with varying resolution bandwidths. Thus, a new separate measurement is provided by the R&S FSW GSM application to determine the wideband noise in multicarrier measurement setups (see Chapter 4.2, "Multicarrier Wideband Noise Measurements", on page 34).

Selecting the measurement type

GSM measurements require a special operating mode on the R&S FSW, which you activate using the MODE key.

► To select the MCWN measurement type, do one of the following:
  - Select the "Overview" softkey. In the "Overview", select the "Select Measurement" button. Select the "MC and Wide Noise Spectrum" measurement.
  - Press the MEAS key. In the "Select Measurement" dialog box, select the "MC and Wide Noise Spectrum" measurement.

The measurement-specific settings for the "MC and Wide Noise Spectrum" measurement are available via the "Overview".

The MARKER FUNCT and LINES menus are currently not used.

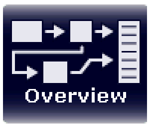
6.4.1 Default Settings for GSM MCWN Measurements

The following default settings are activated when a MCWN measurement is selected:

Table 6-2: Default settings for GSM MCWN measurements

Parameter	Value
Measurement type	MC and Wide Noise Spectrum
Sweep mode	CONTINUOUS
Trigger settings	FREE RUN
Device type	as defined (channel default: BTS Normal)
Frequency band	as defined (channel default: E-GSM 900)
Carriers	1 active carrier at defined center frequency with NB GMSK modulation
Reference power	Maximum measured active carrier level
Noise measurements	Narrowband noise Wideband noise
Intermodulation measure-ments	Order 3 and 5
Average count	Ref. meas: 10 Noise meas: 200
Limit line exceptions	Applied
Evaluations	Window 1: Spectrum Graph Window 2: Carrier Power Table

6.4.2 Configuration Overview



Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.

Note that the configuration "Overview" depends on the selected measurement type. Configuration for the default I/Q measurement (Modulation Accuracy etc.) is described in Chapter 6.3.1, "Configuration Overview", on page 87.

Figure 6-4: Configuration "Overview" for MCWN measurement

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See Chapter 6.4.3, "Signal Description", on page 141
2. Input and Frontend Settings
   See Chapter 6.4.4, "Input and Frontend Settings", on page 145
3. Triggering
   See Chapter 6.4.5, "Trigger Settings", on page 156
4. Data Acquisition
   See Chapter 6.4.6, "Sweep Settings", on page 162
5. Reference Measurement Settings
   See Chapter 6.4.7, "Reference Measurement Settings", on page 163

6. Noise Measurement Settings
   See Chapter 6.4.8, "Noise Measurement Settings", on page 166
7. Result Configuration
   See Chapter 7.1, "Result Configuration", on page 169
8. Display Configuration
   See Chapter 6.2, "Display Configuration", on page 86

To configure settings

► Select any button to open the corresponding dialog box. The corresponding dialog box is opened with the focus on the selected setting.

For step-by-step instructions on configuring GSM measurements, see Chapter 9, "How to Perform Measurements in the GSM Application", on page 181.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FSW (except for the default Spectrum application channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 201

Select Measurement
Selects a measurement to be performed.

See "Selecting the measurement type" on page 84.

6.4.3 Signal Description

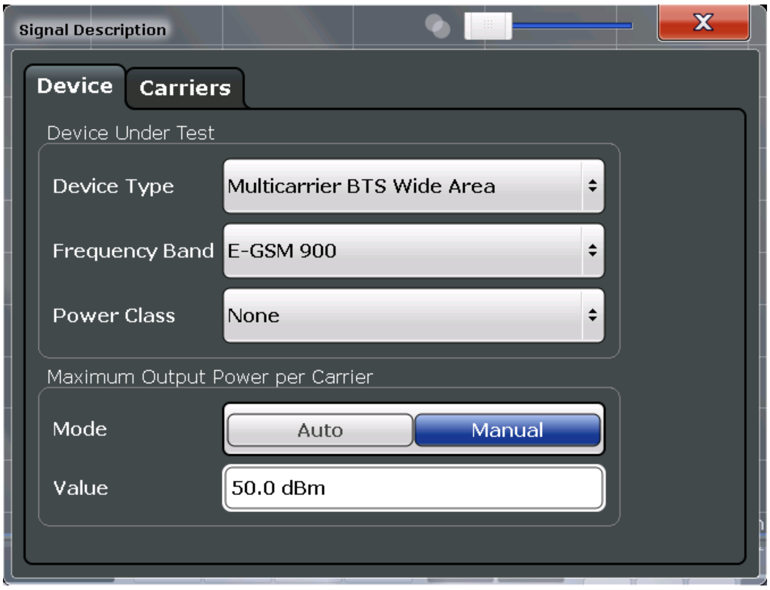
The signal description provides information on the expected input signal, which optimizes frame detection and measurement.

The "Signal Description" settings are available from the configuration "Overview".

6.4.3.1 Device Under Test Settings

Access: "Overview" > "Signal Description" > "Device"

The type of device to be tested provides additional information on the signal to be expected.



Device Type

Defines the type of device under test (DUT). The following types are available:

- BTS Normal
- BTS Micro
- BTS Pico
- MS Normal
- MS Small
- Multicarrier BTS Wide Area
- Multicarrier BTS Medium Range
- Multicarrier BTS Local Area

The default device type is "BTS Normal".

Remote command:

`CONFigure[:MS]:DEVice:TYPE` on page 203

Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 46.

The following frequency bands are supported:

- DCS 1800
- E-GSM 900
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- GSM 850

- PCS 1900
- P-GSM 900
- R-GSM 900
- T-GSM 380
- T-GSM 410
- T-GSM 810
- T-GSM 900

The default frequency band is "E-GSM 900".

Remote command:
CONFigure[:MS]:NETWork[:TYPE] on page 204
CONFigure[:MS]:NETWork:FREQuency:BAND on page 205

Power Class
The following power classes are supported:

(For MCWN measurements no power class is used: "NONE".)

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
CONFigure[:MS]:POWer:CLASs on page 206

Maximum Output Power per Carrier (multicarrier measurements only)
Defines the maximum output power per carrier, which determines the limit lines for the modulation spectrum (I/Q measurements) and MCWN measurement.

In "Auto" mode, the maximum measured power level for the carriers is used.

This setting is only available for multicarrier measurements.

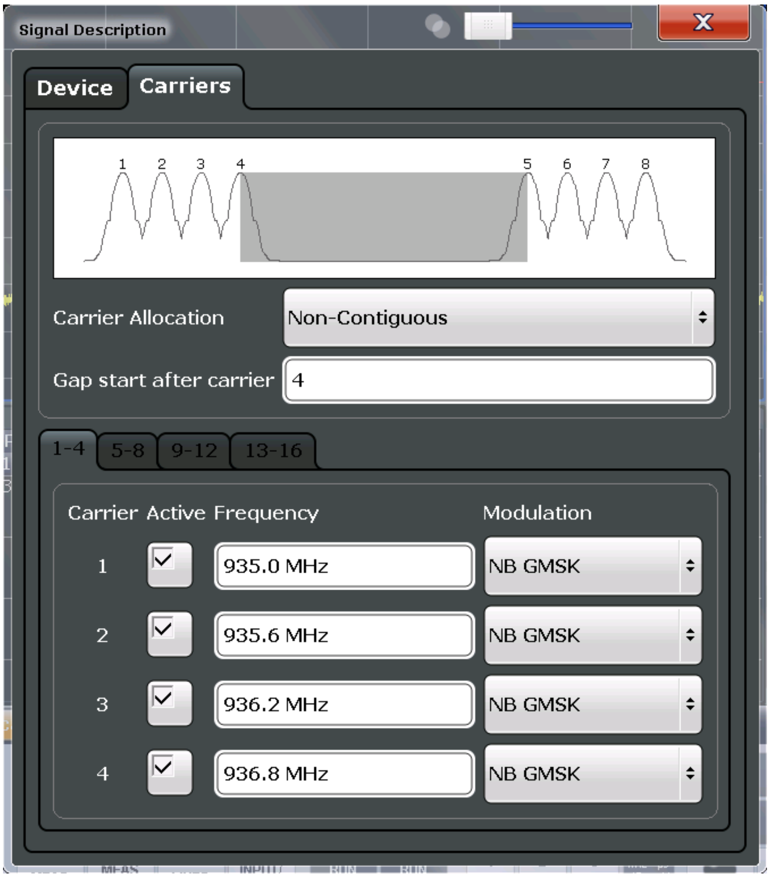
Remote command:
CONFigure[:MS]:POWer:PCARrier:AUTO? on page 208
CONFigure[:MS]:POWer:PCARrier? on page 208

6.4.3.2 Carrier Settings

Access: "Overview" > "Signal Description" > "Carriers"

The "Carrier" settings define whether the expected signal contains a single or multiple carriers. Multiple carriers can only be defined if a multicarrier Device Type is selected (see Chapter 6.3.2.1, "Device Under Test Settings", on page 89.

Up to 16 carriers can be configured for a single MCWN measurement.



The carriers can also be configured automatically, see "Adjusting the Center Frequency Automatically (Auto Freq)" on page 137.

Carrier Allocation

Defines whether a multicarrier measurement setup contains one subblock of regularly spaced carriers only (contiguous), or two subblocks of carriers with a gap in-between (non-contiguous).

For details see Chapter 5.15.2, "Contiguous vs Non-Contiguous Multicarrier Allocation", on page 72.

Remote command:

`CONFigure[:MS]:MCARrier:FALLocation` on page 218

Gap start after carrier (Non-contiguous carriers only)

For non-contiguous setups (see Carrier Allocation) the position of the gap must be defined as the number of the active carrier after which the gap starts.

Remote command:
`CONFigure[:MS]:MCARrier:FALLocation:NCONtiguous:GSACarrier` on page 218

Active carriers
Defines which of the defined carriers are active for the current measurement.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>[:STATe]?` on page 216

Frequency
Defines the absolute frequency of each (active) carrier.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>:FREQuency` on page 216

Modulation
Defines the burst type, modulation and pulse shape filter of each (active) carrier.

For possible combinations see Chapter 5.8, "Dependency of Slot Parameters", on page 58.

Note: This setting determines the appropriate limits from the 3GPP standard.

Remote command:
`CONFigure[:MS]:MCARrier:CARRier<c>:MTYPe` on page 217

6.4.4 Input and Frontend Settings

The R&S FSW can evaluate signals from different input sources and provide various types of output (such as noise or trigger signals).

The frequency and amplitude settings represent the "frontend" of the measurement setup.

6.4.4.1 Radio Frequency Input

The default input source for the R&S FSW is "Radio Frequency", i.e. the signal at the RF INPUT connector. This is the only available input source for MCWN measurements.

Input Coupling

The RF input of the R&S FSW can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 219

Impedance

For MCWN measurements, the impedance is always 50 Ω.

Direct Path

Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be deactivated. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

"Auto"	(Default) The direct path is used automatically for frequencies close to zero.
"Off"	The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 220

High-Pass Filter 1...3 GHz
Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

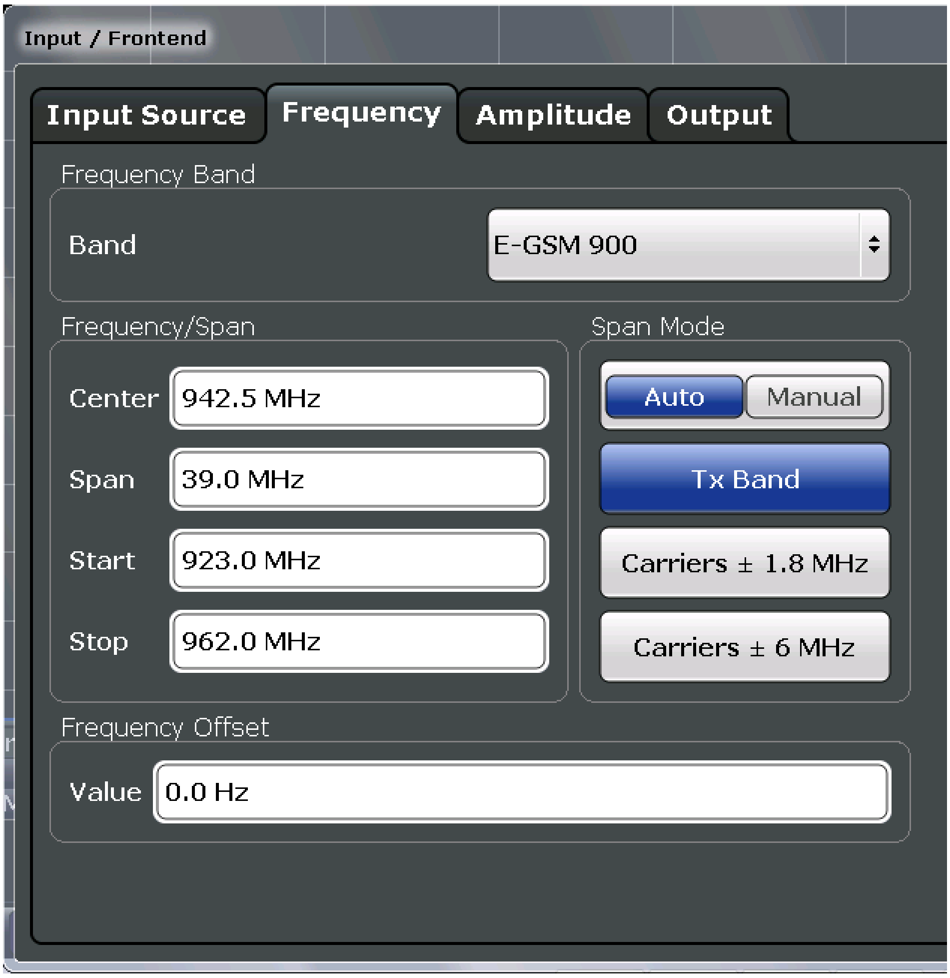
(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 220

6.4.4.2 Frequency Settings

The frequency span to be measured can be defined using a start and stop frequency, or a center frequency and span; alternatively, it can be set to a specific characteristic value automatically.

Frequency and span settings can be configured via the "Frequency" dialog box, which is displayed when you press the FREQ or SPAN key and then select "Frequency Config".



Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 46.

The following frequency bands are supported:

- DCS 1800
- E-GSM 900
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- GSM 850
- PCS 1900
- P-GSM 900

- R-GSM 900
- T-GSM 380
- T-GSM 410
- T-GSM 810
- T-GSM 900

The default frequency band is "E-GSM 900".

Remote command:
CONFigure[:MS]:NETWork[:TYPE] on page 204
CONFigure[:MS]:NETWork:FREQuency:BAND on page 205

Center Frequency

Specifies the center frequency of the signal to be measured (typically the center of the Tx band).

If the frequency is modified, the "ARFCN" is updated accordingly (for I/Q measurements, see ARFCN).

Remote command:
[SENSe:]FREQuency:CENTer on page 232

Span

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

$span_{min} \leq f_{span} \leq f_{max}$

f_{max} and $span_{min}$ are specified in the data sheet.

Remote command:
[SENSe:]FREQuency:SPAN on page 267

Start / Stop

Defines the start and stop frequencies.

Remote command:
[SENSe:]FREQuency:STARt on page 268
[SENSe:]FREQuency:STOP on page 268

Setting the Span to Specific Values Automatically

In "Manual" mode, the frequency span is defined by a Start / Stop, or a Center Frequency and Span.

If the "Auto" span mode is enabled (default), the span for the MCWN measurement is set to one of the following values automatically.

"Tx Band" The span for the MCWN measurement is set to the Tx band ±10 MHz (for multicarrier BTS device types) or ±2 MHz (for all other device types).
The Tx bands are defined in the standard in 3GPP TS 45.005, chapter "*2 Frequency bands and channel arrangement*".
This setting is recommended for measurements according to the standard.

"Carriers ± 1.8 MHz"
The span is set to the span of all active (GSM) carriers, plus a margin of 1.8 MHz to either side.
This setting is suitable for narrowband noise measurements.

"Carriers ± 6 MHz"
The span is set to the span of all active (GSM) carriers, plus a margin of 6 MHz to either side.
This setting is suitable for all narrowband noise and most of the wideband noise and intermodulation measurements.

Remote command:
`SENSe:FREQuency:SPAN:MODE` on page 267

Frequency Offset

Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, or on the captured data or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies, but not if it shows frequencies relative to the signal's center frequency.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

Note: In MSRA/MSRT mode, this function is only available for the MSRA/MSRT Master.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 233

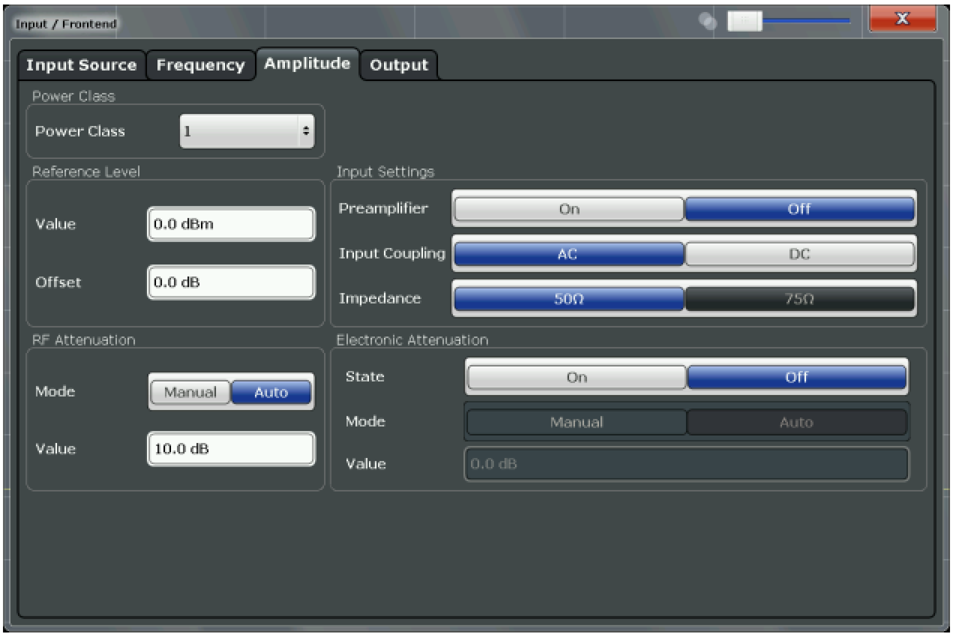
6.4.4.3 Amplitude Settings

Amplitude settings affect the y-axis values.

To configure the amplitude settings

Amplitude settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:
- Select "Input/Frontend" from the "Overview" and then select the "Amplitude" tab.
- Select the AMPT key and then the "Amplitude Config" softkey.



Power Class

The following power classes are supported:

(For MCWN measurements no power class is used: "NONE".)

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
`CONFigure[:MS]:POWer:CLASs` on page 206

Reference Level

Defines the expected maximum input signal level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

The reference level can also be used to scale power diagrams; the reference level is then used as the maximum on the y-axis.

Since the hardware of the R&S FSW is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level. Thus you ensure an optimum measurement (no compression, good signal-to-noise ratio).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 234

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the R&S FSW so the application shows correct power results. All displayed power level results are shifted by this value.

The setting range is ±200 dB in 0.01 dB steps.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S FSW must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 235

Mechanical Attenuation
Defines the mechanical attenuation for RF input.

Attenuation Mode / Value ← Mechanical Attenuation
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that no overload occurs at the RF INPUT connector for the current reference level. It is the default setting.

By default and when no (optional) electronic attenuation is available, mechanical attenuation is applied.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload may lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 236
`INPut:ATTenuation:AUTO` on page 236

Using Electronic Attenuation
If the (optional) Electronic Attenuation hardware is installed on the R&S FSW, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) > 13.6 GHz.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation may provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation can be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

Both the electronic and the mechanical attenuation can be varied in 1 dB steps. Other entries are rounded to the next lower integer value.

For the R&S FSW85, the mechanical attenuation can be varied only in 10 dB steps.

If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed in the status bar.

Remote command:
`INPut:EATT:STATe` on page 237
`INPut:EATT:AUTO` on page 237
`INPut:EATT` on page 237

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

For details see Chapter 6.3.3.1, "Input Source Settings", on page 100.

Preamplifier ← Input Settings
If the (optional) Preamplifier hardware is installed, a preamplifier can be activated for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low output power.

For R&S FSW26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW8 or 13 models, the following settings are available:

"Off"	Deactivates the preamplifier.
"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 235
`INPut:GAIN[:VALue]` on page 235

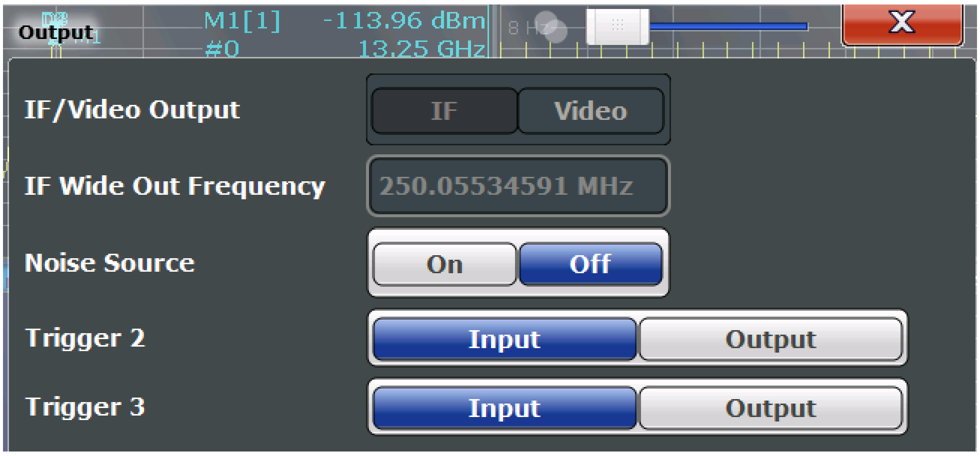
6.4.4.4 Output Settings

Access: INPUT/OUTPUT > "Output"

The R&S FSW can provide output to special connectors for other devices.

For details on connectors, refer to the R&S FSW Getting Started manual, "Front / Rear Panel View" chapters.

How to provide trigger signals as output is described in detail in the R&S FSW User Manual.



IF/VIDEO/DEMOD Output

This function is not available for the R&S FSW GSM application.

IF Out Frequency

This function is not available for the R&S FSW GSM application.

Noise Source

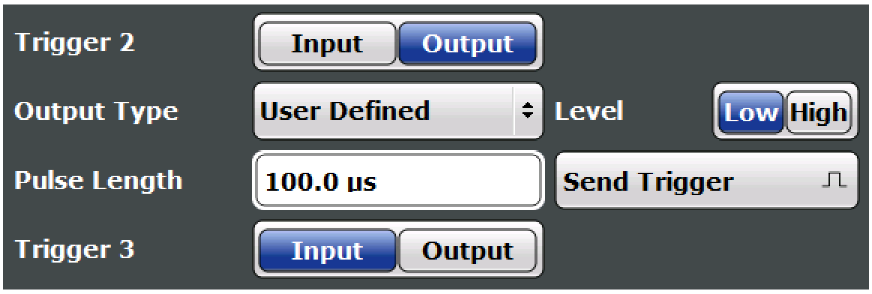
This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSW on and off.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSW itself, for example when measuring the noise level of a DUT.

Remote command:

`DIAGnostic:SERVice:NSOurce` on page 231

Trigger 2/3



Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input"	The signal at the connector is used as an external trigger source by the R&S FSW. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The R&S FSW sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

Remote command:
OUTPut:TRIGger<port>:DIRection on page 243

Output Type ← Trigger 2/3

Type of signal to be sent to the output

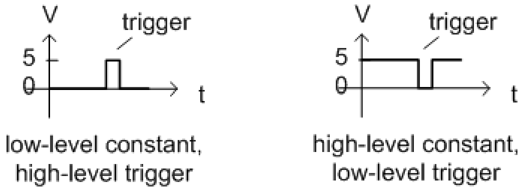
"Device Triggered"	(Default) Sends a trigger when the R&S FSW triggers.
"Trigger Armed"	Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state. This state is indicated by a status bit in the STATus:OPERation register (bit 5), as well as by a low-level signal at the AUX port (pin 9).
"User Defined"	Sends a trigger when you select the "Send Trigger" button. In this case, further parameters are available for the output signal.

Remote command:
OUTPut:TRIGger<port>:OTYPe on page 244

Level ← Output Type ← Trigger 2/3

Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level = High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 243

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 245

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

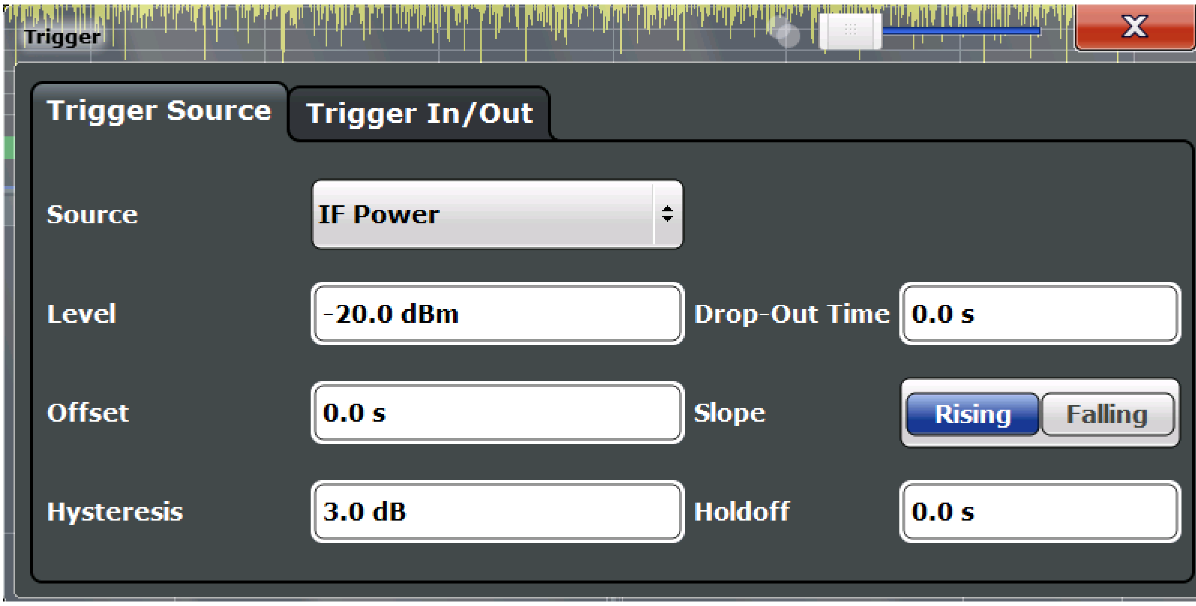
Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 244

6.4.5 Trigger Settings

Trigger settings determine when the input signal is measured.

Trigger settings can be configured in the "Trigger" dialog box, which is displayed when you do one of the following:

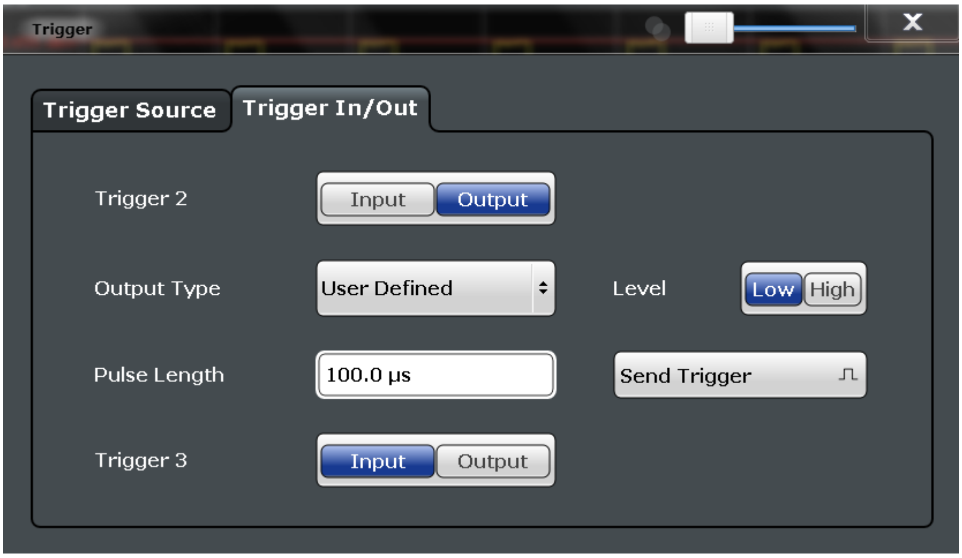
- Press the TRIG key and then select the "Trigger Config" softkey.
- In the "Overview", select the "Trigger" button.



The GSM measurements can be performed in "Free Run" (untriggered) mode; however, an external trigger or a power trigger can speed up measurements.

For more information see Chapter 5.5, "Trigger settings", on page 51.

External triggers from one of the TRIGGER INPUT/OUTPUT connectors on the R&S FSW are configured in a separate tab of the dialog box.



Note that manually configured gating is not available for GSM measurements. Measurements that require gating (such as reference power and narrowband noise measurement) use internal gating mechanisms automatically.

For step-by-step instructions on configuring triggered measurements, see the R&S FSW User Manual.

Trigger Settings
The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Settings
Defines the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

Note: Trigger source for MSRA Master.
Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application (see Chapter 5.5, "Trigger settings", on page 51). For this purpose, the trigger is considered to be in "Free Run" mode.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 242

Free Run ← Trigger Source ← Trigger Settings
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 242

External Trigger 1/2/3 ← Trigger Source ← Trigger Settings
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

(See "Trigger Level" on page 119).

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT connector on the front panel.

For details, see the "Instrument Tour" chapter in the R&S FSW Getting Started manual.

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT connector.

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 115).

"External Trigger 3"
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector on the rear panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 115).

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
`TRIG:SOUR EXT3`
See `TRIGger[:SEQuence]:SOURce` on page 242

IF Power ← Trigger Source ← Trigger Settings
The R&S FSW starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger bandwidth at the third IF depends on the RBW and sweep type.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

For details on available trigger levels and trigger bandwidths, see the data sheet.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 242

RF Power ← Trigger Source ← Trigger Settings
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose, the instrument uses a level detector at the first intermediate frequency.

The input signal must be in the frequency range between 500 MHz and 8 GHz.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels, see the instrument's data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement may be aborted. A message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 242

Trigger Level ← Trigger Settings
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the data sheet.

Remote command:
TRIGger[:SEQuence]:LEVel:IFPower on page 240
TRIGger[:SEQuence]:LEVel:IQPower on page 241
TRIGger[:SEQuence]:LEVel[:EXTernal<port>] on page 240
TRIGger[:SEQuence]:LEVel:RFPower on page 241

Drop-Out Time ← Trigger Settings
Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
TRIGger[:SEQuence]:DTIMe on page 239

Trigger Offset ← Trigger Settings
Defines the time offset between the trigger event and the start of the measurement.

Note: When using an external trigger, the trigger offset is particularly important to detect the frame start correctly! (See Chapter 5.5, "Trigger settings", on page 51.) The R&S FSW GSM application expects the trigger event to be the start of the "active part" in slot 0.

Offset > 0:	Start of the measurement is delayed
Offset < 0:	Measurement starts earlier (pretrigger)

Remote command:
TRIGger[:SEQuence]:HOLDoff[:TIME] on page 239

Slope ← Trigger Settings
For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
TRIGger[:SEQuence]:SLOPe on page 242

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

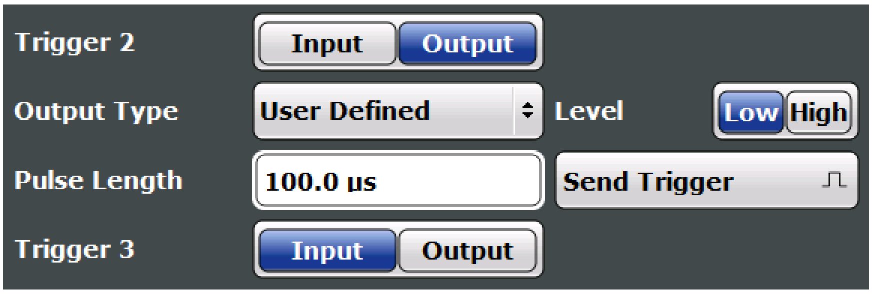
This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote command:
TRIGger[:SEQuence]:IFPower:HYSTeresis on page 239

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

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 239

Trigger 2/3



Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSW sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:DIRection` on page 243

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSW triggers.

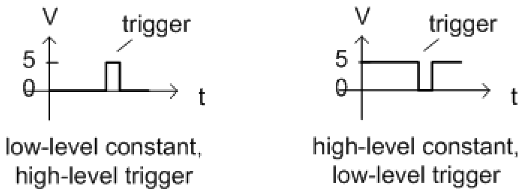
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when you select the "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 244

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level = High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 243

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 245

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 244

6.4.6 Sweep Settings

The "Sweep" settings define how often data is captured from the input signal by the R&S FSW GSM application.

Reference Average Count
Defines the number of reference measurements to be performed in order to determine the average reference values.

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:AVERage:COUNt` on page 268

Noise Average Count
Defines the number of noise measurements to be performed in order to determine the average result values.

Remote command:
`[SENSe:]SWEep:COUNt` on page 252

Continuous Sweep/RUN CONT
While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 249

Single Sweep/ RUN SINGLE
While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

Remote command:
`INITiate<n>[:IMMediate]` on page 250

Continue Single Sweep
While the measurement is running, the "Continue Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
`INITiate<n>:CONMeas` on page 248

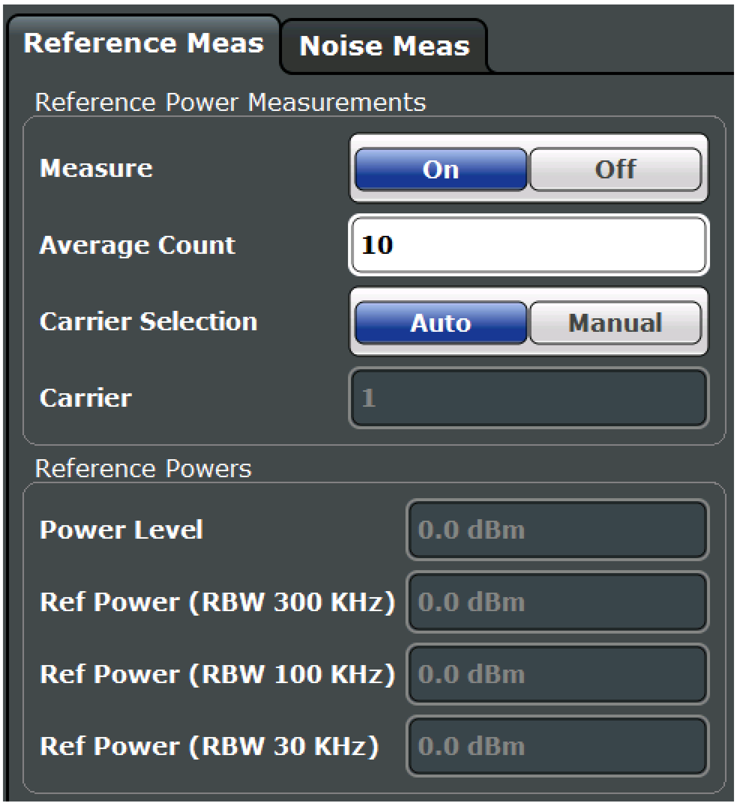
6.4.7 Reference Measurement Settings

Reference power levels can either be defined manually or determined automatically by a reference measurement prior to the noise measurement.

Reference power settings can be configured in the "Reference Meas" tab of the "Measurement Settings" dialog box, which is displayed when you do one of the following:

- Press the MEAS CONFIG key and then select the "Reference Meas" softkey.

- In the "Overview", select the "Reference Meas" button.



Enabling a reference power measurement (Measure)

If enabled, the reference powers of all active carriers are measured for MCWN measurements.

If disabled, the reference powers must be defined manually (see "Defining Reference Powers Manually" on page 165).

For details see "Reference measurement" on page 71.

Remote command:

`CONFigure:SPECtrum:MODulation:REFerence:MEASure` on page 270

Reference Average Count

Defines the number of reference measurements to be performed in order to determine the average reference values.

Remote command:

`CONFigure:SPECtrum:MODulation:REFerence:AVERage:COUNt` on page 268

Carrier Selection / Carrier
Specifies the carrier at which the reference powers for the MCWN measurement are measured (if reference power measurement is enabled, see "Enabling a reference power measurement (Measure)" on page 164).

In "Auto" mode, the carrier with the maximum power level is selected as a reference.

In "Manual" mode, you must specify the carrier to be used as a reference in the "Carrier" field. All active carriers can be selected (see "Active carriers" on page 100).

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:CARRier[:AUTO]` on page 269
`CONFigure:SPECtrum:MODulation:REFerence:CARRier:NUMBer` on page 269

Defining Reference Powers Manually
Alternatively to performing a measurement to determine the reference powers for MCWN measurements, you can define them manually.

Note that reference power levels depend on the modulation characteristics. For details see Chapter 5.15.3, "Manual Reference Power Definition for MCWN Measurements", on page 74

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:MEASure` on page 270

Power Level ← Defining Reference Powers Manually
Manually defined carrier power level to be used as a reference for MCWN measurements.

(If reference measurement is enabled (see"Enabling a reference power measurement (Measure)" on page 164), this value is displayed for information only.)

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:PLEVel` on page 270

Ref Power (RBW 300 kHz) ← Defining Reference Powers Manually
Manually defined reference power level measured with an RBW of 300 kHz for MCWN measurements.

(If reference measurement is enabled (see"Enabling a reference power measurement (Measure)" on page 164), this value is displayed for information only.)

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:RPOWer` on page 270

Ref Power (RBW 100 kHz) ← Defining Reference Powers Manually
Manually defined reference power level measured with an RBW of 100 kHz for MCWN measurements.

(If reference measurement is enabled (see"Enabling a reference power measurement (Measure)" on page 164), this value is displayed for information only.)

Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:RPOWer` on page 270

Ref Power (RBW 30 kHz) ← Defining Reference Powers Manually
Manually defined reference power level measured with an RBW of 30 kHz for MCWN measurements.

(If reference measurement is enabled (see"Enabling a reference power measurement (Measure)" on page 164), this value is displayed for information only.)

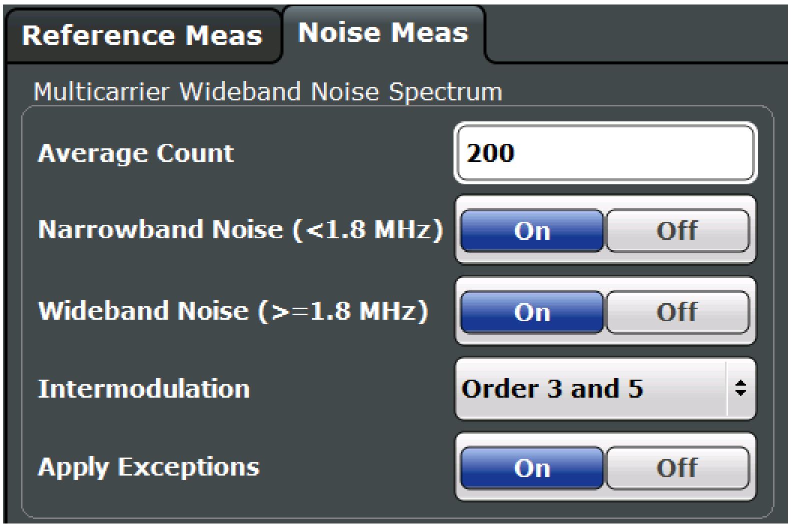
Remote command:
`CONFigure:SPECtrum:MODulation:REFerence:RPOWer` on page 270

6.4.8 Noise Measurement Settings

The noise measurement can provide various results.

Noise measurement settings can be configured in the "Noise Meas" tab of the "Measurement Settings" dialog box, which is displayed when you do one of the following:

- Press the MEAS CONFIG key and then select the "Noise Meas" softkey.
- In the "Overview", select the "Noise Meas" button.



Noise Average Count
Defines the number of noise measurements to be performed in order to determine the average result values.

Remote command:
`[SENSe:]SWEep:COUNt` on page 252

Narrowband Noise (<1.8 MHz)
If enabled, narrowband noise is measured as part of the MCWN measurement. Note that narrowband noise measurement is only available for multicarrier device types (see "Device Type" on page 90) for which at least 2 carriers are configured (see Chapter 6.3.2.4, "Carrier Settings", on page 98).

Narrowband noise is measured with an RBW of 30 kHz at 3 single offset frequencies below the lowermost active carrier of the lower sub-block and above the uppermost active carrier of the upper sub-block.

For details see "Narrowband noise measurement" on page 71 and "Outer Narrowband Table" on page 39.

Remote command:
`CONFigure:SPECtrum:NNARrow` on page 272

Wideband Noise (≥1.8 MHz)
If enabled, wideband noise is measured as part of the MCWN measurement. Wideband noise is measured with an RBW of 100 kHz over the defined span (typically the RF bandwidth).

For details see "Wideband noise and intermodulation sweeps" on page 72.

Remote command:
`CONFigure:SPECtrum:NWIDe` on page 273

Intermodulation
The MCWN noise measurement performs special measurements at the locations of the intermodulation (IM) products of the defined order. To disable intermodulation measurement, select "off".

For details see Chapter 5.15.5, "Intermodulation Calculation", on page 77.

Remote command:
`CONFigure:SPECtrum:IMPorder` on page 271

Adapting the limit lines for wideband noise (Apply Exceptions)
If enabled, exceptions from the limit line check as defined in the 3GPP standard are applied to the limit checks of the MCWN measurements.

Remote command:
`CONFigure:SPECtrum:LIMit:EXCeption[:STATe]` on page 272

6.4.9 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

To activate the automatic adjustment of a setting, select the corresponding function in the AUTO SET menu or in the configuration dialog box for the setting, where available.

Adjusting the Center Frequency Automatically (Auto Freq)
This function adjusts the center frequency and ARFCN (I/Q mode only) automatically.

For multicarrier measurements, all carrier settings are automatically adjusted (see Chapter 6.3.2.4, "Carrier Settings", on page 98).

This command is not available when using the Digital Baseband Interface (R&S FSW-B17) or the Analog Baseband Interface (R&S FSW-B71).

Carriers are only detected in a range of approximately 25 MHz to 2 GHz. For further details see Chapter 5.16, "Automatic Carrier Detection", on page 81.

Remote command:
`[SENSe:]ADJust:FREQuency` on page 265

Setting the Reference Level Automatically (Auto Level)
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

This function is **not** available in **MSRA** mode.

Remote command:
`CONFigure[:MS]:AUTO:LEVel ONCE` on page 265

7 Analysis

Access: "Overview" > "Result Config"

or: MEAS CONFIG > "Result Config"

General result analysis settings concerning the trace, markers, windows etc. can be configured.

7.1 Result Configuration

Access: "Overview" > "Result Config"

or: MEAS CONFIG > "Result Config"

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window (see "Specifics for" on page 89).

7.1.1 Traces

Access: "Overview" > "Result Config" > "Traces"

or: TRACE

The number of available traces depends on the selected window (see "Specifics for" on page 89). Only graphical evaluations have trace settings.

The following traces are activated directly after a GSM measurement channel has been opened, or after a Preset Channel:

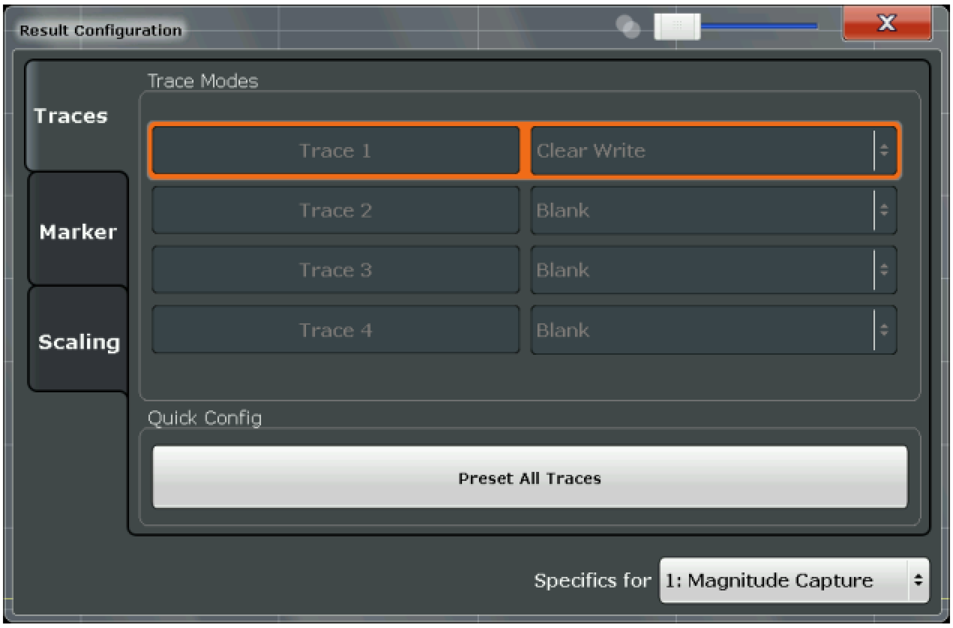
Table 7-1: Default traces depending on result display

Result display	Trace 1	Trace 2	Trace 3	Trace 4
Magnitude Capture	Clear Write	-	-	-
Power vs Time EVM vs Time Phase Error vs Time Magnitude Error vs Time	Average	Max Hold	Min Hold	Clear Write
Constellation: Graph	Clear Write	-	-	-
Modulation Spectrum Graph	Average	Clear Write	-	-

Result display	Trace 1	Trace 2	Trace 3	Trace 4
Transient Spectrum Graph	Max Hold	Clear Write	-	-
Trigger to Sync: Graph	Histogram	PDF of Average	-	-

The trace settings are configured in the "Trace" dialog box, which is displayed when you do one of the following:

- In the "Overview", select the "Result Config" button, then switch to the "Traces" tab.



Trace 1/Trace 2/Trace 3/Trace 4

Selects the corresponding trace for configuration. The currently selected trace is highlighted orange.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 282

Selected via numeric suffix of `TRACe<t>` commands

Trace Mode

Defines the update mode for subsequent traces.

The available trace modes depend on the selected result display. Not all evaluations support all trace modes.

"Clear Write" Overwrite mode: the trace is overwritten by each sweep.

"Max Hold"	The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.
"Min Hold"	The minimum value is determined from several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.
"Average"	The average is formed over several sweeps. The Statistic Count determines the number of averaging procedures.
"PDFAvg"	Displays the probability density function (PDF) of the average value.
"Blank"	Removes the selected trace from the display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 283

Preset All Traces
Restores the active traces and trace modes defined by the default settings for the active result displays.

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)
Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 282

7.1.2 Markers

Access: "Overview" > "Result Config" > "Marker"

or: MKR

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display. Up to 4 markers can be configured.

7.1.2.1 Individual Marker Settings

Access: "Overview" > "Result Config" > "Marker" > "Markers"

or: MKR > "Marker Config"

In GSM evaluations, up to 4 markers can be activated in each diagram at any time.

Selected Marker

Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State

Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 286
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 285

X-value

Defines the position of the marker on the x-axis (channel, slot, symbol, depending on evaluation).

Remote command:
`CALCulate<n>:DELTamarker<m>:X` on page 344
`CALCulate<n>:MARKer<m>:X` on page 346

Marker Type

Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 286
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 285

Assigning the Marker to a Trace

The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 286

All Markers Off

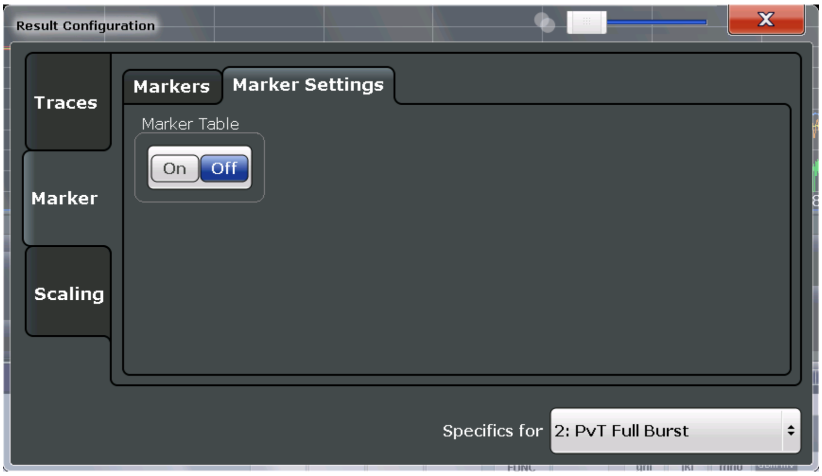
Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 286

7.1.2.2 General Marker Settings

Access: "Overview" > "Result Config" > "Marker" > "Marker Settings"

or: MKR > "Marker Config" > "Marker Settings" tab



Marker Table Display

Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area. No separate marker table is displayed.

Remote command:
`DISPlay:MTABle` on page 287

7.1.2.3 Marker Positioning Functions

Access: MKR ->

The following functions set the currently selected marker to the result of a peak search.

Select Marker

Selects the subsequent marker (marker 1/2/3/4 or delta marker) to be edited or to be used for a marker function. The currently selected marker number is highlighted.

Remote command:
Marker selected via suffix <m> in remote commands.

Peak Search

Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 288
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 288

Search Minimum
Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 288
`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 289

Max |Peak|
Sets the active marker/delta marker to the largest absolute peak value (maximum or minimum) of the selected trace.

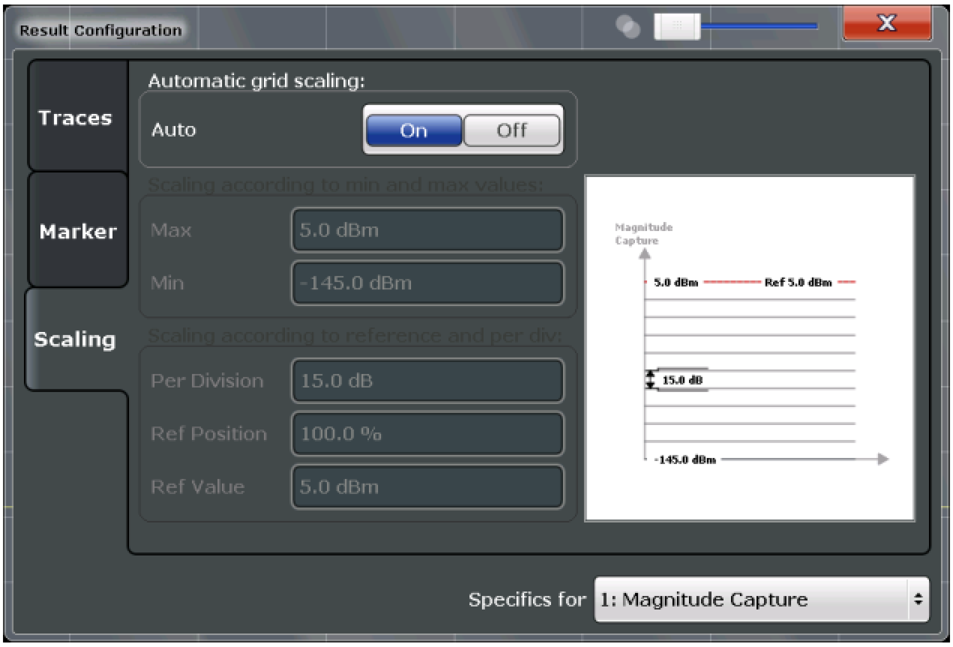
Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:APEak` on page 287

7.1.3 Y-Axis Scaling

Access: "Overview" > "Result Config" > "Scaling"

or: MEAS CONFIG > "Result Config" > "Scaling"

The scaling for the vertical axis in (most) graphical displays is highly configurable, using either absolute or relative values. These settings are described here.



Automatic Grid Scaling
The y-axis is scaled automatically according to the current measurement settings and results.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO on page 289

Absolute Scaling (Min/Max Values)
Define the scaling using absolute minimum and maximum values.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum on page 289
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum on page 290

Relative Scaling (Reference/ per Division)
Define the scaling relative to a reference value, with a specified value range per division.

Per Division ← Relative Scaling (Reference/ per Division)
Defines the value range to be displayed per division of the diagram (1/10 of total range).

Note: The value defined per division refers to the default display of 10 divisions on the y-axis. If fewer divisions are displayed (e.g. because the window is reduced in height), the range per division is increased in order to display the same result range in the smaller window. In this case, the per division value does not correspond to the actual display.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision on page 234

Ref Position ← Relative Scaling (Reference/ per Division)
Defines the position of the reference value in percent of the total y-axis range.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition on page 291

Ref Value ← Relative Scaling (Reference/ per Division)
Defines the reference value to be displayed at the specified reference position.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue on page 291

8 I/Q Data Import and Export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the in phase (I) and the quadrature (Q) channel. Such signals are referred to as I/Q signals. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Importing and exporting I/Q signals is useful for various applications:

- Generating and saving I/Q signals in an RF or baseband signal generator or in external software tools to analyze them with the R&S FSW later
- Capturing and saving I/Q signals with an RF or baseband signal analyzer to analyze them with the R&S FSW or an external software tool later

For example, you can capture I/Q data using the I/Q Analyzer application, if available, and then analyze that data later using the R&S FSW GSM application.

As opposed to storing trace data, which may be averaged or restricted to peak values, I/Q data is stored as it was captured, without further processing. The data is stored as complex values in 32-bit floating-point format. Multi-channel data is not supported. The I/Q data is stored in a format with the file extension `.iq.tar`.

For a detailed description see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

I/Q data import and export is only available for Modulation Accuracy measurements. (MCWN measurements include a combination of I/Q-based and sweep-based measurements.)

Export only in MSRA mode

In MSRA mode, I/Q data can only be exported to other applications; I/Q data cannot be imported to the MSRA Master or any MSRA applications.

8.1 Import/Export Functions

Access: "Save"/ "Open" icon in the toolbar > "Import" / "Export"

These functions are only available if no measurement is running.

In particular, if Continuous Sweep/RUN CONT is active, the import/export functions are not available.

For a description of the other functions in the "Save/Recall" menu, see the R&S FSW User Manual.

Import
Access: "Save/Recall" > Import

Provides functions to import data.

I/Q Import ← Import
Opens a file selection dialog box to select an import file that contains I/Q data. This function is only available in single sweep mode and only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

Note that the I/Q data must have a specific format as described in the R&S FSW I/Q Analyzer and I/Q Input User Manual.

I/Q import is not available in MSRA mode.

Remote command:
`MMEMory:LOAD:IQ:STATe` on page 347

Export
Access: "Save/Recall" > Export

Opens a submenu to configure data export.

I/Q Export ← Export
Opens a file selection dialog box to define an export file name to which the I/Q data is stored. This function is only available in single sweep mode.

Note: Storing large amounts of I/Q data (several Gigabytes) can exceed the available (internal) storage space on the R&S FSW. In this case, it can be necessary to use an external storage medium.

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

8.2 How to Export and Import I/Q Data

I/Q data can only be exported in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

Capturing and exporting I/Q data

1. Press the PRESET key.
2. Press the MODE key and select the R&S FSW GSM application or any other application that supports I/Q data.
3. Configure the data acquisition.
4. Press the RUN SINGLE key to perform a single sweep measurement.
5. Select the "Save" icon in the toolbar.
6. Select the "I/Q Export" softkey.
7. In the file selection dialog box, select a storage location and enter a file name.
8. Select "Save".

   The captured data is stored to a file with the extension `.iq.tar`.

Importing I/Q data

1. Press the MODE key and select the "I/Q Analyzer" or any other application that supports I/Q data.
2. If necessary, switch to single sweep mode by pressing the RUN SINGLE key.
3. Select the "Open" icon in the toolbar.
4. Select the "I/Q Import" softkey.
5. Select the storage location and the file name with the `.iq.tar` file extension.
6. Select "Open".

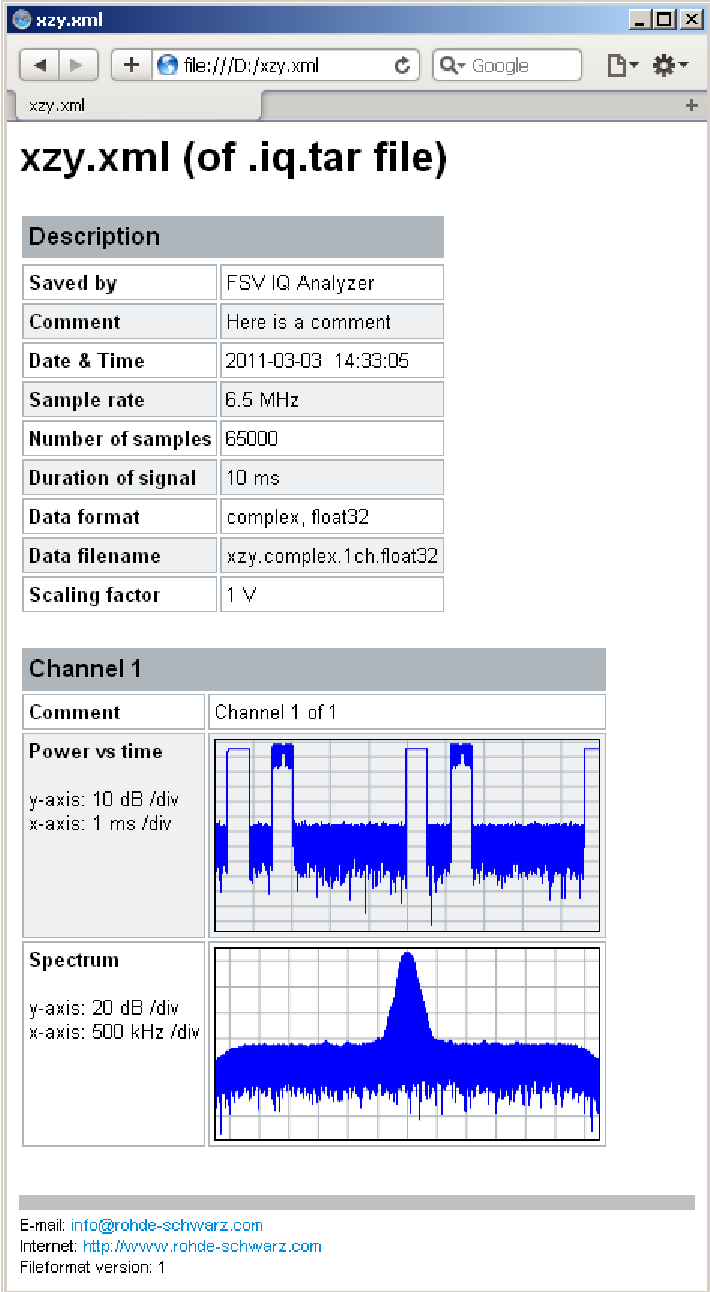
   The stored data is loaded from the file and displayed in the current application.

Previewing the I/Q data in a web browser

The `iq-tar` file format allows you to preview the I/Q data in a web browser.

1. Use an archive tool (e.g. WinZip® or PowerArchiver®) to unpack the `iq-tar` file into a folder.
2. Locate the folder using Windows Explorer.
3. Open your web browser.

4. Drag the I/Q parameter XML file, e.g. `example.xml`, into your web browser.



9 How to Perform Measurements in the GSM Application

The following step-by-step instructions demonstrate how to perform common GSM measurements with the R&S FSW GSM application.

9.1 How to Perform a Basic Measurement on GSM Signals

1. Press the MODE key and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".

8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Measurement" button and define the special measurement settings for the Spectrum, Trigger to Sync and Power vs Time measurements.
   In particular, define the frequency list to be used to determine the modulation spectrum, and filters to be used for multicarrier measurements.
10. Select the "Display Config" button and select up to 16 displays that are of interest to you.
    Arrange them on the display to suit your preferences.
11. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
12. Select the "Result Config" button to configure settings for specific result displays. These settings can be configured individually for each window, so select the window first and then configure the settings.
    - Define the "Traces" to be displayed in the window.
      Optionally, configure the trace to display the average over a series of measurements. If necessary, increase the "Statistics Count" in the "Sweep Config" dialog box.
    - Configure markers and delta markers to determine deviations and offsets within the results, e.g. when comparing errors or peaks.
    - Adapt the diagram scaling to the displayed data.
13. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.

9.2 How to Determine Modulation Accuracy Parameters for GSM Signals

1. Press the MODE key and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.

- For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.

4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Display Config" button and activate one or more of the following result displays for modulation accuracy and error parameters (up to a total of 16 windows):
   - Modulation Accuracy
   - EVM
   - Magnitude Error
   - Phase Error

   Tip: Also activate the Magnitude Capture result display for a general overview of the measured data.
   Arrange them on the display to suit your preferences.
10. Exit the SmartGrid mode.
11. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.
12. Check the Magnitude Capture for irregular behavior, e.g. an unexpected rise or fall in power. If such an effect occurs, determine whether it occured in the current slot scope and current slot to measure (compare the green and blue bars beneath the trace). If necessary, zoom into the display to view it in greater detail.
13. If necessary, change the **slot scope** or **slot to measure** to display the slot of interest (e.g. using the softkeys in the "GSM" menu).

    Now you can analyze the Magnitude Error, Phase Error, or EVM for that slot.
14. Compare the current results of the EVM with those of previous measurements to find out if the error occurs only sporadically or repeatedly.

9.3 How to Analyze the Power in GSM Signals

1. Press the MODE key and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Measurement" button and define the special measurement settings for the Power vs Time measurement:
   - Define the PvT filter to be used (for selection criteria see Chapter 5.7.1, "Power vs Time Filter", on page 55).
   - Define how the limit line defined by the standard is to be aligned to the measured slots, and whether the relative positioning of the TSCs is measured or derived from the position of the specified Slot to Measure only.
     For measurements strictly **according to standard**, use the default "Limit Line Time Alignment": "Slot to Measure".
     For **non-standard** signals or signals with conspicuous slot timing, use the "Per Slot" setting.
     (**Tip**: use the "Delta to Sync" result of the Power vs Slot measurement to verify the slot timing.)

10. Select the "Display Config" button and select one or more of the following displays for power results (up to a total of 16 windows):
    - PvT Full Burst (power **graph** of **all slots** (bursts) in the selected slot scope **over time**)
    - Power vs Slot (**table** of power **per slot** in the current frame and over all frames)

    Tip: Also display the Magnitude Capture for a general overview of the measured data.
    Arrange them on the display to suit your preferences.
11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.
13. Check the PvT Full Burst results to determine if the signal remains within the limits specified by the standard in all slots to measure.
14. If the "Limit Check" indicates "FAIL", zoom into the Power vs Time graph to determine the time at which the power exceeded the limit.
    Note: in measurements according to standard, the delta value will be identical for all slots in the scope due to the "Limit Line Time Alignment": "Slot to Measure" setting (see step 9).
15. Check the irregular slot in more detail in the Magnitude Capture (compare the green and blue bars beneath the trace). If necessary, zoom into the display to view it in greater detail.

9.4 How to Analyze the Spectrum of GSM Signals

1. Press the MODE key and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
    - Define the expected burst type and modulation for each active slot.
    - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
    - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
    - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
    - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.

4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Measurement" button and define the special measurement settings for the Spectrum measurements:
   - For **multicarrier** base stations, define which carriers are measured:
     – the left-most carrier only ("Enable Left Limit" = ON)
     – the right-most carrier only ("Enable Right Limit" = ON)
     – all carriers ("Enable Left Limit" = ON, "Enable Right Limit" = ON)
   - Select the type of resolution filter to be used.
     For measurements strictly according to standard, use the "Normal (3dB)" filter.
   - Select the frequency list to be used to determine the modulation spectrum.
     For a quick overview, select a sparse list; for a conformance test, use the list specified by the standard
     As a rule, use the narrow list to test mobile devices, use the wide list for base station tests.
   - Select the reference power to be used to determine the relative limit values for the transient spectrum.
     For measurements strictly according to standard, use the "RMS" setting.
10. Select the "Display Config" button and select one or more of the following displays for spectrum results (up to a total of 16 windows):
   - "Modulation Spectrum Graph" on page 23
   - "Modulation Spectrum Table" on page 24
   - "Transient Spectrum Graph" on page 29
   - "Transient Spectrum Table" on page 30

   Tips:
   - Also display the Magnitude Capture for a general overview of the measured data.
   - Use the **graph** displays for a general overview of the currently measured spectrum; the **tables** provide detailed numeric values, and an accurate conformance check of the DUT to the GSM standard.
   - The **modulation spectrum** shows the spectrum for a portion of a burst in a single slot (see "Modulation Spectrum Graph" on page 23); the **transient spec-**

trum shows the spectrum for all slots in the slot scope, including the rising and falling edges of the bursts.

Arrange the windows on the display to suit your preferences.

11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.
13. Check the result of the limit check in the graph. If it indicates "FAIL", refer to the numeric results in the table display for more precise information on which frequency exceeds the limit (indicated by a negative "Δ to Limit" value and red characters).

9.5 How to Measure Wideband Noise in Multicarrier Setups

1. Press the MODE key and select the "GSM" application.
2. Press the MEAS key and select the "MC and Wide Noise" measurement.
3. Select the "Overview" softkey to display the "Overview" for the MCWN measurement.
4. Select the "Signal Description" button and configure the expected signal by selecting a multicarrier device type and defining the active carriers.
    - Select a device type supports multiple carriers on the "Device" tab.
    - Activate the required number of carriers and define the frequency, expected burst type and modulation for each active carrier in the "Carriers" tab.
5. Select the "Input/Frontend" button and then the "Frequency" tab to define the required frequency band and measurement span.
6. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
7. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
8. Select the "Reference measurement" button to determine how the reference powers are determined. Do one of the following:
    - Enable automatic measurement with automatic carrier selection.
    - Enable automatic measurement and select a carrier to be used for reference.

- Disable the reference measurement and define the power level and the three reference power levels (for 30 kHz/100 kHz/300 kHz RBW; see also Chapter 5.15.3, "Manual Reference Power Definition for MCWN Measurements", on page 74).

9. Select the "Measurement" button and define which of the noise and intermodulation measurements are to be performed.
   If necessary, increase the number of measurements to be performed for averaging (Average count).
10. Select the "Display Config" button and select up to 16 displays that are of interest to you.
    Arrange them on the display to suit your preferences.
11. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
12. Select the "Result Config" button to configure settings for specific result displays. These settings can be configured individually for each window, so select the window first and then configure the settings.
    - Configure markers and delta markers to determine deviations and offsets within the results, e.g. when comparing errors or peaks.
    - Adapt the diagram scaling to the displayed data.
13. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.

10 Optimizing and Troubleshooting the Measurement

If the results of a GSM measurement do not meet your expectations, try the following recommendations to optimize the measurement.

10.1 Improving Performance

If the GSM measurement seems to take a long time, try the following tips.

Using external triggers to mark the frame start

The R&S FSW GSM application needs the frame start as a time reference. It either searches for a frame start after every I/Q data acquisition, or relies on a trigger event that marks the frame start. An external trigger or a power trigger that mark the frame start can speed up measurements. See also Chapter 5.5, "Trigger settings", on page 51.

In MSRA mode, trigger events are not considered when determining the frame start in a GSM measurement, as the trigger is defined by the MSRA Master for all applications simultaneously and most likely does not coincide with the frame start for the GSM signal.

Avoiding unnecessary high sample rates

According to the GSM standard, modulation spectrum results must be performed at frequencies up to 6 MHz from the carrier in some cases. When the frequency list to be used is set to 6 MHz in the "Measurement" settings (see "Modulation Spectrum Table: Frequency List" on page 135), the R&S FSW GSM application uses a sample rate of 19.5 MHz, as opposed to the usual 6.5 MHz sample rate. The higher sample rate extends the required measurement time. Only use the 6 MHz frequency list setting if you actually require "Modulation Spectrum" results according to standard.

10.2 Improving EVM Accuracy

If the EVM results show unexpected power levels, check the following issues.

Extending the data basis

Sporadic distortions in the EVM can be eliminated by evaluating several measurements and determining the average over all traces. Increase the Statistic Count in the "Sweep" settings to obtain sufficiently stable results.

Excluding results from adjacent channels

For signals from base stations capable of using **multiple carriers**, configure the DUT as such in the signal description. In this case, an additional multicarrier (PvT) filter suppresses power from adjacent channels. This filter is also taken into account during the generation of the ideal (reference) signal, otherwise there would be an increase in EVM because the measured signal has a smaller bandwidth compared to the reference signal. Define which PvT filter to use, depending on whether the channel to be measured has a reduced or equal power compared to its adjacent channels (see "Power vs Time Filter" on page 132).

For single carrier measurements, make sure the correct "Device Type" setting is selected so the correct PvT filter is used for the power measurement.

10.3 Optimizing Limit Checks

If the limit checks fail unexpectedly, check the following issues.

Excluding results from adjacent channels

In limit checks for multicarrier **spectrum measurements**, the frequencies from adjacent carriers in the signal may distort the results of the limit check for a single carrier. If you only want to check the frequencies from a single carrier in a **multicarrier signal**, disable the limit check for frequencies to the left or right of the carrier frequency of interest (see "Enable Left Limit/ Enable Right Limit" on page 134). This allows you to measure the spectrum of the left or right-most channel while ignoring the side where adjacent channels are located.

Make sure you select the correct Slot to Measure for **Modulation Spectrum** results (see Chapter 6.3.6.1, "Slot Scope", on page 127).

Calculating limit lines according to the used DUT

For **multicarrier** measurements, ensure that the **DUT** is configured correctly (see Chapter 6.3.2.2, "Frame", on page 91). The number of active carriers and the specified BTS class affect the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement.

Aligning the limit line correctly

The limit line defined by the standard must be aligned to the measured slots. The alignment can either be determined individually for each slot, or the entire line is aligned according to the Slot to Measure (see "Limit Line Time Alignment" on page 133).

The **standard** requires that the entire line be aligned according to the Slot to Measure. However, in this case the "Delta to Sync" value will be identical for all slots in the scope (see Table 4-7).

Note that the R&S FSW GSM application assumes that all slots have equal length. If they do not, disable this setting in the "Frame" settings (see "Equal Timeslot Length" on page 93) so the limit line is aligned to the slots correctly.

For **non-standard** signals or if you require more precise delta values, use the "Time Alignment": "Per Slot" setting.

10.4 Error Messages

The following error messages may be displayed in the status bar of the R&S FSW GSM application. Check these descriptions for possible error causes and solutions.

Burst not found

Possible causes	Possible solutions
Training sequence (TSC) or sync is not defined correctly.	Check the TSC/sync definition in "Slot" settings (see "Training Sequence TSC / Sync" on page 97)
Slot is not in defined slot scope	Include the slot in the slots to measure (see Chapter 6.3.6.1, "Slot Scope", on page 127)

Sync not found

Possible causes	Possible solutions
Training sequence (TSC) or sync is not defined correctly.	Check the TSC/sync definition in "Slot" settings (see "Training Sequence TSC / Sync" on page 97)
No or incorrect position of access burst in slot defined.	Define the correct "Timing Advance" for the slots containing an access burst (see "Timing Advance (Access Burst only)" on page 97).
The trigger event does not correspond to the start of the "active part" in slot 0.	Correct the trigger offset (for an external trigger, see "Trigger Offset" on page 119)
The DUT interchanged the I and Q parts of the signal.	Swap the I and Q values after data acquisition in the R&S FSW GSM application to reverse this effect (see "Swap I/Q" on page 124).

11 Remote Commands to Perform GSM Measurements

The following commands are required to perform measurements in the GSM application in a remote environment. It is assumed that the R&S FSW has already been set up for remote operation in a network as described in the R&S FSW User Manual.

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSW User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

The following topics specific to the GSM application are described here:

11.1 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank).

If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSW.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

11.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSW follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

11.1.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

11.1.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

11.1.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

11.1.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

11.1.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

11.1.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.

- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

11.1.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

11.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see Chapter 11.1.2, "Long and Short Form", on page 194.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

11.1.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

11.1.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

11.2 Common Suffixes

In the R&S FSW GSM application, the following common suffixes are used in remote commands:

Table 11-1: Common suffixes used in remote commands in the R&S FSW GSM application

Suffix	Value range	Description
<m>	1 to 4	Marker
<n>	1 to 16	Window (**in the currently selected measurement channel**)
<t>	1 to 4	Trace
<k>	not applicable	Limit line

11.3 Activating GSM Measurements

GSM measurements require a special application on the R&S FSW. A measurement is started immediately with the default settings.

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA/MSRT Master channel is selected.

Example:
`INST:SEL 'IQAnalyzer'`
`INST:CRE:DUPL`
Duplicates the channel named 'IQAnalyzer' and creates a new measurement channel named 'IQAnalyzer2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 199.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 199).

Example:
`INST:CRE IQ, 'IQAnalyzer2'`
Adds an additional I/Q Analyzer channel named "IQAnalyzer2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see INSTrument:LIST? on page 199.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see INSTrument:LIST? on page 199).

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named 'IQAnalyzer2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the INSTrument:REName command.

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 11-2: Available measurement channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
802.11ad (R&S FSW-K95)	WIGIG	802.11ad
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
Avionics (R&S FSW-K15)	AVIonics	Avionics
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
DOCSIS 3.1 (R&S FSW-K192/193)	DOCSis	DOCSIS 3.1
GSM (R&S FSW-K10)	GSM	GSM
I/Q Analyzer	IQ	IQ Analyzer
LTE (R&S FSW-K10x)	LTE	LTE
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Pulse (R&S FSW-K6)	PULSE	Pulse
Real-Time Spectrum (R&S FSW-B160R/-K160RE)	RTIM	Real-Time Spectrum
Spurious Measurements (R&S FSW-K50)	SPUR	Spurious
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
Transient Analysis (R&S FSW-K60)	TA	Transient Analysis
VSA (R&S FSW-K70)	DDEM	VSA
WLAN (R&S FSW-K91)	WLAN	WLAN
*) the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

See also `INSTrument:CREate[:NEW]` on page 198.

For a list of available channel types see Table 11-2.

Parameters:

<ChannelType> **GSM**
GSM application, R&S FSW–K10

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST:SEL 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 89

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

Manual operation: See "Sequencer State" on page 85

11.4 Selecting the Measurement

In addition to the default GSM I/Q measurement, a new separate measurement is now available for multicarrier wideband noise (see Chapter 4.2, "Multicarrier Wideband Noise Measurements", on page 34).

CONFigure:MEASurement <MeasType>

This command selects the measurement to be performed in the GSM application.

Note: if you switch between the IQ measurement and MCWN measurement, the enable, positive and negative transition settings in the status registers are set to their default values. Thus, you must reconfigure the transitions after switching measurements, if necessary. (See Chapter 11.10.4, "Querying the Status Registers", on page 353).

Parameters:

<MeasType>

IQ
Default I/Q measurement to determine the modulation accuracy, modulation /transient spectrum, trigger parameters etc.

MCWNoise
Sweep measurement to determine noise and intermodulation in multicarrier setups.

*RST: IQ

Example: `CONF:MEAS MCWN`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

11.5 Configuring and Performing GSM I/Q Measurements

The following commands are required to configure a default GSM I/Q (Modulation Accuracy...) measurement on an R&S FSW in a remote environment.

11.5.1 Signal Description

The signal description provides information on the expected input signal, which optimizes frame detection and measurement.

11.5.1.1 Device under Test Settings

The type of device to be tested provides additional information on the signal to be expected.

CONFigure[:MS]:DEVice:TYPE <Value>

This command specifies the type of device to be measured.

Parameters for setting and query:

<Value>

BTSNormal
BTS, TRX power class Normal

BTSMicro
BTS, TRX power class Micro

BTSPico
BTS, TRX power class Pico

MSNormal
MS, normal type

MSSMall
MS, small type

MCBLocal
Multicarrier BTS Local Area

MCBMedium
Multicarrier BTS Medium Range

MCBWide
Multicarrier BTS Wide Area

*RST: BTSNormal

Example: `CONF:DEV:TYPE BTSNormal`

Example: For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Device Type" on page 90

CONFigure[:MS]:NETWork[:TYPE] <Value>

This command works in conjunction with the `CONFigure[:MS]:NETWork:FREQuency:BAND` on page 205 command to specify the frequency band of the signal to be measured. The command is not in-line with the manual operation so the SCPI remote control command remains compatible with the R&S FS-K5.

Parameters for setting and query:

<Value> PGSM | EGSM | DCS | PCS | TGSM | RGSM | GSM

PGSM
Primary GSM

EGSM
Extended GSM

DCS
DCS

PCS
PCS

TGSM
T-GSM

RGSM
Railway GSM

GSM
GSM

*RST: EGSM

Example: `CONF:NETW PGSM`

Example: For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Frequency Band" on page 90

CONFigure[:MS]:NETWork:FREQuency:BAND <Value>

This command works in conjunction with the`CONFigure[:MS]:NETWork[:TYPE]` command to specify the frequency band of the signal to be measured. The command is not in-line with the manual operation so the SCPI remote control command remains compatible with the R&S FS-K5.

Parameters for setting and query:

<Value> 380 | 410 | 450 | 480 | 710 | 750 | 810 | 850 | 900 | 1800 | 1900

380
380 MHz band – valid for TGSM

410
410 MHz band – valid for TGSM

450
450 MHz band – valid for GSM

480
480 MHz band – valid for GSM

710
710 MHz band – valid for GSM

750
750 MHz band – valid for GSM

810
810 MHz band – valid for TGSM

850
850 MHz band – valid for GSM

900
900 MHz band – valid for PGSM, EGSM, RGSM and TGSM

1800
1800 MHz band – valid for DCS

1900
1900 MHz band – valid for PCS

*RST: 900

Example: `CONF:NETW:FREQ 380`

Example: For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Frequency Band" on page 90

CONFigure[:MS]:POWer:CLASs <Value>

This command the power class of the device under test.

Parameters for setting and query:

<Value> 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | E1 | E2 | E3 | M1 | M2 | M3 | P1 | NONE

1
MS and BTS power class 1

2
MS and BTS power class 2

3
MS and BTS power class 3

4
MS and BTS power class 4

5
MS and BTS power class 5

6
BTS power class 6

7
BTS power class 7

8
BTS power class 8

E1
MS power class E1

E2
MS power class E2

E3
MS power class E3

M1
BTS power class M1 (Micro)

M2
BTS power class M2 (Micro)

M3
BTS power class M3 (Micro)

P1
BTS power class P1 (Pico)

NONE
No power classes defined

*RST: 2

Example: `CONF:POW:CLAS 1`

Example: For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Power Class" on page 91

CONFigure[:MS]:POWer:PCARrier? <Power>

Defines the maximum output power per carrier, which determines the limit lines for the modulation spectrum (I/Q measurements) and MCWN measurement.

This value is ignored if `CONFigure[:MS]:POWer:PCARrier:AUTO?` is `ON`.

Parameters:
<Power> maximum output power in dBm
*RST: 0 dBm

Example:
```
CONF:POW:PCAR:AUTO OFF
CONF:POW:PCAR 4 dBm
```

Usage: Query only

Manual operation: See "Maximum Output Power per Carrier (multicarrier measurements only)" on page 91

CONFigure[:MS]:POWer:PCARrier:AUTO? <State>

If enabled, the maximum measured power level for the carriers is used as the maximum output power per carrier.

If disabled, the maximum power is defined by `CONFigure[:MS]:POWer:PCARrier?` on page 208.

Parameters:
<State> ON | OFF
*RST: ON

Example:
```
CONF:POW:PCAR:AUTO OFF
CONF:POW:PCAR 4 dBm
```

Usage: Query only

Manual operation: See "Maximum Output Power per Carrier (multicarrier measurements only)" on page 91

11.5.1.2 Frame

Frame settings determine the frame configuration used by the device under test.

CONFigure[:MS]:CHANnel:FRAMe:EQUal <State>

If activated, all slots of a frame have the same length (8 x 156.26 normal symbol periods).

If deactivated, slots number 0 and 4 of a frame have a longer duration, all other a shorter duration compared to the "equal slot length" (157, 156, 156, 156, 157, 156, 156, 156 normal symbol periods).

See 3GPP TS 51.0213GPP TS 51.021 and 3GPP TS 45.0103GPP TS 45.010 chapter "6.7 Timeslot length" for further details.

This parameter is used to adjust the time for the "Power vs Time" masks of all slots. The "Slot to measure" is used as the time reference for the entire frame.

Parameters for setting and query:

<State>	1 | 0 | ON | OFF *RST: ON

Example: `CONF:CHAN:FRAM:EQU OFF`

Manual operation: See "Equal Timeslot Length" on page 93

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

11.5.1.3 Slot

The R&S FSW GSM application is slot-based. Thus, information on the expected slots of the input signal are required. The following commands are required to provide this information.

CONFigure[:MS]:CHANnel:SLOT<Number>:FILTer <Type>

This command specifies the pulse shape of the ideal modulator.

Suffix:

<Number>	<0..7> the slot to configure

Parameters for setting and query:

<Type> GMSK | LINearised | NARRow | WIDE

GMSK
GMSK Pulse

LINearised
Linearised GMSK Pulse

NARRow
Narrow Pulse

WIDE
Wide Pulse

*RST: GMSK

Example: `CONF:CHAN:SLOT:FILT GMSK`

Manual operation: See "Filter" on page 97

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

CONFigure[:MS]:CHANnel:SLOT<Number>[:STATe] <State>

This command activates this slot (this means that e.g. this slot is not considered as inactive in the PvT evaluation).

Suffix:

<Number> <0..7>
Select the slot to configure.

Parameters for setting and query:

<State> ON | OFF

Example: `CONF:CHAN:SLOT ON`

Manual operation: See "Slot State (On/Off)" on page 96

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:SLOT<Number>:MTYPe <Modulation>

This command specifies the modulation type.

Suffix:

<Number> <0..7>
the slot to configure

Parameters for setting and query:

<Modulation>

GMSK
GMSK, Gaussian Minimum Shift Keying, 1 bit/symbol.

QPSK
QPSK, Quadrature Phase Shift keying, 2 bits/symbol.

PSK8
8PSK (EDGE), Phase Shift Keying, 3 bits/symbol.

QAM16
16QAM, 16-ary Quadrature Amplitude Modulation, 4 bits/symbol.

QAM32
32QAM, 16-ary Quadrature Amplitude Modulation, 5 bits/symbol.

*RST: GMSK

Example: `CONF:CHAN:SLOT0:MTYP GMSK`

Manual operation: See "Modulation" on page 97

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:SLOT<s>:SCPir <Value>

This command specifies the Subchannel Power Imbalance Ratio (SCPIR) of the specified slot.

Notes:

This command is only available for AQPSK modulation.

Suffix:

<s> <0..7>
Number of slot to configure

Parameters for setting and query:

<Value> numeric value

Subchannel Power Imbalance Ratio (SCPIR) in dB

Range: -15 to 15
*RST: 0
Default unit: NONE

Example: // Subchannel Power Imbalance Ratio (SCPIR) = 4 dB
`CONFigure:MS:CHANnel:SLOT0:SCPir 4`

Manual operation: See "SCPIR" on page 97

For a detailed example see Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER <Value>

This command sets the bits of the user definable TSC. The number of bits must be 26. `CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER` must be set first.

This command is only available for AQPSK modulation.

Suffix:

<s>	<0..7> Number of slot to configure
<ch>	<1|2> Subchannel number

Parameters for setting and query:

<Value>	string String containing the 26 user-defined bits

Example: // Subchannel 1: User TSC
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC USER`
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?`
// -> USER

Manual operation: See "User TSC / User Sync " on page 98

For a detailed example see Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC <Value>

This command selects the training sequence of the specified slot and subchannel used by the mobile or base station.

This command is only available for AQPSK modulation.

Suffix:

<s>	<0..7> Number of slot to configure
<ch>	<1|2> Subchannel number

Query parameters:

<ResultType>	TSC | SET Queries the currently used TSC number or the set.

Parameters for setting and query:

<Value>	0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2 | USER TSC number and Set or User TSC Set 2 is only available for subchannel 2. *RST: 0,1

Example: // Subchannel 1: TSC 0 (Set 1)
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC 0,1`
// Subchannel 1: Query TSC number and Set number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?`
// -> 0,1
// Subchannel 1: Query TSC number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC? TSC`
// -> 0
// Subchannel 1: Query Set number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC? SET`
// -> 1

Manual operation: See "Training Sequence TSC / Sync" on page 97

For a detailed example see Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:SLOT<Number>:TADVance <Offset>

Specifies the position of an access burst within a single slot.

This command is only available for access bursts (see `CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE` on page 215).

Suffix:
<Number> <0..7>

Parameters for setting and query:
<Offset> offset from slot start in symbols

Range: 0 to 63
Increment: 10
*RST: 0

Example: `CONF:CHAN:SLOT:TADV 1`

Manual operation: See "Timing Advance (Access Burst only)" on page 97

CONFigure[:MS]:CHANnel:SLOT<s>:TSC <Value>

This command selects the training sequence code TSC (Normal and Higher Symbol Rate Bursts) or training (synchronization) sequence TS (for Access Bursts) of the specified slot and subchannel used by the mobile or base station. See 3GPP TS 45.002, chapter 5.2 'Bursts'.

This command is not available for AQPSK modulation (use `CONFigure[:MS]:CHANnel:SLOT<s>:TSC` instead).

Suffix:
<s> 0..7
Number of the slot to configure

Query parameters:

<ResultType> TSC | SET

Queries the currently used TSC number or the set.
If no query parameter is defined, only the TS or the TSC is returned.

TSC
Only the TSC or TS is returned.

SET
The set of the TSC is returned.

Parameters for setting and query:

<Value> 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2 | TS0 | TS1 | TS2 | USER

training sequence for normal burst

0...7
One of the 7 pre-defined training sequence codes is used

0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2
TSC number and set for normal burst rates

TS0 | TS1 | TS2
Training (synchronization) sequence for access bursts

USER
A user-defined training sequence is used (see `CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER` on page 214).

*RST: 0

Example:

// TSC 3 (Set 1)
`CONFigure:MS:CHANnel:SLOT0:TSC 3,1`
// Query TSC number
`CONFigure:MS:CHANnel:SLOT0:TSC? TSC`
// -> 3
// Query Set number
`CONFigure:MS:CHANnel:SLOT0:TSC? SET`
// -> 1

Manual operation: See "Training Sequence TSC / Sync" on page 97

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER <Value>

This command sets the bits of the user definable TSC. The number of bits must be in accordance with the defined burst type and modulation (as indicated in Number of TSC bits depending on burst type and modulation).
`CONFigure:MS:CHANnel:SLOT0:TSC USER` must be defined first (see `CONFigure[:MS]:CHANnel:SLOT<s>:TSC` on page 213).

Suffix:
<s> <0..7>
The slot to configure

Parameters for setting and query:
<Value> String containing the user defined bits, e.g. '10101111101010101100111100' for a GMSK normal burst.

Example: `CONF:CHAN:SLOT:TSC:USER`

Manual operation: See "User TSC / User Sync " on page 98

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

Table 11-3: Number of TSC bits depending on burst type and modulation

Burst Type	Modulation	Number of Bits
Normal	GMSK	26
Normal	8PSK	78
Normal	16QAM	104
Normal	32QAM	130
Higher Symbol Rate	QPSK	62
Higher Symbol Rate	16QAM	124
Higher Symbol Rate	32QAM	155
Access Burst	GMSK	41

CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE <BurstType>

Specifies the type of the burst.

Suffix:
<Number> <0..7>

Parameters for setting and query:
<BurstType> NB | HB | AB

NB
Normal Burst

HB
Higher Symbol Rate Burst

AB
Access Burst

*RST: NB

Example: `CONF:CHAN:SLOT:TYPE NB`

Manual operation: See "Burst Type" on page 96

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

11.5.1.4 Carrier

The following commands are required to provide information on the carriers in the input signal.

CONFigure[:MS]:MCARrier:CARRier<c>[:STATe]?

This command queries the activity of the selected carrier.

Note: to activate a carrier, define its absolute frequency using `CONFigure[:MS]:MCARrier:CARRier<c>:FREQuency` on page 216.

Suffix:

<c> 1..16
Active carrier

Return values:

<State> ON | OFF
*RST: OFF

Example: `CONF:MCAR:CARR3?`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Active carriers" on page 100

CONFigure[:MS]:MCARrier:CARRier<c>:FREQuency <AbsFreq>

This command defines or queries the absolute frequency of the selected carrier.

Suffix:

<c> 1..16
Active carrier

Parameters:

<AbsFreq> Frequency in Hz
*RST: 0

Example: CONF:MCAR:CARR3:FREQ 1GHZ

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Frequency" on page 100

CONFigure[:MS]:MCARrier:CARRier<c>:MTYPe <Modulation>

This command defines or queries the burst type and modulation of the selected carrier.

Suffix:

<c> 1..16
Active carrier

Parameters:

<Modulation> Frequency in Hz

AGMSk
Access burst, GMSK modulation

HN16qam
Higher symbol rate burst, narrow pulse, 16 QAM modulation

HN32qam
Higher symbol rate burst, narrow pulse, 32 QAM modulation

HNQPsk
Higher symbol rate burst, narrow pulse, QPSK modulation

HW16qam
Higher symbol rate burst, wide pulse, 16 QAM modulation

HW32qam
Higher symbol rate burst, wide pulse, 32 QAM modulation

HWQPsk
Higher symbol rate burst, wide pulse, 16 QPSK modulation

N16Qam
Normal burst, 16 QAM modulation

N32Qam
Normal burst, 32 QAM modulation

N8PSk
Normal burst, 8PSK modulation

NAQPsk
Normal burst, AQPSK modulation

NGMSk
Normal burst, GMSK modulation

*RST: NGMS

Example: CONF:MCAR:CARR3:MTYP AQPS

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Modulation" on page 100

CONFigure[:MS]:MCARrier:FALLocation <Mode>

This command describes the measurement setup for multicarrier measurements.

Parameters:

<Mode>

CONTiguous
Setup contains one subblock of regularly spaced carriers only

NCONtiguous
Setup contains two subblocks of carriers with a gap inbetween. The position of the gap between the subblocks must be defined using `CONFigure[:MS]:MCARrier:FALLocation:NCONtiguous:GSACarrier` on page 218.

*RST: CONT

Example: `CONF:MCAR:FALL NCON`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Carrier Allocation" on page 99

CONFigure[:MS]:MCARrier:FALLocation:NCONtiguous:GSACarrier <CarrNo>

This command defines the position of the gap for non-contiguous setups (see `CONFigure[:MS]:MCARrier:FALLocation` on page 218).

Parameters:

<CarrNo> Number of the active carrier after which the gap starts.

Range: 1..16
*RST: 1

Example: `CONF:MCAR:FALL:NCON:GSAC 7`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Gap start after carrier (Non-contiguous carriers only)" on page 100

11.5.2 Input/Output Settings

The R&S FSW can analyze signals from different input sources and provide various types of output (such as noise or trigger signals). The following commands are required to configure data input and output.

11.5.2.1 RF Input

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

Usage: Event

INPut:CONNector <ConnType>

Determines whether the RF input data is taken from the RF input connector or the optional Analog Baseband I connector. This command is only available if the Analog Baseband interface (R&S FSW-B71) is installed and active for input. It is not available for the R&S FSW67 or R&S FSW85.

For Multicarrier Wideband Noise (MCWN) measurements, only input from the RF input connector is allowed.

For more information on the Analog Baseband Interface (R&S FSW-B71) see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:

<ConnType>

RF
RF input connector

AIQI
Analog Baseband I connector

*RST: RF

Example: `INP:CONN:AIQI`
Selects input from the analog baseband I connector.

Usage: SCPI confirmed

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType>

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 102

INPut:DPATh <State>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<State>

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

*RST: 1

Example: `INP:DPAT OFF`

Usage: SCPI confirmed

Manual operation: See "Direct Path" on page 102

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Parameters:

<State>

ON | OFF

*RST: OFF

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 102

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

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG-preselector described in "YIG-Preselector" on page 103.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA, Pulse, Amplifier, Transient Analysis, DOCSIS and MC Group Delay measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 103

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 102

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSW.

If no additional input options are installed, only RF input is supported.

For Multicarrier Wideband Noise (MCWN) measurements, only RF input is allowed.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

DIQ
Digital IQ data (only available with optional Digital Baseband Interface
For details on I/Q input see the R&S FSW I/Q Analyzer User Manual.

AIQ
Analog Baseband signal (only available with optional Analog Baseband Interface R&S FSW-B71)
For details on Analog Baseband input see the R&S FSW I/Q Analyzer User Manual.

*RST: RF

Manual operation: See "Radio Frequency State" on page 101
See "Digital I/Q Input State" on page 104
See "Analog Baseband Input State" on page 106

11.5.2.2 Configuring Digital I/Q Input and Output

Useful commands for digital I/Q data described elsewhere:

- `INP:SEL DIQ` (see `INPut:SELect` on page 221)
- `TRIGger[:SEQuence]:LEVel:BBPower` on page 240

Remote commands for the R&S DigIConf software

Remote commands for the R&S DigIConf software always begin with `SOURce:EBOX`. Such commands are passed on from the R&S FSW to the R&S DigIConf automatically which then configures the R&S EX-IQ-BOX via the USB connection.

All remote commands available for configuration via the R&S DigIConf software are described in the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Example 1:

```
SOURce:EBOX:*RST
SOURce:EBOX:*IDN?
```

Result:

"Rohde&Schwarz,DigIConf,02.05.436 Build 47"

Example 2:

```
SOURce:EBOX:USER:CLOCk:REFerence:FREQuency 5MHZ
```

Defines the frequency value of the reference clock.

Remote commands exclusive to digital I/Q data input and output

INPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital I/Q input from the optional Digital Baseband Interface.

For details see the section "Interface Status Information" for the optional Digital Baseband Interface in the R&S FSW I/Q Analyzer User Manual.

Return values:

<ConnState> Defines whether a device is connected or not.

0
No device is connected.

1
A device is connected.

<DeviceName> Device ID of the connected device

<SerialNumber> Serial number of the connected device

<PortName> Port name used by the connected device

<SampleRate> Maximum or currently used sample rate of the connected device in Hz (depends on the used connection protocol version; indicated by <SampleRateType> parameter)

<MaxTransferRate> Maximum data transfer rate of the connected device in Hz

<ConnProtState> State of the connection protocol which is used to identify the connected device.

Not Started

Has to be Started

Started

Passed

Failed

Done

<PRBSTestState> State of the PRBS test.

Not Started

Has to be Started

Started

Passed

Failed

Done

<SampleRateType> **0**
Maximum sample rate is displayed

1
Current sample rate is displayed

<FullScaleLevel> The level (in dBm) that should correspond to an I/Q sample with the magnitude "1" (if transferred from connected device);
If not available, `1.#QNAN` (not a number) is returned

Example: `INP:DIQ:CDEV?`
Result:
`1,SMW200A,101190,BBMM 1 OUT,`
`100000000,200000000,Passed,Passed,1,1.#QNAN`

Manual operation: See "Connected Instrument" on page 105

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

This command is only available if the optional Digital Baseband interface is installed.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Full Scale Level" on page 104

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Adjust Reference Level to Full Scale Level" on page 105

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<Level> <numeric value>

Range: 1 µV to 7.071 V
*RST: 1 V

Manual operation: See "Full Scale Level" on page 104

INPut:DIQ:RANGe[:UPPer]:UNIT <Unit>

Defines the unit of the full scale level (see "Full Scale Level" on page 104). The availability of units depends on the measurement application you are using.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<Level> VOLT | DBM | DBPW | WATT | DBMV | DBUV | DBUA | AMPere

*RST: Volt

Manual operation: See "Full Scale Level" on page 104

INPut:DIQ:SRATe <SampleRate>

This command specifies or queries the sample rate of the input signal from the optional Digital Baseband Interface (see "Input Sample Rate" on page 104).

Parameters:

<SampleRate> Range: 1 Hz to 10 GHz
*RST: 32 MHz

Example: INP:DIQ:SRAT 200 MHz

Manual operation: See "Input Sample Rate" on page 104

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Input Sample Rate" on page 104

11.5.2.3 Configuring Input via the Optional Analog Baseband Interface

The following commands are required to control the optional Analog Baseband Interface in a remote environment. They are only available if this option is installed.

Useful commands for Analog Baseband data described elsewhere:

- `INP:SEL AIQ` (see `INPut:SELect` on page 221)
- `[SENSe:]FREQuency:CENTer` on page 232

Commands for the Analog Baseband calibration signal are described in the R&S FSW User Manual.

Remote commands exclusive to Analog Baseband data input and output

---

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

This command defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 single-ended lines.

Parameters:

<State>

ON
Differential

OFF
Single ended

*RST: ON

Example: `INP:IQ:BAL OFF`

Manual operation: See "Input Configuration" on page 106

INPut:IQ:FULLscale:AUTO <State>

This command defines whether the full scale level (i.e. the maximum input power on the Baseband Input connector) is defined automatically according to the reference level, or manually.

Parameters:

<State>

ON
Automatic definition

OFF
Manual definition according to `INPut:IQ:FULLscale[:LEVel]` on page 227

*RST: ON

Example: `INP:IQ:FULL:AUTO OFF`

INPut:IQ:FULLscale[:LEVel] <PeakVoltage>

This command defines the peak voltage at the Baseband Input connector if the full scale level is set to manual mode (see `INPut:IQ:FULLscale:AUTO` on page 226).

Parameters:

<PeakVoltage> 0.25 V | 0.5 V | 1 V | 2 V

Peak voltage level at the connector.
For probes, the possible full scale values are adapted according to the probe's attenuation and maximum allowed power.

*RST: 1V

Example: `INP:IQ:FULL 0.5V`

INPut:IQ:TYPE <DataType>

This command defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ
The input signal is filtered and resampled to the sample rate of the application.
Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I
The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the in-phase component of the input signal is down-converted first (Low IF I).

Q
The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example: `INP:IQ:TYPE Q`

Manual operation: See "I/Q Mode" on page 106

CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

For more information see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
The high accuracy timing function is switched on.
The cable for high accuracy timing must be connected to trigger ports 1 and 2.

OFF | 0
The high accuracy timing function is switched off.

*RST: OFF

Example: `CAL:AIQ:HAT:STAT ON`

Manual operation: See "High Accuracy Timing Trigger - Baseband - RF" on page 107

11.5.2.4 Setting up Probes

Probes can be connected to the optional BASEBAND INPUT connectors, if the Analog Baseband interface (option R&S FSW-B71) is installed.

[SENSe:]PROBe<p>:SETup:CMOFfset <CMOffset>

Sets the common mode offset. The setting is only available if a differential probe is connected to the R&S FSW.

If the probe is disconnected, the common mode offset of the probe is reset to 0.0 V.

Suffix:
<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Parameters:
<CMOffset> Range: -100E+24 to 100E+24
Increment: 1E-3
*RST: 0
Default unit: V

Manual operation: See "Common Mode Offset" on page 108

[SENSe:]PROBe<p>:ID:PARTnumber?

Queries the R&S part number of the probe.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<PartNumber> Part number in a string.

Usage: Query only

[SENSe:]PROBe<p>:ID:SRNumber?

Queries the serial number of the probe.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<SerialNo> Serial number in a string.

Usage: Query only

[SENSe:]PROBe<p>:SETup:MODE <Mode>

Select the action that is started with the micro button on the probe head.

See also: "Microbutton Action" on page 108.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Parameters:

<Mode>

RSINgle
Run single: starts one data acquisition.

NOACtion
Nothing is started on pressing the micro button.

*RST: RSINgle

Manual operation: See "Microbutton Action" on page 108

[SENSe:]PROBe<p>:SETup:NAME?

Queries the name of the probe.

Suffix:

<p>

1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<Name> Name string

Usage: Query only

[SENSe:]PROBe<p>:SETup:STATe?

Queries if the probe at the specified connector is active (detected) or not active (not detected). To switch the probe on, i.e. activate input from the connector, use `INP:SEL:AIQ` (see `INPut:SELect` on page 221).

Suffix:

<p>

1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<State> DETected | NDETected

*RST: NDETected

Usage: Query only

[SENSe:]PROBe<p>:SETup:TYPE?

Queries the type of the probe.

Suffix:

<p>	1 | 2 | 3 Selects the connector: 1 = Baseband Input I 2 = Baseband Input Q 3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<Type>	String containing one of the following values: – None (no probe detected) – active differential – active single-ended
Usage:	Query only

11.5.2.5 Configuring the Outputs

Configuring trigger input/output is described in Chapter 11.5.4.2, "Configuring the Trigger Output", on page 243.

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSW on and off.

Suffix:

<n>	Window

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`DIAG:SERV:NSO ON`
Manual operation:	See "Noise Source" on page 114

11.5.3 Frontend Configuration

The following commands are required to configure frequency and amplitude settings, which represent the "frontend" of the measurement setup.

11.5.3.1 Frequency

The following commands are required to configure the frequencies to measure.

Useful commands for configuring frequencies described elsewhere:

- `CONFigure[:MS]:NETWork:FREQuency:BAND` on page 205
- `CONFigure[:MS]:NETWork[:TYPE]` on page 204

Remote commands exclusive to configuring frequencies:

CONFigure[:MS]:ARFCn <Value>

This command specifies the Absolute Radio Frequency Channel Number (ARFCN) to be measured. Setting the ARFCN updates the frequency.

Parameters for setting and query:

<Value> numeric value

Range: 0 to 1023 (some values may not be allowed depending on the selected frequency band)

Default unit: NONE

Example: `CONF:ARFC 5`

Manual operation: See "ARFCN" on page 110

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

If you change the frequency, the R&S FSW updates the "ARFCN" accordingly.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2

Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Usage: SCPI confirmed

Manual operation: See "Center Frequency" on page 107
See "Center Frequency" on page 110

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency Stepsize" on page 110

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

This command couples or decouples the center frequency step size to the span.

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:
```
FREQ:CENT:STEP:AUTO ON
```
Activates the coupling of the step size to the span.

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Note: In MSRA/MSRT mode, the setting command is only available for the MSRA/MSRT Master. For MSRA/MSRT slave applications, only the query command is available.

Parameters:

<Offset> Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example:
```
FREQ:OFFS 1GHZ
```

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 110

11.5.3.2 Amplitude Settings

The following commands are required to configure the amplitude settings in a remote environment.

Useful commands for amplitude settings described elsewhere:

- `INPut:COUPling` on page 219
- `INPut:IMPedance` on page 221
- `CONFigure[:MS]:POWer:CLASs` on page 206

Remote commands exclusive to amplitude settings:

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Value> numeric value WITHOUT UNIT (unit according to the result display)
Defines the range per division (total range = 10*<Value>)
*RST: depends on the result display

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Per Division" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces in all windows).

Suffix:

<n>, <t> irrelevant

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 112

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces in all windows).

Suffix:
<n>, <t> irrelevant

Parameters:
<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 112

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces).

Suffix:
<n> Window

<t> irrelevant

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifier hardware.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 113

INPut:GAIN[:VALue] <Gain>

This command selects the gain if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 235).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> 15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSW.
R&S FSW8/13: 15dB and 30 dB
R&S FSW26 or higher: 30 dB
All other values are rounded to the nearest of these two.

*RST: OFF

Example:

```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```

Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 113

11.5.3.3 Configuring the Attenuation

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation>
Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example:

```
INP:ATT 30dB
```

Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 112

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 112

INPut:EATT <Attenuation>

This command defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 237).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:
<Attenuation> attenuation in dB

Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)

Example: `INP:EATT:AUTO OFF`
`INP:EATT 10 dB`

Manual operation: See "Using Electronic Attenuation" on page 113

INPut:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Parameters:
<State> 1 | 0 | ON | OFF

1 | ON

0 | OFF

*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation" on page 113

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

Parameters:

<State> 1 | 0 | ON | OFF

1 | ON

0 | OFF

*RST: 0

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See "Using Electronic Attenuation" on page 113

11.5.4 Triggering Measurements

Trigger settings determine when the input signal is measured.

11.5.4.1 Configuring the Triggering Conditions

The following commands are required to configure the trigger for the GSM measurement.

TRIGger[:SEQuence]:BBPower:HOLDoff <Period>

This command defines the holding time before the baseband power trigger event.

The command requires the optional Digital Baseband Interface or the optional Analog Baseband Interface.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 239 command for new remote control programs.

Parameters:

<Period> Range: 150 ns to 1000 s
*RST: 150 ns

Example:
`TRIG:SOUR BBP`
Sets the baseband power trigger source.
`TRIG:BBP:HOLD 200 ns`
Sets the holding time to 200 ns.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime> Dropout time of the trigger.
Range: 0 s to 10.0 s
*RST: 0 s

Manual operation: See "Drop-Out Time" on page 119

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the measurement.

Parameters:

<Offset> *RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 119

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

This command defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s

Example:
`TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 120

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

This command defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB

Example:
`TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 120

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

This command sets the level of the baseband power trigger.

This command is available for the optional Digital Baseband Interface and the optional Analog Baseband Interface.

Parameters:

<Level> Range: -50 dBm to +20 dBm
*RST: -20 dBm

Example: `TRIG:LEV:BBP -30DBM`

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:

<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:

<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 119

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -10 dBm

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See "Trigger Level" on page 119

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See "Trigger Level" on page 119

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

This command defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

Manual operation: See "Trigger Level" on page 119

TRIGger[:SEQuence]:RFPower:HOLDoff <Time>

This command defines the holding time before the next trigger event. Note that this command is available for any trigger source, not just RF Power.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 239 command for new remote control programs.

Parameters:

<Time> Default unit: S

TRIGger[:SEQuence]:SLOPe <Type>

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 120

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the TRIGGER INPUT connector.

EXT2
Trigger signal from the TRIGGER INPUT/OUTPUT connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.

BBPower
Baseband power (for digital input via the optional Digital Baseband Interface
Baseband power (for digital input via the optional Digital Baseband Interface or the optional Analog Baseband interface

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See "Trigger Source" on page 117
See "Free Run" on page 118
See "External Trigger 1/2/3" on page 118
See "I/Q Power" on page 118
See "RF Power" on page 118
See "Power Sensor" on page 119
See "Time" on page 119
See "Trigger Source" on page 158
See "IF Power" on page 159

11.5.4.2 Configuring the Trigger Output

The following commands are required to send the trigger signal to one of the variable TRIGGER INPUT/OUTPUT connectors on the R&S FSW.

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:
<port> Selects the used trigger port.
2 = trigger port 2 (front panel)
3 = trigger port 3 (rear panel)

Parameters:
<Direction> **INPut**
Port works as an input.
OUTPut
Port works as an output.
*RST: INPut

Manual operation: See "Trigger 2/3" on page 115

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the (TTL compatible) signal generated at the trigger output.

This command works only if you have selected a user defined output with `OUTPut:TRIGger<port>:OTYPe`.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<Level> **HIGH**
5 V

LOW
0 V

*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

Manual operation: See "Level" on page 116

OUTPut:TRIGger<port>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<OutputType> **DEVice**
Sends a trigger signal when the R&S FSW has triggered internally.

TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
Sends a user defined trigger signal. For more information see `OUTPut:TRIGger<port>:LEVel`.

*RST: DEVice

Manual operation: See "Output Type" on page 115

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Usage: Event

Manual operation: See "Send Trigger" on page 116

OUTPut:TRIGger<port>:PULSe:LENGth <Length>

This command defines the length of the pulse generated at the trigger output.

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Length> Pulse length in seconds.

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See "Pulse Length" on page 116

11.5.5 Data Acquisition

You must define how much and how often data is captured from the input signal.

MSRA operating mode

In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The data acquisition settings for the R&S FSW GSM application in MSRA mode define the **application data extract** and **analysis interval**.

For details on the MSRA operating mode see Chapter 5.17, "GSM in MSRA Operating Mode", on page 81 and the R&S FSW MSRA User Manual.

11.5.5.1 Data Acquisition

The "Data Acquisition" settings define how long data is captured from the input signal by the R&S FSW GSM application.

[SENSe:]SWAPiq <State>

This command defines whether or not the recorded I/Q pairs should be swapped (I<->Q) before being processed. Swapping I and Q inverts the sideband.

This is useful if the DUT interchanged the I and Q parts of the signal; then the R&S FSW can do the same to compensate for it.

Try this function if the TSC can not be found.

Parameters:

<State>

ON
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: OFF

Manual operation: See "Swap I/Q" on page 124

[SENSe:]SWEep:TIME <Time>

This command defines the data capture time.

Tip: If you use an external trigger which indicates the frame start, the minimum allowed capture time is reduced from 10 ms to 866 us

Parameters:

<Time>

Time in seconds
In MSRA mode, the *RST value is 0.02 s.

Range: 0.01 s to 1 s
*RST: 0.1

Example: `SWE:TIME 1s`

Usage: SCPI confirmed

Manual operation: See "Capture Time" on page 123

[SENSe:]SWEep:TIME:AUTO <State>

If enabled, the capture time is determined according to the set statistic count with the objective of getting a fast measurement.

If disabled, the capture time must be defined manually using `[SENSe:]SWEep:TIME` on page 246.

Tip: In order to improve the measurement speed further by using short capture times, consider the following:

- Use an external trigger which indicates the frame start. In this case, the minimum allowed capture time is reduced from 10 ms to 866 us (see `TRIGger[:SEQuence]:SOURce` on page 242)
- Measure only slots at the beginning of the frame, directly after the trigger (see Chapter 11.5.6.1, "Slot Scope", on page 253)
- Use a small statistic count (see `[SENSe:]SWEep:COUNt` on page 252)

Parameters:

<State>

ON | OFF

*RST: OFF

Example:
```
SWE:TIME:AUTO OFF
SWE:TIME 1s
```

Manual operation: See "Capture Time" on page 123

TRACe:IQ:SRATe?

This command queries the final user sample rate for the acquired I/Q data.

Parameters:

<SampleRate> The sample rate is a fixed value, depending on the frequency range to be measured (see also "Modulation Spectrum Table: Frequency List" on page 135).

Range: 100 Hz to 10 GHz continuously adjustable;
*RST: 32 MHz

Example: See Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

Usage: Query only

Manual operation: See "Sample rate" on page 123

TRACe:IQ:BWIDth?

This command queries the bandwidth of the resampling filter.

The bandwidth of the resampling filter depends on the sample rate.

Usage: Query only

Manual operation: See "Analysis Bandwidth" on page 123

11.5.5.2 Configuring and Performing Sweeps

The "Sweep" settings define how often data is captured from the input signal by the R&S FSW GSM application.

Useful commands for configuring sweeps described elsewhere:

- `[SENSe:]SWEep:TIME` on page 246
- `INITiate<n>:REFResh` on page 294

Remote commands exclusive to configuring and performing sweeps

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single measurement mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:
<n> irrelevant

Usage: Event

Manual operation: See "Continue Single Sweep" on page 126

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the measurement mode is changed for a measurement channel while the Sequencer is active (see `INITiate<n>:SEQuencer:IMMediate` on page 250) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

Example:
`INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

Manual operation: See "Continuous Sweep/RUN CONT" on page 125

INITiate:DISPlay <State>

This command turns the display update during single sweep measurements on and off.

Parameters:

<State>	ON | OFF *RST: ON

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Suffix:
<n> irrelevant

Usage: Event

Manual operation: See "Single Sweep/ RUN SINGLE" on page 126

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 250.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 201.

Suffix:
<n> irrelevant

Usage: Event

Manual operation: See "Sequencer State" on page 85

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 201).

Suffix:
<n> irrelevant

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

Manual operation: See "Sequencer State" on page 85

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FSW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 201).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Suffix:
<n> irrelevant

Parameters:
<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Manual operation: See "Sequencer Mode" on page 85

[SENSe]:BURSt:COUNt <Count>
[SENSe:]SWEep:COUNt <SweepCount>

These commands define the number of measurements the R&S FSW uses to average traces.

In case of continuous sweep measurements, the R&S FSW calculates the moving average over the Statistic Count.

In case of single sweep measurements, the R&S FSW stops the measurement and calculates the average after Statistic Count measurements.

Parameters:

<SweepCount> If you set a sweep count of 0 or 1, the R&S FSW performs one single measurement.

Range: 0 to 32767
*RST: 200

Example:

`SWE:COUN 64`
Sets the number of measurements to 64.
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*OPC?`
Starts a series of 64 measurements and waits till its end.

Usage: SCPI confirmed

Manual operation: See "Statistic Count" on page 125
See "Noise Average Count" on page 163

[SENSe:]SWEep:COUNt:CURRent?

This command returns the currently reached number of frames or measurements used for statistical evaluation. It can be used to track the progress of the averaging process until it reaches the set "Statistic Count" (see `[SENSe:]SWEep:COUNt` on page 252).

For Trigger to Sync measurements, use the `[SENSe:]SWEep:COUNt:TRGS:CURRent?` command to query the number of data acquisitions that contribute to the current result.

Usage: Query only

[SENSe:]SWEep:COUNt:TRGS:CURRent?

This command returns the currently reached number of data acquisitions that contribute to the Trigger to Sync result. It can be used to track the progress of the averaging process until it reaches the set "Statistic Count" (see `[SENSe:]SWEep:COUNt` on page 252).

For GSM measurements other than Trigger to Sync, use the `[SENSe:]SWEep:COUNt:CURRent?` command to query the number of frames or measurements that contribute to the current result.

Usage: Query only

11.5.6 Demodulation

Demodulation settings determine how frames and slots are detected in the input signal and which slots are to be evaluated.

The commands for frame and slot configuration are described in Chapter 11.5.1.2, "Frame", on page 208 and Chapter 11.5.1.3, "Slot", on page 209.

11.5.6.1 Slot Scope

The slot scope defines which slots are to be evaluated (see also Chapter 5.6, "Defining the Scope of the Measurement", on page 52).

CONFigure[:MS]:CHANnel:MSLots:MEASure <SlotToMeasure>

This command specifies the slot to be measured in single-slot measurements relative to the GSM frame boundary.

Parameters for setting and query:

<SlotToMeasure> Slot to measure in single-slot measurements.

*RST: 0 Slots

Example: `CONF:CHAN:MSL:MEAS 5`

Manual operation: See "Slot to Measure" on page 128

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:MSLots:NOFSlots <NofSlotsToMeas>

This command specifies the number of slots to measure for the measurement interval of multi-slot measurements, i.e. the "Power vs Time" and "Transient Spectrum" measurements. Between 1 and 8 consecutive slots can be measured.

Parameters for setting and query:

<NofSlotsToMeas> Number of slots to measure.

Range: 1 to 8
*RST: 8 Slots

Example: `CONF:CHAN:MSL:NOFS 5`

Manual operation: See "Number of Slots to measure" on page 128

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

CONFigure[:MS]:CHANnel:MSLots:OFFSet <FirstSlotToMeas>

This command specifies the start for the measurement interval for multi-slot measurements, i.e. the "Power vs Time" and "Transient Spectrum" measurements, relative to the GSM frame boundary.

Parameters for setting and query:

<FirstSlotToMeas> 0-based index for the first slot to measure relative to the GSM frame start.

*RST: 0 Slots

Example: `CONF:CHAN:MSL:OFFS 5`

Manual operation: See "First Slot to measure" on page 128

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

11.5.6.2 Demodulation

The demodulation settings provide additional information to optimize frame, slot and symbol detection.

CONFigure[:MS]:SYNC:MODE <Mode>

This command sets the synchronization mode of the R&S FSW-K10.

Parameters for setting and query:

<Mode> ALL | TSC | BURSt | NONE

ALL
First search for the power profile (burst search) according to the frame configuration in the capture buffer. Second, inside the found bursts search for the TSC of the "Slot to measure" as given in the frame configuration. "ALL" is usually faster than "TSC" for bursted signals.

TSC
Search the capture buffer for the TSC of the "Slot to measure" as given in the frame configuration. This mode corresponds to a correlation with the given TSC. This mode can be used for continuous (but framed) signals or bursted signals.

BURSt
Search for the power profile (burst search) according to the frame configuration in the capture buffer.
Note: For "Burst" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

NONE
Do not synchronize at all. If an external or power trigger is chosen, the trigger instant corresponds to the frame start.
Tip: Manually adjust the trigger offset to move the burst to be analyzed under the mask in the "Power vs Time" measurement.
Note: For "None" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

*RST: ALL

Example: `CONF:SYNC:MODE TSC`

Manual operation: See "Synchronization" on page 130

CONFigure[:MS]:SYNC:ONLY <State>

If activated, only results from frames (slots) where the "Slot to measure" was found are displayed and taken into account in the averaging of the results. The behavior of this function depends on the value of the"Synchronization" parameter (see `CONFigure[:MS]:SYNC:MODE` on page 254).

Parameters for setting and query:

<State> ON | OFF

*RST: ON

Example: `CONF:SYNC:MODE TSC`
Search the capture buffer for the TSC of the "Slot to measure" as given in the frame configuration.
`CONF:SYNC:ONLY ON`
Only if the TSC is found, the results are displayed.

Manual operation: See "Measure only on Sync" on page 130

CONFigure[:MS]:SYNC:IQCThreshold <Value>

This command sets the IQ correlation threshold. The IQ correlation threshold decides whether a burst is accepted if "Measure only on Sync" is activated. If the correlation value between the ideal IQ signal of the given TSC and the measured TSC is below the IQ correlation threshold, then the application reports "Sync not found" in the status bar. Additionally, such bursts are ignored if "Measure only on Sync" is activated.

Parameters for setting and query:

<Value> Range: 0 to 100
*RST: 85
Default unit: NONE

Example: `CONF:SYNC:IQCT 0`

Manual operation: See "I/Q Correlation Threshold" on page 130

CONFigure[:MS]:DEMod:DECision <Value>

This command determines how the symbols are detected in the demodulator. The setting of this parameter does not effect the demodulation of Normal Bursts with GMSK modulation.

For Normal Bursts with 8PSK, 16QAM, 32QAM or AQPSK modulation or Higher Symbol Rate Bursts with QPSK, 16QAM or 32QAM modulation use this parameter to get a trade-off between performance (symbol error rate of the K10) and measurement speed.

Parameters for setting and query:

<Value> AUTO | LINear | SEQuence

AUTO
Automatically selects the symbol decision method.

LINear
Linear symbol decision: Uses inverse filtering (a kind of zero-forcing filter) and a symbol-wise decision method. This method is recommended for high symbol to noise ratios, but not for Higher Symbol Rate bursts with a narrow pulse. The inverse filter colors the noise inside the signal bandwidth and therefore is not recommended for narrow-band signals or signals with a low signal to noise ratio. Peaks in the "EVM vs Time" measurement (see "EVM" on page 18) may occur if the "Linear" symbol decision algorithm fails. In that case use the "Sequence" method. Linear is the fastest option.

SEQuence
Symbol decision via sequence estimation. This method uses an algorithm that minimizes the symbol errors of the entire burst. It requires that the tail bits in the analyzed signal are correct. It has a better performance (lower symbol error rate) compared to the "Linear" method, especially at low signal to noise ratios, but with a loss of measurement speed. This method is recommended for normal bursts with 16QAM or 32QAM modulation and for Higher Symbol Rate bursts with a narrow pulse.

*RST: AUTO

Example: // Use 'sequence estimator' for the symbol decision

```
CONFigure:MS:DEMod:DECision SEQuence
```

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.2, "Programming Example: Measuring an AQPSK Signal", on page 370.

Manual operation: See "Symbol Decision" on page 131

CONFigure[:MS]:DEMod:STDBits <Value>

The demodulator of the R&S FSW GSM application requires the bits of the burst (Tail, Data, TSC, Data, Tail) to provide an ideal version of the measured signal. The "Data" bits can be random and are typically not known inside the demodulator of the R&S FSW GSM application.

Parameters for setting and query:

<Value> DETected | STD

DETected
The detected tail and TSC bits are used to construct the ideal signal.

STD
The standard tail and TSC bits (as set using `CONFigure[:MS]:CHANnel:SLOT<s>:TSC`) are used to construct the ideal signal.
Using the standard bits can be advantageous to verify whether the device under test sends the correct tail and TSC bits. Incorrect bits would lead to peaks in the "EVM vs Time" trace (see "EVM" on page 18) at the positions of the incorrect bits.

*RST: DETected

Example: // Replace detected Tail & TSC bits by the standard bits
`CONFigure:MS:DEMod:STDBits STD`
For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

Manual operation: See "Tail & TSC Bits" on page 131

11.5.7 Measurement

Measurement settings define how power or spectrum measurements are performed.

11.5.7.1 Power vs Time

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see Chapter 5.7.1, "Power vs Time Filter", on page 55).

CONFigure:BURSt:PTEMplate:FILTer <Type>

The PvT Filter controls the filter used to reduce the measurement bandwidth for "Power vs Time" measurements.

The PvT filter is optimized to get smooth edges after filtering burst signals and to suppress adjacent, active channels.

Depending on the device type (single carrier or multicarrier, see `CONFigure[:MS]:DEVice:TYPE` on page 203), different PvT filters are supported.

Parameters for setting and query:

<Type>

G1000
Default for single carrier device, Gaussian Filter, 1000 kHz

B600
(single carrier only) Gaussian Filter, 600 kHz

G500
(single carrier only) Gaussian Filter, 500 kHz

MC400
Recommended for measurements with multi channels of equal power.

MC300
Recommended for measurement scenarios where a total of six channels is active and the channel to be measured has a reduced power (e.g. 30 dB) compared to its adjacent channels.

*RST: G1000 (single carrier), MC400 (multicarrier)

Example: `CONF:BURS:PTEM:FILT G500`

Manual operation: See "Power vs Time Filter" on page 132

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

CONFigure:BURSt:PTEMplate:TALign <Mode>

This command controls the time-alignment of the limit lines for the "Power vs Time" measurement (see "PvT Full Burst" on page 28).

Parameters for setting and query:

<Mode> STMeasure | PSLot

STMeasure
For each slot the mid of TSC is derived from the measured mid of TSC of the "Slot to measure" and the timeslot lengths specified in the standard (see "Timeslot length" in 3GPP TS 45.010).

PSLot
For each slot the mid of TSC is measured. This provides reasonable time-alignment if the slot lengths are not according to standard. However, the "Power vs Time" limit check is also passed.

*RST: STMeasure

Example: `CONF:BURS:PTEM:TAL PSL`

Manual operation: See "Limit Line Time Alignment" on page 133

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

11.5.7.2 Spectrum

The modulation and transient spectrum measurements allow for further configuration.

CONFigure:SPECtrum:LIMit:LEFT <State>

This command controls the left limit check of the spectrum trace (spectrum graph measurement) and which offset frequencies in the table (spectrum list measurement) are checked against the limit. This command affects the "Modulation Spectrum" and "Transient Spectrum" measurements.

Note: For measurements on multicarrier signals, use either the check on the left or right side to measure the spectrum of the left- or right-most channel and to ignore the side where adjacent channels are located.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

1 | ON
check limit

0 | OFF
do not check limit

*RST: 1

Example: `CONF:SPEC:LIM:LEFT OFF`

Manual operation: See "Enable Left Limit/ Enable Right Limit" on page 134

CONFigure:SPECtrum:LIMit:RIGHt <State>

This command controls the right limit check of the spectrum trace (spectrum graph measurement) and which offset frequencies in the table (spectrum list measurement) are checked against the limit. This command affects the "Modulation Spectrum" and "Transient Spectrum" measurements.

Note: For measurements on multicarrier signals, use either the check on the left or right side to measure the spectrum of the left- or right-most channel and to ignore the side where adjacent channels are located.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

1 | ON
check limit

0 | OFF
do not check limit

*RST: 1

Example: `CONF:SPEC:LIM:LEFT OFF`

Manual operation: See "Enable Left Limit/ Enable Right Limit" on page 134

CONFigure:SPECtrum:SWITching:TYPE <DetectorMode>

This command is retained for compatibility with R&S FSW-K5 only.

Parameters for setting and query:

<DetectorMode> PEAK | RMS

*RST: RMS

Example: `CONFigure:SPECtrum:SWITching:TYPE?`

Manual operation: See "Transient Spectrum: Reference Power" on page 135

CONFigure:SPECtrum:SWITching:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "Transient Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit. This command is only available when the "Transient Spectrum" measurement is selected (see `CONFigure:SPECtrum:SWITching[:IMMediate]` on page 359).

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example:

// Select Transient Spectrum measurement
// (measurement on captured I/Q data)
`CONFigure:SPECtrum:SWITching:IMMediate`
// Only list results are required
`CONFigure:SPECtrum:SELect LIST`
// Absolute power and limit results in dBm
`CONFigure:SPECtrum:SWITching:LIMit ABSolute`
// Run one measurement and query absolute list results
`READ:SPECtrum:SWITching:ALL?`
// -> 0,933200000,933200000,-101.55,-36.00,ABS,PASSED, ...

CONFigure:SPECtrum:MODulation:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "Modulation Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit.

This command is only available if one of the following result displays are selected (see `LAYout:ADD[:WINDow]?` on page 275:

- "Modulation Spectrum"
- Inner / Outer Narrowband tables
- Inner / Outer Wide band tables
- Inner / Outer Intermodulation tables

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example: // Absolute power and limit results in dBm
`CONFigure:SPECtrum:MODulation:LIMit ABSolute`
// Run one measurement and query absolute list results
`READ:SPECtrum:MODulation:ALL?`
// -> 0,933200000,933200000,-108.66,-65.00,ABS,PASSED, ...

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

CONFigure:WSPectrum:MODulation:LIST:SELect <Mode>

For Modulation Spectrum Table measurements, this command controls whether offset frequencies are measured up to 1800 kHz or 5800 kHz.

Parameters for setting and query:

<Mode> **NARRow**
The frequency list comprises offset frequencies up to 1.8 MHz from the carrier. The sample rate is 6.5 MHz.

NSParse
More compact version of "NARRow". The sample rate is 6.5 MHz.

WIDE
The frequency list comprises offset frequencies up to 6 MHz from the carrier. The sample rate is 19.5 MHz.

WSParse
More compact version of `WIDE`. The sample rate is 19.5 MHz.

*RST: WIDE

Example: `CONFigure:WSPectrum:MODulation:LIST:SELect NARRow`

Manual operation: See "Modulation Spectrum Table: Frequency List" on page 135

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

[SENSe:]BANDwidth[:RESolution]:TYPE <Type>

This command switches the filter type for the resolution filter for the "Modulation Spectrum", "Transient Spectrum" and "Wide Modulation Spectrum" measurement.

Parameters for setting and query:

<Type> NORMal | P5

NORMal
Gaussian filter with a 3 dB bandwidth of either 30 kHz or 100 kHz. This value is retained for compatibility with R&S FS-K5 only.

P5
5 Pole filter with a 3 dB bandwidth of either 30 kHz or 100 kHz. This filter is required by the GSM standard specification.

*RST: P5

Example: `BAND:TYPE NORM`

Manual operation: See "Filter Type" on page 134

READ:WSPectrum:MODulation:GATing?

This command reads out the gating settings for gated "Modulation Spectrum" measurements (see "Modulation Spectrum Table" on page 24).

The returned values can be used to set the gating interval for "list" measurements (i.e. a series of measurements in zero span mode at several offset frequencies). This is done in the "Spectrum" mode using the `SENSe:LIST` subsystem (see `[SENSe:]LIST:POWer:SET`).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see Chapter 11.5.4, "Triggering Measurements", on page 238).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

Example: `READ:WSP:MOD:GAT?`
Result:
`0.00032303078,0.00016890001`

Usage: Query only

11.5.7.3 Trigger to Sync

CONFigure:TRGS:NOFBins <Value>

This command specifies the number of bins for the histogram of the "Trigger to Sync" measurement.

Parameters for setting and query:

<Value> numeric value

Number of bins

Range: 10 to 1000
*RST: 10
Default unit: NONE

Manual operation: See "No. of Bins" on page 136

CONFigure:TRGS:ADPSize <Value>

This command specifies the number of measurements after which the x-axis is fixed for the histogram calculation of the "Trigger to Sync" measurement.

Parameters for setting and query:

<Value> numeric value

Adaptive data size

Range: 10 to 1000
*RST: 100
Default unit: NONE

Manual operation: See "Adaptive Data Size" on page 137

11.5.8 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

CONFigure[:MS]:AUTO:FRAMe ONCE <Value>

This command automatically performs a single measurement to detect the optimal frame configuration (i.e. frame and slot parameters) depending on the current measurement settings and results.

This function is **not** available in **MSRA** mode if the **Sequencer** is active.

Note that in Signal and Spectrum Analyzer mode, if the **Sequencer** is active, this command cannot be aborted via the `ABORt` command!

Example: `CONF:AUTO:FRAM ONCE`

Manual operation: See "Automatic Frame Configuration" on page 138

CONFigure[:MS]:AUTO:LEVel ONCE

This command is used to perform a single measurement to detect the required level automatically.

This command is **not** available in **MSRA** mode.

Note that this command cannot be aborted via the `ABORt` command!

Example: `CONF:AUTO:LEV ONCE`

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 137

CONFigure[:MS]:AUTO:TRIGger ONCE

This command is used to perform a single measurement that determines the trigger offset automatically.

This command is **not** available in **MSRA** mode.

Note that in Signal and Spectrum Analyzer mode, if the **Sequencer** is active, this command cannot be aborted via the `ABORt` command! This can lead to a hang up situation when no trigger signal is available or the trigger level is not set correctly. Use a `device clear` to abort the operation correctly.

Example: `CONF:AUTO:TRIG ONCE`

Usage: Setting only

Manual operation: See "Automatic Trigger Offset" on page 138

CONFigure[:MS]:POWer:AUTO:SWEep:TIME <Value>

This command is used to specify the auto track time, i.e. the capture time for auto detection.

This setting can currently only be defined in remote control, not in manual operation.

Tip: increase this value if less than every second GSM frame contains a signal.

Parameters for setting and query:

<Value> numeric value

Auto level measurement sweep time

Range: 0.01 to 1
*RST: 0.1 s
Default unit: S

Example: `CONF:POW:AUTO:SWE:TIME 0.01 MS`

[SENSe:]ADJust:FREQuency

This function adjusts the center frequency and ARFCN (I/Q mode only) automatically.

For multicarrier measurements, all carrier settings are automatically adjusted (see Chapter 6.3.2.4, "Carrier Settings", on page 98).

This command is not available when using the Digital Baseband Interface (R&S FSW-B17) or the Analog Baseband Interface (R&S FSW-B71).

Example: `ADJ:FREQ`

Usage: Event

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 137

11.6 Configuring and Performing MCWN Measurements

A new separate measurement is provided by the R&S FSW GSM application to determine the wideband noise in multicarrier measurement setups (see Chapter 4.2, "Multi-carrier Wideband Noise Measurements", on page 34).

11.6.1 Signal Description

The commands required for signal description are described in:

- Chapter 11.5.1.1, "Device under Test Settings", on page 203
- Chapter 11.5.1.4, "Carrier", on page 216

11.6.2 Input/Output and Frontend Settings

The commands required for input, output and amplitude settings are described in:

- Chapter 11.5.2.1, "RF Input", on page 219
- Chapter 11.5.2.5, "Configuring the Outputs", on page 231
- Chapter 11.5.3.2, "Amplitude Settings", on page 234

11.6.2.1 Frequency Settings

The frequency span to be measured can be defined using a start and stop frequency, or a center frequency and span; alternatively, it can be set to a specific characteristic value automatically.

Useful commands for frequency settings described elsewhere:

- `CONFigure[:MS]:ARFCn` on page 232
- `[SENSe:]FREQuency:CENTer` on page 232
- `[SENSe:]FREQuency:CENTer:STEP` on page 233
- `[SENSe:]FREQuency:OFFSet` on page 233

Remote commands exclusive to frequency settings in MCWN measurements

---

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

Usage: SCPI confirmed

Manual operation: See "Span" on page 149

SENSe:FREQuency:SPAN:MODE <Mode>

This command sets the span for the MCWN measurement to a predefined value.

Parameters:

<Mode>

TXBand
The span for the MCWN measurement is set to the TX band ±2 MHz (for single carrier BTS or MS) or ±10 MHz (for multicarrier BTS device types).

CNARrow
The span is set to the span of the active carriers, plus a margin of 1.8 MHz to either side.
This setting is suitable for narrowband noise measurements.

CWIDe
The span is set to the span of the active carriers, plus a margin of 6 MHz to either side.
This setting is suitable for narrowband noise and most of the wideband noise and intermodulation measurements.

MANual
the frequency span is defined by a start and stop frequency, or a center frequency and span.

*RST: TXB

Example:

```
FREQ:SPAN:MODE MAN
FREQ:SPAN:STAR 9150000
FREQ:SPAN:STOP 970000000
```

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Setting the Span to Specific Values Automatically" on page 149

[SENSe:]FREQuency:STARt <Frequency>

Parameters:

<Frequency> 0 to (fmax - min span)

*RST: 0

Example: `FREQ:STAR 20MHz`

Usage: SCPI confirmed

Manual operation: See "Start / Stop" on page 149

[SENSe:]FREQuency:STOP <Frequency>

Parameters:

<Frequency> min span to fmax

*RST: fmax

Example: `FREQ:STOP 2000 MHz`

Usage: SCPI confirmed

Manual operation: See "Start / Stop" on page 149

11.6.3 Triggering Measurements

The commands for triggering measurements are described in:

- Chapter 11.5.4, "Triggering Measurements", on page 238

11.6.4 Configuring the Reference Measurement

Reference power levels can either be defined manually or determined automatically by a reference measurement prior to the noise measurement. the following commands are required to configure the reference measurement.

CONFigure:SPECtrum:MODulation:REFerence:AVERage:COUNt <Number>

This command defines the number of reference measurements to be performed in order to determine the average reference values.

This value is ignored if no reference measurement is performed (see CONFigure:SPECtrum:MODulation:REFerence:MEASure on page 270).

Parameters:

<Number> integer value

Range: 1..32767
*RST: 10

Example: `CONF:SPEC:MOD:REF:AVER:COUN 5`

Manual operation: See "Reference Average Count" on page 162

CONFigure:SPECtrum:MODulation:REFerence:CARRier[:AUTO] <State>

This command specifies whether the carrier at which the reference powers for the MCWN measurement are measured is selected automatically (if reference power measurement is enabled, see CONFigure:SPECtrum:MODulation:REFerence:MEASure on page 270).

Parameters:

<State> ON | OFF

ON
The carrier with the maximum power level is selected as a reference.

OFF
The carrier to be used as a reference must be specified using CONFigure:SPECtrum:MODulation:REFerence:CARRier:NUMBer on page 269.

*RST: ON

Example:
```
CONF:SPEC:MOD:REF:MEAS ON
CONF:SPEC:MOD:REF:CARR:AUTO OFF
CONF:SPEC:MOD:REF:CARR:AUTO:NUMB 2
```

Manual operation: See "Carrier Selection / Carrier" on page 165

CONFigure:SPECtrum:MODulation:REFerence:CARRier:NUMBer <CarrNo>

This command specifies the carrier at which the reference powers for the MCWN measurement are measured (if reference power measurement is enabled, see CONFigure:SPECtrum:MODulation:REFerence:MEASure on page 270).

Parameters:

<CarrNo> Number of the active carrier after which the gap starts.

Range: 1..16
*RST: 1

Example:
```
CONF:SPEC:MOD:REF:MEAS ON
CONF:SPEC:MOD:REF:CARR:AUTO OFF
CONF:SPEC:MOD:REF:CARR:AUTO:NUMB 2
```

Manual operation: See "Carrier Selection / Carrier" on page 165

CONFigure:SPECtrum:MODulation:REFerence:MEASure <State>

This command specifies whether a reference power measurement is performed.

Parameters:

<State> ON | OFF

ON
The reference powers of all active carriers are measured for MCWN measurements.

OFF
the reference powers must be defined manually (see `CONFigure:SPECtrum:MODulation:REFerence:PLEVel` on page 270).

*RST: ON

Example: `CONF:SPEC:MOD:REF:MEAS OFF`

Manual operation: See "Enabling a reference power measurement (Measure)" on page 164
See "Defining Reference Powers Manually" on page 165

CONFigure:SPECtrum:MODulation:REFerence:PLEVel <Level>

This command defines the reference power level for MCWN measurements (if no reference measurement is performed, see `CONFigure:SPECtrum:MODulation:REFerence:MEASure` on page 270).

Parameters:

<Level> power level in dBm

*RST: 0.00

Example:
```
CONF:SPEC:MOD:REF:MEAS OFF
CONF:SPEC:MOD:REF:PLEV 35
```

Manual operation: See "Power Level" on page 165

CONFigure:SPECtrum:MODulation:REFerence:RPOWer <RBW>,<Level>

This command defines the reference power level using different RBWs for MCWN measurements (if no reference measurement is performed, see `CONFigure:SPECtrum:MODulation:REFerence:MEASure` on page 270).

The query returns the measured values and is only available if a reference measurement is performed.

Parameters:

<Level> reference power level in dBm (without a unit!)

Parameters for setting and query:

<RBW> RBW in Hz

30e3
Reference power for RBW = 30 kHz

100e3
Reference power for RBW = 100 kHz

300e3
Reference power for RBW = 300 kHz

Example:
```
CONF:SPEC:MOD:REF:MEAS OFF
CONF:SPEC:MOD:REF:PLEV        35
CONF:SPEC:MOD:REF:RPOW 300e3, 34.7
CONF:SPEC:MOD:REF:RPOW 100e3, 32.8
CONF:SPEC:MOD:REF:RPOW  30e3, 27.2
```

Example:
```
CONF:SPEC:MOD:REF:MEAS ON
CONF:SPEC:MOD:REF:RPOW? 30e3
```
Queries the measured reference power level for an RBW of 30 kHz.

Manual operation: See "Ref Power (RBW 300 kHz)" on page 165
See "Ref Power (RBW 100 kHz)" on page 165
See "Ref Power (RBW 30 kHz)" on page 166

11.6.5 Configuring the Noise Measurement

The noise measurement can provide various results. The following commands are required to configure the noise measurement.

Useful commands for configuring noise measurements described elsewhere:

- `[SENSe:]SWEep:COUNt` on page 252

Remote commands exclusive to configuring noise measurements:

CONFigure:SPECtrum:IMPorder <Order>

This command defines for which order of intermodulation products the noise measurement determines the level.

Parameters:

<Order> 0 | 3 | 3,5

0
No intermodulation products are measured.

3
IM products order of 3 are measured

3,5
IM products order of 3 and 5 are measured

*RST: 3,5

Example: `CONF:SPEC:IMP 3`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Intermodulation" on page 167

CONFigure:SPECtrum:LIMit:EXCeption[:STATe] <State>

If enabled, exceptions from the limit line check as defined in the 3GPP standard are applied to the limit checks of the MCWN measurements.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:SPEC:LIM:EXC OFF`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Adapting the limit lines for wideband noise (Apply Exceptions)" on page 167

CONFigure:SPECtrum:NNARrow <State>

If enabled, narrowband noise is measured as part of the MCWN measurement. Narrowband noise is measured with an RBW of 30 kHz at 3 single offset frequencies below the lowermost active carrier of the lower sub-block and above the uppermost active carrier of the upper sub-block.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:SPEC:NNAR OFF`

Manual operation: See "Narrowband Noise (<1.8 MHz)" on page 167

CONFigure:SPECtrum:NWIDe <State>

If enabled, wideband noise is measured as part of the MCWN measurement. Wideband noise is measured with an RBW of 100 kHz over the defined span (typically the RF bandwidth).

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:SPEC:NWID OFF`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Manual operation: See "Wideband Noise (≥1.8 MHz)" on page 167

11.6.6 Adjusting Settings Automatically

The commands required to adjust settings automatically are described in:

- Chapter 6.4.9, "Adjusting Settings Automatically", on page 167

11.6.7 Performing Sweeps

The commands required to perform sweeps are described in:

- Chapter 11.5.5.2, "Configuring and Performing Sweeps", on page 247

11.7 Analyzing GSM Measurements

General analysis settings and functions concerning the trace, markers, windows etc. are available for GSM measurement results.

11.7.1 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

11.7.1.1 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 278).

Suffix:

<n> Window

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

11.7.1.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value
Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD:WIND? '1',RIGH,MACC`
Adds a Modulation Accuracy display to the right of window 1.

Usage: Query only

Manual operation: See "Constellation" on page 18
See "EVM" on page 18
See "Magnitude Capture" on page 19
See "Magnitude Error" on page 20
See "Marker Table" on page 20
See "Modulation Accuracy" on page 21
See "Modulation Spectrum Graph" on page 23
See "Modulation Spectrum Table" on page 24
See "Phase Error" on page 26
See "Power vs Slot" on page 27
See "PvT Full Burst" on page 28
See "Transient Spectrum Graph" on page 29
See "Transient Spectrum Table" on page 30
See "Trigger to Sync Graph" on page 32
See "Trigger to Sync Table" on page 33
See "Spectrum Graph" on page 35
See "Carrier Power Table" on page 36
See "Inner IM Table" on page 37
See "Outer IM Table" on page 38
See "Inner Narrow Band Table" on page 39
See "Outer Narrowband Table" on page 39
See "Inner Wideband Table" on page 41
See "Outer Wideband Table" on page 42

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

Table 11-4: <WindowType> parameter values for GSM application

Parameter value	Window type
Default I/Q (Modulation Accuracy,...) measurement:	
CONStell	Constellation
ETIMe	EVM vs. Time
MCAPture	Magnitude Capture
MERRor	Magnitude Error vs. Time
MTABle	Marker Table
MACCuracy	Modulation Accuracy
MSFDomain	Modulation Spectrum Graph (Frequency domain)
MSTable	Modulation Spectrum Table
PERRor	Phase Error vs. Time
PSTable	Power vs. Slot
PTFull	PvT Full Burst
TGSGraph	Trigger vs. Sync Graph
TGSTable	Trigger to Sync Table
TSFDomain	Transient Spectrum Graph (Frequency domain)

Parameter value	Window type
TSTable	Transient Spectrum Table
Multicarrier wideband noise measurement:	
IIMProducts	Inner IM Table
INAR	Inner Narrowband Table
IWID	Inner Wideband Table
OIMProducts	Outer IM Table
ONAR	Outer Narrowband Table
OWID	Outer Wideband Table
WSFDomain	Spectrum Graph
WSRPower	Carrier Power Table

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:
<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:
<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:
<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 275 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 274 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

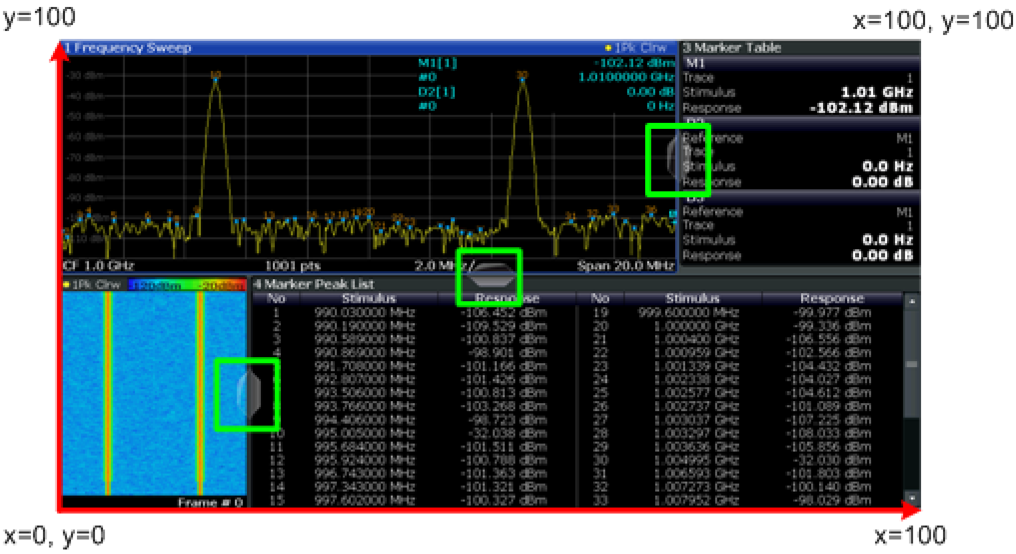


Figure 11-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 11-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:
<n> Window

Parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 275 for a list of available window types.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:
<n> Window

Parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 275 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

LAYout:WINDow<n>:TYPe?

Queries the window type of the window specified by the index <n>. For a list of possible window types see `LAYout:ADD[:WINDow]?` on page 275.

Suffix:
<n> Window

Example: `LAY:WIND2:TYPE?`
Response:
`MACC`
Modulation accuracy

Usage: Query only

11.7.2 Result Config

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window.

11.7.2.1 Traces

The number of available traces depends on the selected window (see "Specifics for" on page 89). Only graphical evaluations have trace settings.

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Suffix:
<n> Window

<t> Trace

Parameters:
<State> ON | OFF | 1 | 0
*RST: 1 for TRACe1, 0 for TRACe 2 to 6

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4" on page 170
See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 171

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command controls whether a trace is displayed or not, and in which mode. Each trace can only display a certain mode, or nothing at all ("Blank"). Table 11-5 below indicates which measurements can display which traces and which trace modes.

Note: even if a trace is not displayed, the results can still be queried (see `TRACe<n>[:DATA]?` on page 297).

In case of max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

For a description of the trace modes see the "Trace Mode Overview" section in the base unit manual.

Suffix:

<n> Window

<t> Trace

Parameters:

<Mode>

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

BLANk
Hides the selected trace.

MAXHold
The maximum value is determined over several measurements and displayed. The R&S FSW saves the measurement result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSW saves the measurement result in the trace memory only if the new value is lower than the previous one.

PDFavg
The probability density function (PDF) of the average value.

WRITe
Overwrite mode: the trace is overwritten by each sweep.

Example:

// Preset the instrument
```
*RST
```
// Enter the GSM option K10
```
INSTrument:SELect GSM
```
// Switch to single sweep mode and stop measurement
```
INITiate:CONTinuous OFF;:ABORt
```
// Modulation spectrum graph measurement
```
LAY:ADD:WIND? '1',RIGH,MSFD
```
//Result: 2
```
INITiate:IMMediate
```
// Switch off the display of all available traces
```
DISPlay:WINDow2:TRACe1:MODE BLANk
DISPlay:WINDow2:TRACe2:MODE BLANk
```
// Switch on the display of all available traces again
```
DISPlay:WINDow2:TRACe1:MODE AVERage
DISPlay:WINDow2:TRACe2:MODE WRITe
```

Manual operation: See "Trigger to Sync Graph" on page 32
See "Trace Mode" on page 170

Table 11-5: Available traces and trace modes for the result diplays

Measurement	Trace 1	Trace 2	Trace 3	Trace 4
Magnitude Capture Constellation Graph	WRITe	-	-	-
EVM Phase Error Magnitude Error PvT Full Burst	AVERage	MAXHold	MINHold	WRITe
Modulation Spectrum Graph Transient Spectrum Graph	AVERage	WRITe	-	-
Trigger to Sync	WRITe (histogram)	PDFavg	-	-
Spectrum Graph (MCWN mode)	AVERage	-	-	-

11.7.2.2 Marker

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display. Up to 4 markers can be configured.

Individual Marker Settings

In GSM evaluations, up to 4 markers can be activated in each diagram at any time. the following commandas are required to configure the markers.

CALCulate<n>:DELTamarker<m>:AOFF

This command turns *all* delta markers off.

Suffix:

<n> Window

<m> irrelevant

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 172
See "Marker Type" on page 173

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> Window

<m> Marker

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 172
See "Marker Type" on page 173

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 173

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:

<Trace> **1 to 4**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual operation: See "Assigning the Marker to a Trace" on page 173

General Marker Settings

The following commands define general settings for all markers.

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode> **ON**
Turns the marker table on.
OFF
Turns the marker table off.
*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 174

Marker Positioning Settings

The following commands are required to set a specific marker to the result of a peak search.

CALCulate<n>:MARKer<m>:MAXimum:APEak

sets the marker to the largest absolute peak value (maximum or minimum) of the selected trace.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Max |Peak|" on page 175

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Peak Search" on page 174

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Minimum" on page 175

CALCulate<n>:DELTamarker<m>:MAXimum:APEak

This command positions the active marker or deltamarker on the largest absolute peak value (maximum or minimum) of the selected trace.

Suffix:
<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Peak Search" on page 174

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Minimum" on page 175

11.7.2.3 Scaling

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These commands are described here.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO <State>

If enabled, the Y-axis is scaled automatically according to the current measurement.

Suffix:

<n> Window

<t> irrelevant

Parameters for setting and query:

<State>

OFF
Switch the function off

ON
Switch the function on

*RST: ON

Manual operation: See "Automatic Grid Scaling" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for all traces in the selected result display.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Value> <numeric value>

*RST: depends on the result display

The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for all traces in the selected result display.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Value> <numeric value>

*RST: depends on the result display

The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Value> numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Per Division" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid (for all traces).

The R&S FSW adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.
*RST: 100 PCT = frequency display; 50 PCT = time display

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual operation: See "Ref Position" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

The command defines the power value assigned to the reference position in the grid (for all traces).

For external generator calibration measurements (requires the optional External Generator Control), this command defines the power offset value assigned to the reference position.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Value> *RST: 0 dBm, coupled to reference level

Example: `DISP:TRAC:Y:RVAL -20dBm`
Sets the power value assigned to the reference position to -20 dBm

Manual operation: See "Ref Value" on page 176

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MAXimum <Value>

This command defines the maximum value on the y-axis for all traces in the specified window.

Suffix:

<n>	Window
<t>	irrelevant

Parameters:

<Value>	numeric value Default unit: dBm

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MINimum <Value>

This command defines the minimum value on the y-axis for all traces in the specified window.

Suffix:

<n>	Window
<t>	irrelevant

Parameters:

<Value>	numeric_value Default unit: dBm

11.7.3 Configuring an Analysis Interval and Line (MSRA mode only)

In MSRA operating mode, only the MSRA Master actually captures data; the MSRA slave applications define an extract of the captured data for analysis, referred to as the **analysis interval**. The **analysis line** is a common time marker for all MSRA slave applications.

For the GSM slave application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see Chapter 11.5.5.1, "Data Acquisition", on page 245. Be sure to select the correct measurement channel before executing these commands.

In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval for the GSM measurement.

Remote commands exclusive to MSRA slave applications

The following commands are only available for MSRA slave application channels:

CALCulate<n>:MSRA:ALINe:SHOW

This command defines whether or not the analysis line is displayed in all time-based windows in all MSRA slave applications and the MSRA Master.

Note: even if the analysis line display is off, the indication whether or not the currently defined line position lies within the analysis interval of the active slave application remains in the window title bars.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: ON

CALCulate<n>:MSRA:ALINe[:VALue] <Position>

This command defines the position of the analysis line for all time-based windows in all MSRA slave applications and the MSRA Master.

Suffix:

<n> irrelevant

Parameters:

<Position> Position of the analysis line in seconds. The position must lie within the measurement time of the MSRA measurement.

Default unit: s

CALCulate<n>:MSRA:WINDow<n>:IVAL?

This command queries the analysis interval for the window specified by the WINDow suffix <n> (the CALC suffix is irrelevant). This command is only available in slave application measurement channels, not the MSRA View or MSRA Master.

Suffix:

<n> Window

Return values:

<IntStart> Start value of the analysis interval in seconds

Default unit: s

<IntStop> Stop value of the analysis interval in seconds

Usage: Query only

CALCulate<n>:MSRA:WINDow<n>:MIVal?

This command queries the individual analysis intervals in the window specified by the WINDow suffix <n> (the CALC suffix is irrelevant). This command is only available for GSM measurement channels (R&S FSW-K10) in MSRA mode, and only for result displays that display traces with a history, i.e. maxhold, minhold or average traces.

The result is a comma-separated list of <IntStart>,<IntStop> values for each interval.

Return values:

<IntStart> Start value of the analysis interval in seconds (global time scale)

Default unit: s

<IntStop> Stop value of the analysis interval in seconds (global time scale)

Example:
```
CALC:MSRA:WIND2:MIV?
```
//Result:
```
+3.707922995E-003,+4.509000108E-003,
+8.323308080E-003,+9.124384262E-003,
+1.293869223E-002,+1.373976935E-002
```

Usage: Query only

INITiate<n>:REFResh

This function is only available if the Sequencer is deactivated (SYSTem:SEQuencer SYST:SEQ:OFF) and only for slave applications in MSRA/MSRT mode, not the MSRA/MSRT Master.

The data in the capture buffer is re-evaluated by the currently active slave application only. The results for any other slave applications remain unchanged.

Suffix:

<n> irrelevant

Example:
```
SYST:SEQ:OFF
```
Deactivates the scheduler
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a new data measurement and waits for the end of the sweep.
```
INST:SEL 'IQ ANALYZER'
```
Selects the IQ Analyzer channel.
```
INIT:REFR
```
Refreshes the display for the I/Q Analyzer channel.

Usage: Event

Manual operation: See "Refresh (MSRA/MSRT only)" on page 126

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for slave applications in MSRA mode, not for the MSRA Master. It has a similar effect as the trigger offset in other measurements.

Parameters:

<Offset> This parameter defines the time offset between the capture buffer start and the start of the extracted slave application data. The offset must be a positive value, as the slave application can only analyze data that is contained in the capture buffer.

Range: 0 to <Record length>

*RST: 0

Manual operation: See "Capture Offset" on page 124

11.8 Retrieving Results

The following commands are required to retrieve the results from the GSM measurements.

11.8.1 Graphical Results

The results of the trace queries depend on the selected evaluation (see Chapter 11.8.2, "Measurement Results for TRACe<n>[:DATA]? TRACE<n>", on page 301).

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSW to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSW. The R&S FSW automatically recognizes the data it receives, regardless of the format.

Parameters:
<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:
<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator.
Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

[SENSe:]IQ:FFT:LENGth?

Queries the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

Return values:
<NoOfBins> integer value

Range: 3 to 524288
*RST: 1024

Example:
```
IQ:FFT:LENG?
// 2048
```

Usage: Query only
SCPI confirmed

TRACe<n>[:DATA]? <TraceNumber>

This command reads trace data out of the window specified by the suffix <n>. This command is only available for graphical result displays.

The returned values are scaled in the current level unit. The data format depends on `FORMat[:DATA]` on page 295.

For Constellation diagrams, the result is a vector of I/Q values for the measured points in the diagram. The result is returned as a list of (I,Q) value pairs.

Suffix:
<n> Window

Query parameters:
<TraceNumber> TRACe1 | TRACe2 | TRACe3 | TRACe4

Trace name to be read out

TRACe1
Average trace; (transient spectrum: Maximum trace)

TRACe2
Maximum trace

TRACe3
Minimum trace

TRACe4
Current trace

Example: `TRAC1:DATA? TRACe1`

Usage: Query only

Manual operation:
See "EVM" on page 18
See "Magnitude Capture" on page 19
See "Magnitude Error" on page 20
See "Modulation Spectrum Graph" on page 23
See "Phase Error" on page 26
See "PvT Full Burst" on page 28
See "Transient Spectrum Graph" on page 29
See "Trigger to Sync Graph" on page 32
See "Spectrum Graph" on page 35

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

TRACe<n>[:DATA]:X? <TraceNumber>

This command reads the x-values (time in seconds) of the "Power vs Time" measurement (if active) out of the window specified by the suffix <n>.

If a trace number is defined as a parameter for this command, the x-values (time in seconds) of the "Trigger to Sync" measurement (if active) out of the window specified by the suffix <n> are returned.

For details see Chapter 11.8.2.5, "Trigger to Sync Results", on page 303.

Suffix:

<n> Window

Query parameters:

<TraceNumber> TRACe1 | TRACe2 | TRACe3 | TRACe4

Trace number

TRACe1
Average trace; (Transient Spectrum: Maximum trace, Trigger to Sync: histogram values)

TRACe2
Maximum trace (Trigger to Sync: PDF of average trace)

TRACe3
Minimum trace

TRACe4
Current trace

Example:

`TRACe2:DATA:X?`
Returns the Power vs Time values for the active trace in window 2.
`TRACe3:DATA:X? TRACe1`
Returns the Trigger to Sync values for trace 1 in window 3.

Usage: Query only

Manual operation: See "PvT Full Burst" on page 28
See "Trigger to Sync Graph" on page 32

TRACe:IQ:DATA?

This command initiates a measurement with the current settings and returns the captured data from measurements with the I/Q Analyzer.

This command corresponds to:

`INIT:IMM;*WAI;: TRACe:IQ:DATA:MEMory?`

However, the `TRACe:IQ:DATA?` command is quicker in comparison.

Return values:

<Results> Measured voltage for I and Q component for each sample that has been captured during the measurement.
The data format depends on `TRACe:IQ:DATA:FORMat` on page 299.

Default unit: V

Example:

`TRAC:IQ:STAT ON`
Enables acquisition of I/Q data
`TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096`
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 0
Number of Samples = 4096
`FORMat REAL,32`
Selects format of response data
`TRAC:IQ:DATA?`
Starts measurement and reads results

Usage: Query only

TRACe:IQ:DATA:FORMat <Format>

This command selects the order of the I/Q data.

Parameters:

<Format> COMPatible | IQBLock | IQPair

COMPatible
I and Q values are separated and collected in blocks: A block (512k) of I values is followed by a block (512k) of Q values, followed by a block of I values, followed by a block of Q values etc. (I,I,I,I,Q,Q,Q,Q,I,I,I,I,Q,Q,Q,Q...)

IQBLock
First all I-values are listed, then the Q-values
(I,I,I,I,I,I,...Q,Q,Q,Q,Q,Q)

IQPair
One pair of I/Q values after the other is listed
(I,Q,I,Q,I,Q...).

*RST: IQBL

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

This command queries the I/Q data currently stored in the memory of the R&S FSW.

By default, the command returns all I/Q data in the memory. You can, however, narrow down the amount of data that the command returns using the optional parameters.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRACe:IQ:DATA?`. (Note, however, that the `TRAC:IQ:DATA?` command initiates a new measurement before returning the captured values, rather than returning the existing data in the memory.)

By default, the amount of available data depends on `TRACe:IQ:SRATe?` on page 247 and `[SENSe:]SWEep:TIME` on page 246.

Parameters:

<OffsetSamples> Selects an offset at which the output of data should start in relation to the first data. If omitted, all captured samples are output, starting with the first sample.

Range: 0 to <# of samples> – 1, with <# of samples> being the maximum number of captured values

*RST: 0

<NoOfSamples> Number of samples you want to query, beginning at the offset you have defined. If omitted, all captured samples (starting at offset) are output.

Range: 1 to <# of samples> - <offset samples> with <# of samples> maximum number of captured values

*RST: <# of samples>

Return values:

<IQData> Measured value pair (I,Q) for each sample that has been recorded.

The data format depends on `FORMat[:DATA]`.

Default unit: V

Example:

// Preset the instrument
`*RST`
// Enter GSM option
`INST:SEL GSM`
// Set center frequency to 935 MHz
`FREQ:CENT 935MHZ`
Sample Rate = 6.5 MHz
`TRAC:IQ:SRAT 6.5MHz`
Capture Time = 100 ms
`SET:SWE:TIME 0.1 s`
// Set statistic count to 1 to obtain the I/Q data of a single capture.
// Otherwise several captures are performed until the set
// statistic count is reached.
// I/Q data is returned from the last capture.
`SWE:COUN 1`
// Switch to single sweep mode
`INIT:CONT OFF`
// Start measurement and wait for sync
// This performs one sweep or a single I/Q capture.
`INIT;*WAI`
// Determine output format (binary float32)
`FORMat REAL,32`
// Read I/Q data of the entire capture buffer.
// 653751 samples are returned as I,Q,I,Q,...
// 653751 * 4 Bytes (float32) * 2 (I+Q) = 5230008 bytes
`TRAC:IQ:DATA:MEM?`
// Read 2048 I/Q samples starting at the beginning of data acquisition
`TRAC:IQ:DATA:MEM? 0,2048`
// Read 1024 I/Q samples starting at sample 2048.
`TRAC:IQ:DATA:MEM? 2048,1024`

Example: See Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

Usage: Query only

11.8.2 Measurement Results for TRACe<n>[:DATA]? TRACE<n>

The evaluation method selected by the `LAY:ADD:WIND` command also affects the results of the trace data query (see TRACe<n>[:DATA]? TRACE<n>).

Details on the returned trace data depending on the evaluation method are provided here.

For details on the graphical results of these evaluation methods, see Chapter 4.1, "GSM I/Q Measurement Results", on page 17.

11.8.2.1 EVM, Phase Error, Magnitude Error Trace Results

The error vector magnitude (EVM), as well as the phase and magnitude errors are calculated and displayed for each symbol. Thus, the `TRAC:DATA?` query returns one value per symbol. The number of symbols depends on the burst type, modulation and number of carriers used for transmission, as well as the oversampling factor used internally by the R&S FSW GSM application. The following table provides an overview of the possible number of symbols.

Table 11-6: Number of trace result values for EVM, Phase Error, Magnitude Error measurements

Burst Type	Modulation	Multi-carrier BTS	No. of trace points	Comment
AB	GMSK	any	348 = 87 symbols (NSP) * ov	ov = oversampling factor = 4
NB	GMSK	OFF	588 = 147 symbols (NSP) * ov	ov = oversampling factor = 4 this corresponds to the "useful part" of the burst, see 3GPP TS 45.004, § "2.2 Start and stop of the burst"
NB	GMSK	ON	568 samples = 142 symbols (NSP) * ov	ov = oversampling factor = 4 This corresponds to the "useful part" of the burst, excluding the tail bits to allow the multicarrier filter to settle.
NB	not GMSK	any	142 symbols (NSP)	only one sample per symbol (ov=1) this corresponds to the "useful part" of the burst, excluding tail symbols see 3GPP TS 45.005, § "Annex G (normative): Calculation of Error Vector Magnitude"
HSR	any	any	169 symbols (RSP)	only one sample per symbol (ov=1) this corresponds to the "useful part" of the burst, excluding tail symbols see 3GPP TS 45.005, § "Annex G (normative): Calculation of Error Vector Magnitude"
NSP = Normal Symbol Period (= symbol duration for normal symbol rate / normal bursts) RSP = Reduced Symbol Period (= symbol duration for higher symbol rate / HSR bursts)				

11.8.2.2 PvT Full Burst Trace Results

The Power vs Time results depend on the number of slots that are measured, and thus the duration of the measurement. 30 additional symbols (NSP) are added at the beginning and at the end of the trace.

The number of trace result values is calculated as:

(30 + <NofSlots> * 157 + 30) * ov

where:

<NofSlots> = Number of Slots (Slot Scope)

ov = oversampling factor = 24

157 = length of a long slot (a slot can have a length of 156, 156.25 or 157 symbols (NSP))

11.8.2.3 Modulation Spectrum and Transient Spectrum Graph Results

Modulation Spectrum and Transient Spectrum Graphs consist of 1135 trace values (two less than in previous R&S signal and spectrum analyzers).

11.8.2.4 Magnitude Capture Results

The Magnitude Capture trace consists of 32001 trace values, regardless of the defined capture time and thus of the length of the capture buffer.

11.8.2.5 Trigger to Sync Results

The Trigger to Sync Graph results consist of two traces. Thus, the results of the `TRAC:DATA?` query depend on the <TraceNumber> parameter.

TRACe1: returns the height of the histogram bins; the number of values is defined by the number of bins (see `CONFigure:TRGS:NOFBins` on page 263)

TRACe2: returns the y-values for the probability density function (PDF) of the averaged values. The number of values depends on the number of data captures (Statistic Count, see `[SENSe:]SWEep:COUNt` on page 252).

X-values

The results of the `TRAC:DATA:X?` query also depend on the <TraceNumber> parameter:

TRACe1: returns the time (in s) at the center of each bin in the histogram.

TRACe2: returns the time (in s) for the PDF function of the averaged values

11.8.2.6 MCWN Spectrum Graph

The Multicarrier Wideband Noise Spectrum Graph consists of one (average) trace with 10001 trace points.

Note that the final trace consists of combined traces from a sweep with an RBW of 100 kHz and a sweep with an RBW of 300 kHz (see also Chapter 5.15.6, "Wideband Noise Measurement", on page 79).

For narrowband noise measurement no trace results are available. Numerical results can be retrieved using the `FETCh:WSPectrum:NARRow:INNer[:ALL]?` and `FETCh:WSPectrum:NARRow:OUTer[:ALL]?` commands.

11.8.3 Magnitude Capture Results

The following commands are required to query the results of the "Magnitude Capture" evaluation.

FETCh:MCAPture:SLOTs:MEASure?

This command queries the positions of the slots to measure in the current capture buffer (indicated by blue bars in the result display).

Return values:

<Result>
The result is a comma-separated list of positions for each slot with the following syntax:
`xPos[0],xLen[0], xPos[1],xLen[1],…`
where:
`xPos[i]` is the x-value (in seconds) of the i-th slot to measure
`xLen[i]` is the length of the i-th slot to measure (in seconds)
The number of values is 2* [the number of GSM frames in the current capture buffer]. If the number of frames defined by the statistic count all fit into the capture buffer at once, the number of values is 2*statistic count. If not, the number of values is 2*[the number of frames in the last capture].

Example:
`FETCh:MCAPture:SLOTs:MEASure?`
Result for 3 slot scopes (e.g. after a single sweep mode with statistic count = 3)
`0.002261,0.000577,0.006876,0.000577,0.011492, 0.000577`

Usage: Query only

Manual operation: See "Magnitude Capture" on page 19

FETCh:MCAPture:SLOTs:SCOPe?

This command queries the positions of the slot scopes in the current capture buffer (indicated by green bars in the result display).

Return values:

<Result> The result is a comma-separated list of positions for each scope with the following syntax:
`xPos[0],xLen[0], xPos[1],xLen[1],…`
where:
`xPos[i]` is the x-value (in seconds) of the i-th scope
`xLen[i]` is the length of the i-th scope (in seconds)
The number of values is 2* [the number of GSM frames in the current capture buffer]. If the number of frames defined by the statistic count all fit into the capture buffer at once, the number of values is 2*statistic count. If not, the number of values is 2*[the number of frames in the last capture].

Example: `FETCh:MCAPture:SLOTs:SCOPe?`
Result for 3 slots to measure (e.g. after a single sweep mode with statistic count = 3)
`0.002261,0.001154,0.006876,0.001154,0.011492,`
`0.001154`

Usage: Query only

Manual operation: See "Magnitude Capture" on page 19

11.8.4 Modulation Accuracy Results

The following commands are required to query the results of the "Modulation Accuracy" evaluation. For details on the individual results see Table 4-1.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

Statistical results

For most results, both the current result and the statistical evaluation of all results over a number of frames (specified by Statistic Count) are provided.

For details on how the statistical evaluation is performed see Table 4-2.

FETCh:BURSt[:MACCuracy]:ALL?
READ:BURSt[:MACCuracy]:ALL

This command starts the measurement and returns all the modulation accuracy results. For details on the individual parameters see "Modulation Accuracy" on page 21.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<MeasValue> <Error Vector Magnitude RMS>, <Error Vector Magnitude Peak>, <Magnitude Error RMS>, <Magnitude Error Peak>, <Phase Error RMS>, <Phase Error Peak>, <Origin Offset Suppression>, <IQ Offset>, <IQ Imbalance>,< Frequency Error>, <Burst Power>, <Amplitude Droop>, <95%ile EVM>, <95%ile Mag Error>, <95%ile Phase Error>

The results are output as a list of comma separated strings. For each result (except for %iles), the Current, Average, Maximum and Standard Deviation values are returned.

Example:

```
READ:BURS:ALL?
17.283994674682617,17.283994674682617,
17.283994674682617,0,24.647823333740234,
24.647823333740234,24.647823333740234,0,
1.0720701217651367,1.0720701217651367,
1.0720701217651367,0,1.0720850229263306,
1.0720850229263306,
1.0720850229263306,
0,9.8495550155639648,9.8495550155639648,
9.8495550155639648,
0,-14.069089889526367,14.069089889526367,
-14.069089889526367,
0,-0.091422632336616516,-0.091422632336616516,
-0.091422632336616516,
0,101.05810546875,101.05810546875,
101.05810546875,
0,0.036366362124681473,0.036366362124681473,
0.036366362124681473,
0,76.698326110839844,76.698326110839844,
76.698326110839844,0,
-112.8399658203125,-112.8399658203125,
-112.8399658203125,0,
0.083038687705993652,0.083038687705993652,
0.083038687705993652,0,
24.07130241394043,1.0950000286102295,
14.060454368591309
```

Manual operation: See "Modulation Accuracy" on page 21

FETCh:BURSt[:MACCuracy]:ADRoop:AVERage?
FETCh:BURSt[:MACCuracy]:ADRoop:CURRent?
FETCh:BURSt[:MACCuracy]:ADRoop:MAXimum?
FETCh:BURSt[:MACCuracy]:ADRoop:SDEViation?
READ:BURSt[:MACCuracy]:ADRoop:AVERage?
READ:BURSt[:MACCuracy]:ADRoop:CURRent?
READ:BURSt[:MACCuracy]:ADRoop:MAXimum?
READ:BURSt[:MACCuracy]:ADRoop:SDEViation?

This command starts the measurement and reads out the result of the Amplitude Droop.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Amplitude Droop see Table 4-1.

Return values:

<Result> numeric value

Amplitude droop

Default unit: dB

Example: `READ:BURS:ADR:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:BPOWer:AVERage?
FETCh:BURSt[:MACCuracy]:BPOWer:CURRent?
FETCh:BURSt[:MACCuracy]:BPOWer:MAXimum?
FETCh:BURSt[:MACCuracy]:BPOWer:SDEViation?
READ:BURSt[:MACCuracy]:BPOWer:AVERage?
READ:BURSt[:MACCuracy]:BPOWer:CURRent?
READ:BURSt[:MACCuracy]:BPOWer:MAXimum?
READ:BURSt[:MACCuracy]:BPOWer:SDEViation?

This command starts the measurement and reads out the result of the Burst Power.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Burst Power see Table 4-1.

Return values:

<Result> numeric value

Burst Power

Default unit: dB

Example: `READ:BURS:BPOW:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?
READ:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?
READ:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?
READ:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?
READ:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?

This command starts the measurement and reads out the peak result of the Error Vector Magnitude taken over the selected number of bursts. When the measurement is started the analyzer is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the EVM results see Table 4-1

Return values:

<Result> numeric value

EVM

Default unit: NONE

Example: `READ:BURS:PEAK:AVER?`

Usage: Query only

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

FETCh:BURSt[:MACCuracy][:EVM]:RMS:AVERage?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:CURRent?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?
READ:BURSt[:MACCuracy][:EVM]:RMS:AVERage?
READ:BURSt[:MACCuracy][:EVM]:RMS:CURRent?
READ:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?
READ:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Error Vector Magnitude.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the EVM results see Table 4-1.

Return values:

<Result> numeric value
EVM
Default unit: NONE

Example: `READ:BURS:RMS:SDEV?`

Usage: Query only

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

FETCh:BURSt[:MACCuracy]:FREQuency:AVERage?
FETCh:BURSt[:MACCuracy]:FREQuency:CURRent?
FETCh:BURSt[:MACCuracy]:FREQuency:MAXimum?
FETCh:BURSt[:MACCuracy]:FREQuency:SDEViation?
READ:BURSt[:MACCuracy]:FREQuency:AVERage?
READ:BURSt[:MACCuracy]:FREQuency:CURRent?
READ:BURSt[:MACCuracy]:FREQuency:MAXimum?
READ:BURSt[:MACCuracy]:FREQuency:SDEViation?

This command starts the measurement and reads out the result of the Frequency Error.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Frequency Error see Table 4-1.

Return values:

<Result> numeric value

Frequency error

Default unit: Hz

Example: `READ:BURS:FREQ:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:IQIMbalance:AVERage?
FETCh:BURSt[:MACCuracy]:IQIMbalance:CURRent?
FETCh:BURSt[:MACCuracy]:IQIMbalance:MAXimum?
FETCh:BURSt[:MACCuracy]:IQIMbalance:SDEViation?
READ:BURSt[:MACCuracy]:IQIMbalance:AVERage?
READ:BURSt[:MACCuracy]:IQIMbalance:CURRent?
READ:BURSt[:MACCuracy]:IQIMbalance:MAXimum?
READ:BURSt[:MACCuracy]:IQIMbalance:SDEViation?

This command starts the measurement and reads out the result of the I/Q Imbalance.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the I/Q Imbalance see Table 4-1.

Return values:

<Result> numeric value

I/Q Imbalance

Default unit: NONE

Example: `READ:BURS:IQIM:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:IQOFfset:AVERage?
FETCh:BURSt[:MACCuracy]:IQOFfset:CURRent?
FETCh:BURSt[:MACCuracy]:IQOFfset:MAXimum?
FETCh:BURSt[:MACCuracy]:IQOFfset:SDEViation?
READ:BURSt[:MACCuracy]:IQOFfset:AVERage?
READ:BURSt[:MACCuracy]:IQOFfset:CURRent?
READ:BURSt[:MACCuracy]:IQOFfset:MAXimum?
READ:BURSt[:MACCuracy]:IQOFfset:SDEViation?

This command starts the measurement and reads out the standard deviation measurement of the IQ Offset taken over the selected number of bursts. When the measurement is started the analyzer is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:
<Result> numeric value

Standard deviation

Default unit: NONE

Example: READ:BURS:IQOF:SDEV?

Usage: Query only

FETCh:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?
READ:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?
READ:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?
READ:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?
READ:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?

This command starts the measurement and reads out the peak value of the Magnitude Error.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Magnitude Error see Table 4-1.

Return values:
<Result> numeric value

Magnitude error

Default unit: NONE

Example: READ:BURS:MERR:PEAK:SDEV?

Usage: Query only

FETCh:BURSt[:MACCuracy]:MERRor:RMS:AVERage?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:CURRent?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?
READ:BURSt[:MACCuracy]:MERRor:RMS:AVERage?
READ:BURSt[:MACCuracy]:MERRor:RMS:CURRent?
READ:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?
READ:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Magnitude Error.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Magnitude Error see Table 4-1.

Return values:
<Result> numeric value
Magnitude error
Default unit: NONE

Example: `READ:BURS:MERR:RMS:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:OSUPpress:AVERage?
FETCh:BURSt[:MACCuracy]:OSUPpress:CURRent?
FETCh:BURSt[:MACCuracy]:OSUPpress:MAXimum?
FETCh:BURSt[:MACCuracy]:OSUPpress:SDEViation?
READ:BURSt[:MACCuracy]:OSUPpress:AVERage?
READ:BURSt[:MACCuracy]:OSUPpress:CURRent?
READ:BURSt[:MACCuracy]:OSUPpress:MAXimum?
READ:BURSt[:MACCuracy]:OSUPpress:SDEViation?

This command starts the measurement and reads out the result of the I/Q Offset Suppression.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the I/Q Offset Suppression see Table 4-1.

Return values:
<Result> numeric value
I/Q offset suppression
Default unit: dB

Example: `READ:BURS:OSUP:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERCentile:EVM?
READ:BURSt[:MACCuracy]:PERCentile:EVM?

This command starts the measurement and reads out the 95 % percentile of the Error Vector Magnitude measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:
<Result> numeric value
Default unit: NONE

Example: `READ:BURS:PERC:EVM?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERCentile:MERRor?
READ:BURSt[:MACCuracy]:PERCentile:MERRor?

This command starts the measurement and reads out the 95 % percentile of the Magnitude Error measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result>	numeric value Default unit: NONE
Example:	`READ:BURS:PERC:MERR?`
Usage:	Query only

FETCh:BURSt[:MACCuracy]:PERCentile:PERRor?
READ:BURSt[:MACCuracy]:PERCentile:PERRor?

This command starts the measurement and reads out the 95 % percentile of the Phase Error measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result>	numeric value Phase error Default unit: NONE
Example:	`READ:BURS:PERC:PERR?`
Usage:	Query only

FETCh:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?
READ:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?
READ:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?
READ:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?
READ:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?

This command starts the measurement and reads out the peak value of the Phase Error.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Phase Error results see Table 4-1.

Return values:

<Result> numeric value

Phase error

Default unit: NONE

Example: `READ:BURS:PERR:PEAK:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERRor:RMS:AVERage?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:CURRent?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?
READ:BURSt[:MACCuracy]:PERRor:RMS:AVERage?
READ:BURSt[:MACCuracy]:PERRor:RMS:CURRent?
READ:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?
READ:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Phase Error.

When the measurement is started the R&S FSW is automatically set to single sweep mode. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Phase Error results see Table 4-1.

Return values:

<Result> numeric value

Phase error

Default unit: NONE

Example: `READ:BURS:PERR:RMS:SDEV?`

Usage: Query only

11.8.5 Modulation Spectrum Results

The following commands are required to query the results of the "Modulation Spectrum Table" evaluation. For details on the individual results see "Modulation Spectrum Table" on page 24.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

FETCh:SPECtrum:MODulation[:ALL]?
READ:SPECtrum:MODulation[:ALL]?

This command starts the measurement and returns the modulation spectrum of the mobile or base station. This command is only available for "Modulation Spectrum Table" evaluations (see "Modulation Spectrum Table" on page 24).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas, with one list for each measured frequency in the frequency list.

Return values:

<Placeholder>	currently irrelevant
<Freq1>	Absolute offset frequency in Hz
<Freq2>	Absolute offset frequency in Hz
<Level>	Measured level at the offset frequency in dB or dBm (depending on `CONF:SPEC:MOD:LIM`).
<Limit>	Limit at the offset frequency in dB or dBm (depending on `CONF:SPEC:MOD:LIM`).
<Abs/Rel>	Indicates whether relative (dB) or absolute (dBm) limit and level values are returned (depending on `CONF:SPEC:MOD:LIM`).
<Status>	Result of the limit check in character data form **PASSED** no limit exceeded **FAILED** limit exceeded

Example:
```
READ:SPEC:MOD?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
...
```

Usage: Query only

Manual operation: See "Modulation Spectrum Table" on page 24

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

FETCh:SPECtrum:MODulation:REFerence?
READ:SPECtrum:MODulation:REFerence[:IMMediate]?

This command starts the measurement and returns the (internal) reference power of the "Modulation Spectrum". This command is only available for "Modulation Spectrum Table" evaluations (see "Modulation Spectrum Table" on page 24).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Level1>	measured reference power in dBm
<Level2>	measured reference power in dBm
<RBW>	resolution bandwidth used to measure the reference power in Hz; (30 kHz)

Example: `READ:SPECtrum:MODulation:REFerence:IMMediate?`

Usage: Query only

Manual operation: See "Modulation Spectrum Table" on page 24

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

READ:SPECtrum:MODulation:GATing?
READ:WSPectrum:MODulation:GATing?

This command reads out the gating settings for gated "Modulation Spectrum" measurements (see "Modulation Spectrum Table" on page 24).

The returned values can be used to set the gating interval for "list" measurements (i.e. a series of measurements in zero span mode at several offset frequencies). This is done in the "Spectrum" mode using the `SENSe:LIST` subsystem (see `[SENSe:]LIST:POWer:SET`).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see Chapter 11.5.4, "Triggering Measurements", on page 238).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

Example: `READ:WSP:MOD:GAT?`
Results:
`0.00032303078,0.00016890001`

Usage: Query only

11.8.6 Power vs Slot Results

The following commands are required to query the results of the "Power vs Slot" evaluation. For details on the individual results see "Power vs Slot" on page 27.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

FETCh:BURSt:SPOWer:SLOT<s>:ALL:AVERage?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:AVERage?

This command starts the measurement and reads out the average power for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value
Average
Default unit: dBm

Example:

\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:ALL:AVERage?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:ALL:CRESt?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:CRESt?

This command starts the measurement and reads out the crest factor for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:
<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:
<Result> numeric value
Crest factor
Default unit: dB

Example:
\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:ALL:CRESt?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:ALL:MAXimum?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:MAXimum?

This command starts the measurement and reads out the maximum power for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:
<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Maximum

Default unit: dBm

Example:

\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:ALL:MAXimum?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:AVERage?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:AVERage?

This command starts the measurement to read out the average power for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Average

Default unit: dBm

Example:
\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single measurement mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:CURRent:AVERage?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:CRESt?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:CRESt?

This command starts the measurement to read out the crest factor for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:
<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:
<Result> numeric value
Crest factor
Default unit: dB

Example:

\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:CURRent:CRESt?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:MAXimum?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:MAXimum?

This command starts the measurement to read out the maximum power for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Maximum

Default unit: dBm

Example:

\\ Preset the instrument
`*RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:CURRent:MAXimum?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:DELTatosync?
READ:BURSt:SPOWer:SLOT<Slot>:DELTatosync?

This command starts the measurement of the "Delta to Sync" value for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot>

<0..7>
Slot number to measure power on. The selected slot must be within the slot scope, i.e.
(First slot to measure) ≦ <slot> ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result>

numeric value

For equal timeslot length: the expected offset
For non-equal time slots: the measured offset
(See `CONFigure[:MS]:CHANnel:FRAMe:EQUal` on page 208)

Default unit: dBm

Example:
\\ Preset the instrument
`RST`
\\ Enter the GSM option K10
`INSTrument:SELect GSM`
\\ Switch to single sweep mode and stop measurement
`INITiate:CONTinuous OFF;:ABORt`
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
`CONFigure:MS:CHANnel:MSLots:NOFSlots 8`
\\ First Slot to measure = 0
`CONFigure:MS:CHANnel:MSLots:OFFSet 0`
\\ Activate PvT (Power vs Time) measurement
`LAY:ADD? '1',LEFT,PTF`
\\ **Note:** 'READ' starts a new single sweep mode and then reads the results. Use 'FETCh' to query several results!
`READ:BURSt:SPOWer:SLOT1:DELTatosync?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

FETCh:BURSt:SPOWer:SLOT<s>:LIMit:FAIL?
READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?

This command starts a "Power vs Time" measurement and queries the result of the limit check for the selected slot.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Note: in manual operation, the result of the limit check for an individual slot is included in the "Power vs Slot" results (see "Power vs Slot" on page 27).

Suffix:

<Slot> <0..7>
Slot number to perform the limit check on. The selected slot must be within the slot scope, i.e.
(First slot to measure) ≦ <slot> ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> 1 | 0 | ON | OFF

1 | ON
Fail

0 | OFF
Pass

Example: `READ:BURSt:SPOWer:SLOT1:LIMit:FAIL?`

Usage: Query only

Manual operation: See "Power vs Slot" on page 27

For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

11.8.7 Transient Spectrum Results

The following commands are required to query the results of the "Modulation Spectrum Table" evaluation. For details on the individual results see "Modulation Spectrum Table" on page 24.

READ vs FETCh commands

Note that two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

FETCh:SPECtrum:SWITching[:ALL]?
READ:SPECtrum:SWITching[:ALL]?

This command starts the measurement and reads out the transient spectrum.

This command is only available for "Transient Spectrum Table" evaluations (see "Transient Spectrum Table" on page 30).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Placeholder>	currently irrelevant
<Freq1>	Absolute offset frequency in Hz
<Freq2>	Absolute offset frequency in Hz
<Level>	Measured level at the offset frequency in dB or dBm. For more information see `CONFigure:SPECtrum:SWITching:LIMIT`).
<Limit>	Limit at the offset frequency in dB or dBm For more information see `CONFigure:SPECtrum:SWITching:LIMIT`).

<Abs/Rel> Indicates whether relative (dB) or absolute (dBm) limit and level values are returned.
For more information see CONFigure:SPECtrum:SWITching:LIMIT).

<Status> Result of the limit check in character data form

PASSED
no limit exceeded

FAILED
limit exceeded

Example:
```
READ:SPEC:SWIT?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
```

Usage: Query only

Manual operation: See "Transient Spectrum Table" on page 30

FETCh:SPECtrum:SWITching:REFerence?
READ:SPECtrum:SWITching:REFerence[:IMMediate]

This command starts the measurement and returns the measured reference power of the "Transient Spectrum".

This command is only available for "Transient Spectrum Table" evaluations (see "Transient Spectrum Table" on page 30).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Level1> measured reference power in dBm

<Level2> measured reference power in dBm

<RBW> resolution bandwidth used to measure the reference power in Hz

Example: `READ:SPECtrum:SWITching:REFerence:IMMediate?`

Manual operation: See "Transient Spectrum Table" on page 30

READ:SPECtrum:SWITching:REFerence:GATing?

This command reads out the gating settings for gated measurements of the reference power of the "Transient Spectrum" measurement (see "Transient Spectrum Table" on page 30).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see Chapter 11.5.4, "Triggering Measurements", on page 238).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that the useful part of the "Slot to measure" is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that the useful part of the "Slot to measure" is measured.

Example: `READ:SPEC:SWIT:REF:GAT?`
Result:
`0.00000185076,0.00054277002`

Usage: Query only

11.8.8 Trigger to Sync Results

The following commands are required to query the (numeric) results of a Trigger to Sync measurement. For details on the individual results see "Trigger to Sync Table" on page 33.

READ vs FETCh commands

Note that two commands are provided for each result type which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep mode.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

FETCh:BURSt:PTEMplate:TRGS:AVERage?
FETCh:BURSt:PTEMplate:TRGS:CURRent?
FETCh:BURSt:PTEMplate:TRGS:MAXimum?
FETCh:BURSt:PTEMplate:TRGS:MINimum?
FETCh:BURSt:PTEMplate:TRGS:SDEViation?
READ:BURSt:PTEMplate:TRGS:AVERage?
READ:BURSt:PTEMplate:TRGS:CURRent?
READ:BURSt:PTEMplate:TRGS:MAXimum?

READ:BURSt:PTEMplate:TRGS:MINimum?
READ:BURSt:PTEMplate:TRGS:SDEViation?

This command starts a "Trigger to Sync" measurement and reads out the time between the *external* trigger event and the start of the first symbol of the TSC.

This command is only available if an external trigger is selected and the "Trigger to Sync" measurement is active (see `TRIGger[:SEQuence]:SOURce` on page 242 and "Trigger to Sync Graph" on page 32).

Return values:

<Result> numeric value

Trigger to Sync time

Default unit: S

Example:

```
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop measurement
INITiate:CONTinuous OFF;:ABORt
// Set external trigger mode
TRIGger1:SEQuence:SOURce EXTernal
// Set minimum capture time to speed up measurement
SENSe1:SWEep:TIME MINimum
// Auto set trigger offset
// Note: Correct frame / slot configuration assumed!
CONFigure:MS:AUTO:TRIGger ONCE
// Activate Trigger to Sync measurement
LAY:ADD? '1',LEFT,TGSG
LAY:ADD? '1',BEL,TGST
//Query standard deviation of trigger to sync time.
// Note: 'READ' starts a new single sweep mode and then reads
the results.
// Use 'FETCh' to query several results!
READ:BURS:PTEM:TRGS:SDEV?
```

Usage: Query only

11.8.9 Limit Check Results

The following commands are required to query the results of a limit check.

Currently, limit check results can only be queried for the following result displays:

- PvT Full Burst
- Modulation Spectrum Graph
- Transient Spectrum Graph
- Spectrum Graph

Useful commands for retrieving limit check results described elsewhere:

- `READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?` on page 326

- FETCh:SPECtrum:MODulation:LIMit:FAIL? on page 336

Remote commands exclusive to retrieving limit check results:

CALCulate<n>:LIMit<k>:CONTrol:DATA?

This command queries the x-values of the limit specified line.

Suffix:

<n>	Window
<k>	1 | 2 | 3 | 4 The limit line to query **1**: upper limit line for MCWN: wideband noise limit **2**: lower limit line (PvT Full Burst only); for MCWN: intermodulation limit at 100 kHz **3**: (MCWN only:) intermodulation limit at 300 kHz **4**: (MCWN only:) narrowband noise limit

Return values:

<LimitLinePoints>	For PvT Full Burst display: Time in seconds For Modulation Spectrum Graph or Transient Spectrum Graph result displays: relative frequency in Hz For Spectrum Graph result displays: absolute frequency in Hz

Example:	See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.
Usage:	Query only SCPI confirmed
Manual operation:	See "Modulation Spectrum Graph" on page 23 See "PvT Full Burst" on page 28 See "Spectrum Graph" on page 35

CALCulate<n>:LIMit<k>:FAIL?

This command queries the result of the limit check of the limit line indicated in the selected measurement window. Note that a complete sweep must have been performed to obtain a valid result. A synchronization with *OPC, *OPC? Or *WAI should therefore be provided.

Suffix:

<n>	Window

<k> 1 | 2 | 3 | 4
The limit check to query
1: Max trace (-> upper limit line);
for MCWN: wideband noise
2: Min trace (-> lower limit line; PvT Full Burst only);
for MCWN: intermodulation at 100 kHz
3: (MCWN only:) intermodulation at 300 kHz
4: (MCWN only:) narrowband noise
5: (MCWN only:) Exceptions in subblock A
6: (MCWN only:) Exceptions in subblock B

Return values:
<Result> 1 | 0

1
Failed (see Table 11-7)

0
Passed (see Table 11-7)

Example: `CALCulate2:LIMit1:FAIL?`

Example: For a detailed example see Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366 or Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Modulation Spectrum Graph" on page 23
See "PvT Full Burst" on page 28
See "Transient Spectrum Graph" on page 29
See "Spectrum Graph" on page 35

Table 11-7: Meaning of return values depending on result display

Result display	SCPI	Return values
Power vs Time Graph	CALCulate<n>:LIMit**1**:FAIL?	1: the limit check of the upper limit line against the max hold trace failed 0: passed
	CALCulate<n>:LIMit**2**:FAIL?	1: the limit check of the lower limit line against the min hold trace failed 0: passed
Mod. Spectrum Graph	CALCulate<n>:LIMit1:FAIL?	1: the limit check of the upper limit line against the average trace failed 0: passed
Tra. Spectrum Graph	CALCulate<n>:LIMit1:FAIL?	1: the limit check of the upper limit line against the max hold trace failed 0: passed
Power Spectrum (MCWN)	CALCulate<n>:LIMit1:FAIL?	1: the limit check of the wideband noise limit line against the average trace failed 0: passed (possibly with allowed exceptions, if enabled)

Result display	SCPI	Return values
	CALCulate<n>:LIMit2:FAIL?	1: the limit check of the limit line for intermodulation at 100 kHz against the average trace failed 0: passed (possibly with allowed exceptions, if enabled)
	CALCulate<n>:LIMit3:FAIL?	1: the limit check of the limit line for intermodulation at 300 kHz against the average trace failed 0: passed (possibly with allowed exceptions, if enabled)
	CALCulate<n>:LIMit4:FAIL?	1: the limit check of the narrowband noise limit line against the average measured distortion failed 0: passed (possibly with allowed exceptions, if enabled)
	CALCulate<n>:LIMit5:FAIL?	1: the allowed number of exceptions (if enabled) in subblock A was exceeded 0: passed
	CALCulate<n>:LIMit6:FAIL?	1: the allowed number of exceptions (if enabled) in subblock B was exceeded 0: passed

CALCulate<n>:LIMit<k>:LOWer[:DATA]?

This command queries the y-values of the lower limit line.

This command is only available for PvT Full Burst results.

Suffix:

<n> Window

<k> 2: lower limit line (PvT Full Burst only)

Return values:

<LimitLinePoints> Absolute level values in dBm

Usage: Query only
SCPI confirmed

CALCulate<n>:LIMit<k>:UPPer[:DATA]?

This command queries the y-values of the specified limit line.

Suffix:

<n> Window

<k>	1 | 2 | 3 | 4 The limit line to query **1**: upper limit line for MCWN: wideband noise limit **2**: lower limit line (PvT Full Burst only); for MCWN: intermodulation limit at 100 kHz **3**: (MCWN only:) intermodulation limit at 300 kHz **4**: (MCWN only:) narrowband noise limit
Return values:	
<LimitLinePoints>	Absolute level values in dBm
Example:	See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.
Usage:	Query only SCPI confirmed
Manual operation:	See "Modulation Spectrum Graph" on page 23 See "PvT Full Burst" on page 28 See "Spectrum Graph" on page 35

11.8.10 MCWN Results

The following commands are required to retrieve results from a multicarrier wideband noise measurement (see Chapter 4.2, "Multicarrier Wideband Noise Measurements", on page 34).

Useful commands for retrieving MCWN results described elsewhere:

- Chapter 11.8.9, "Limit Check Results", on page 330

Remote commands exclusive to retrieving MCWN results:

CALCulate<n>:LIMit<k>:EXCeption:COUNt:CURR?

This command queries the number of bands with exceptions to the limit line that occurred for the specified limit check in the selected measurement window.

Suffix:

<n>	Window

<k> 1 | 2
The number of the limit check to query
1: Limit check for wideband noise
2: Limit check for intermodulation at 100 kHz (no exceptions allowed)
3: Limit check for intermodulation at 300 kHz (no exceptions allowed)
4: Limit line for narrowband noise (no exceptions allowed)
5: Exceptions in subblock A
6: Exceptions in subblock B

Return values:
<NoExcept> integer
Number of exceptions

Example: `CALCulate2:LIMit1:EXC:COUN:CURR?`
Queries the number of bands with exceptions to the limit line check that occurred for wideband noise in window 2.

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Spectrum Graph" on page 35

CALCulate<n>:LIMit<k>:EXCeption:COUNt:MAX?

This command queries the maximum number of bands with exceptions to the limit line check that are allowed by the standard for the specified limit check in the selected measurement window.

Suffix:
<n> Window

<k> 1 | 2
The number of the limit check to query
1: Limit check for wideband noise
2: Limit check for intermodulation at 100 kHz (no exceptions allowed)
3: Limit check for intermodulation at 300 kHz (no exceptions allowed)
4: Limit line for narrowband noise (no exceptions allowed)
5: Exceptions in range A
6: Exceptions in range B

Return values:
<NoExcept> integer
Number of exceptions

Example: `CALCulate2:LIMit1:EXC:COUN:MAX?`
Queries the maximum number of bands with exceptions to the limit line check allowed for wideband noise in window 2.

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Spectrum Graph" on page 35

FETCh:SPECtrum:MODulation:LIMit:FAIL? <Result>

This command queries the results of the limit check for MCWN measurements.

Parameters:

<Result> 1 | 0 | ON | OFF

Result of the limit check.

1 | ON
Fail

0 | OFF
Pass

Example: `FETC:SPEC:MOD:LIM:FAIL?`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Spectrum Graph" on page 35

FETCh:WSPectrum:IMPRoducts:INNer[:ALL]?

This command queries the results of the measured intermodulation products (up to the order specified using `CONFigure:SPECtrum:IMPorder`) for the frequencies in the gap between the GSM carrier subblocks for non-contiguous carrier allocation.

For each measured offset frequency, the following values are returned:

Return values:

<FreqAbs> numeric value

Absolute frequency of intermodulation

Default unit: Hz

<FreqRel> numeric value

Frequency offsets (from the closest carrier) at which intermodulation power is measured

Default unit: Hz

<IMOrder> 3 | 5 | 3 5
Order of the intermodulation

3
IM order 3

5
IM order 5

3 5
IM orders 3 and 5

<RBW> numeric value
Resolution bandwidth used for measurement
Default unit: Hz

<Power> numeric value
Absolute or relative power level (to reference power) measured at IM frequency
Default unit: dBm/dB

<Limit> numeric value
absolute or relative power level limit (to reference power)
Default unit: dBm/dB

<AbsRelMode> ABS | REL
Determines whether absolute or relative power values are returned

<LimCheck> Result of the limit check at this offset frequency

PASSED
power within limits

FAILED
power exceeds limit

Example: `FETC:WSP:IMPR:INN?`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Inner IM Table" on page 37

FETCh:WSPectrum:IMPRoducts:OUTer[:ALL]?

This command queries the results of the measured intermodulation products (up to the order specified using `CONFigure:SPECtrum:IMPorder`) for the frequencies outside of the subblocks (but not in the gap) for non-contiguous carrier allocation.

For each measured offset frequency, the following values are returned:

Return values:

<FreqAbs> numeric value

Absolute frequency of intermodulation

Default unit: Hz

<FreqRel> numeric value

Frequency offsets (from the closest carrier) at which intermodulation power is measured

Default unit: Hz

<IMOrder> 3 | 5 | 3 5

Order of the intermodulation

3
IM order 3

5
IM order 5

3 5
IM orders 3 and 5

<RBW> numeric value

Resolution bandwidth used for measurement

Default unit: Hz

<Power> numeric value

Absolute or relative power level (to reference power) measured at IM frequency

Default unit: dBm/dB

<Limit> numeric value

absolute or relative power level limit (to reference power)

Default unit: dBm/dB

<AbsRelMode> ABS | REL

Determines whether absolute or relative power values are returned

<LimCheck> Result of the limit check at this offset frequency

PASSED
power within limits

FAILED
power exceeds limit

Example: `FETC:WSP:IMPR:OUT?`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Outer IM Table" on page 38

FETCh:WSPectrum:NARRow:INNer[:ALL]?

This command queries the results of the measured distortion products for the frequencies in the gap between the GSM carrier subblocks for non-contiguous carrier allocation.

The frequency offsets are defined as offsets from the closest carrier, i.e. the uppermost carrier of the lower sub-block and the lowermost carrier of the upper sub-block. Offsets are lower than 1.8 MHz (400 KHz, 600 KHz, 1200 KHz).

(For details see "Outer Narrowband Table" on page 39.)

The rows are sorted in ascending order of the absolute measurement frequency.

For contiguous carrier allocation or if narrowband noise measurement is disabled, this table is empty.

For each measured offset frequency, the following values are returned:

Return values:

<FreqAbs> numeric value

Absolute frequency of distortion

Default unit: Hz

<FreqRel> numeric value

Frequency offsets (from the closest carrier) at which distortion power is measured

Default unit: Hz

<RBW> numeric value

Resolution bandwidth used for measurement

Default unit: Hz

<Power> numeric value

Absolute or relative power level (to reference power) measured at distortion frequency

Default unit: dBm/dB

<Limit> numeric value

Absolute or relative power level limit (to reference power)

Default unit: dBm/dB

<AbsRelMode> ABS | REL

Indicates whether absolute or relative power values are returned; (depending on `CONFigure:SPECtrum:MODulation:LIMIT` on page 261)

<LimCheck> Result of the limit check at this offset frequency

PASSED
power within limits

FAILED
power exceeds limit

Example: `FETC:WSP:NARR:INN?`

Usage: Query only

Manual operation: See "Inner Narrow Band Table" on page 39

FETCh:WSPectrum:NARRow:OUTer[:ALL]?

This command queries the results of the measured distortion products for the frequencies outside of the subblocks (but not in the gap) for non-contiguous carrier allocation.

For details see "Outer Narrowband Table" on page 39.

For each measured offset frequency, the following values are returned:

Return values:

<FreqAbs> numeric value
Absolute frequency of distortion
Default unit: Hz

<FreqRel> numeric value
Frequency offsets (from the closest carrier) at which distortion power is measured
Default unit: Hz

<RBW> numeric value
Resolution bandwidth used for measurement
Default unit: Hz

<Power> numeric value
Absolute or relative power level (to reference power) measured at distortion frequency
Default unit: dBm/dB

<Limit> numeric value
Absolute or relative power level limit (to reference power)
Default unit: dBm/dB

<AbsRelMode> ABS | REL
Determines whether absolute or relative power values are returned

<LimCheck> Result of the limit check at this offset frequency
PASSED
power within limits
FAILED
power exceeds limit

Example: `FETC:WSP:NARR:OUT?`

Usage: Query only

Manual operation: See "Outer Narrowband Table" on page 39

FETCh:WSPectrum:REFerence:POWer[:ALL]?

This command returns the measured power levels and reference powers of all active carriers.

Return values:

<CarrNo> integer

Active carrier number

Range: 1..16

<RefType> Indicates whether carrier is used for reference

REF
carrier selected for reference power

MAX
carrier has the highest power level, is used for reference power

NONE
normal carrier, not used for reference

*RST: RST value

<AbsCarrFreq> numeric value

Absolute frequency at which power was measured

Default unit: Hz

<AbsPow> numeric value

Measured power level (absolute)

Default unit: dBm

<AbsRef300> numeric value

Reference power level (absolute) in a 300 kHz RBW

Default unit: dBm

<AbsRef100> numeric value

Reference power level (absolute) in a 100 kHz RBW

Default unit: dBm

<AbsRef30> numeric value

Reference power level (absolute) in a 30 kHz RBW

Default unit: dBm

Example: `FETC:WSP:REF:POW?`

Example: See Chapter 11.13.5, "Programming Example: Measuring the Wideband Noise for Multiple Carriers", on page 376.

Usage: Query only

Manual operation: See "Carrier Power Table" on page 36

FETCh:WSPectrum:WIDeband:INNer[:ALL]?

This command queries the numeric results of the wideband noise measurement for the frequencies in the gap between the GSM carrier subblocks for non-contiguous carrier allocation.

For details see "Outer Wideband Table" on page 42.

For each limit line segment, the following values are returned:

Return values:

<StartFreqAbs> numeric value
Absolute start frequency of limit line segment
Default unit: Hz

<StopFreqAbs> numeric value
Absolute stop frequency of limit line segment
Default unit: Hz

<WorstFreqRel> numeric value
Frequency offsets (from the closest carrier) to the worst measured wideband noise result in this limit line segment
Default unit: Hz

<WorstFreqAbs> numeric value
Absolute frequency of the worst measured wideband noise result (regarding delta to limit) in this limit line segment
Default unit: Hz

<RBW> numeric value
Resolution bandwidth used for measurement in this limit line segment
Default unit: Hz

<PowerAtWorst> numeric value
Absolute or relative power level (to reference power) at that worst result in this limit line segment
Default unit: dBm/dB

<LimitAtWorst> numeric value
Absolute or relative power level limit (to reference power) at that worst result in this limit line segment
Default unit: dBm/dB

<AbsRelMode> ABS | REL
Indicates whether absolute or relative power values are returned; (depending on `CONFigure:SPECtrum:MODulation:LIMIT` on page 261)

<LimCheck> Result of the limit check in this limit line segment

PASSED
power within limits

FAILED
power exceeds limit

Example: `FETC:WSP:WID:INN?`

Usage: Query only

Manual operation: See "Inner Wideband Table" on page 41

FETCh:WSPectrum:WIDeband:OUTer[:ALL]?

This command queries the results of the wideband noise measurement below the lowest and above the highest carrier (but not in the gap for non-contiguous carrier allocation).

For each limit line segment, the following values are returned:

Return values:

<StartFreqAbs> numeric value

Absolute start frequency of limit line segment

Default unit: Hz

<StopFreqAbs> numeric value

Absolute stop frequency of limit line segment

Default unit: Hz

<WorstFreqRel> numeric value

Frequency offsets (from the closest carrier) to the worst measured wideband noise result in this limit line segment

Default unit: Hz

<WorstFreqAbs> numeric value

Absolute frequency of the worst measured wideband noise result (regarding delta to limit) in this limit line segment

Default unit: Hz

<RBW> numeric value

Resolution bandwidth used for measurement in this limit line segment

Default unit: Hz

<PowerAtWorst> numeric value

Absolute or relative power level (to reference power) at that worst result in this limit line segment

Default unit: dBm/dB

<LimitAtWorst> numeric value
Absolute or relative power level limit (to reference power) at that worst result in this limit line segment
Default unit: dBm/dB

<AbsRelMode> ABS | REL
Indicates whether absolute or relative power values are returned; (depending on CONFigure:SPECtrum:MODulation:LIMIT on page 261)

<LimCheck> Result of the limit check in this limit line segment
PASSED
power within limits
FAILED
power exceeds limit

Example: `FETC:WSP:WID:OUT?`

Usage: Query only

Manual operation: See "Outer Wideband Table" on page 42

11.8.11 Retrieving Marker Results

Useful commands for retrieving marker results described elsewhere:

- CALCulate<n>:DELTamarker<m>:Y? on page 345

Remote commands exclusive to retrieving marker results:

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:
<m> Marker

<n> Window

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "X-value" on page 172

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:

<n>	Window
<m>	Marker

Return values:

<Position>	Position of the delta marker in relation to the reference marker.
Example:	`CALC:DELT3:X:REL?` Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.
Usage:	Query only

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

See also `INITiate<n>:CONTinuous` on page 249.

The unit depends on the application of the command.

Suffix:

<m>	Marker
<n>	Window

Return values:

<Position>	Position of the delta marker in relation to the reference marker or the fixed reference.

Example:	`INIT:CONT OFF`
	Switches to single sweep mode.
	`INIT;*WAI`
	Starts a sweep and waits for its end.
	`CALC:DELT2 ON`
	Switches on delta marker 2.
	`CALC:DELT2:Y?`
	Outputs measurement value of delta marker 2.

Usage:	Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:

<m>	Marker (query: 1 to 16)
<n>	Window

Parameters:

<Position>	Numeric value that defines the marker position on the x-axis. Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 20
See "X-value" on page 172

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

See also `INITiate<n>:CONTinuous` on page 249.

Suffix:

<n>	Window
<m>	Marker

Return values:

<Result>	Result at the marker position.

Example:
`INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 20

11.9 Importing and Exporting I/Q Data and Results

The I/Q data to be evaluated in the GSM application can not only be measured by the GSM application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the GSM application can be exported for further analysis in external applications.

For details on importing and exporting I/Q data see Chapter 8, "I/Q Data Import and Export", on page 177.

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

This command restores I/Q data from a file.

The file extension is *.iqw.

Parameters:

<FileName> String containing the path and name of the source file.

Example: `MMEM:LOAD:IQ:STAT 1, 'C:\R_S\Instr\user\data.iqw'`
Loads IQ data from the specified file.

Usage: Setting only

Manual operation: See "I/Q Import" on page 178

MMEMory:STORe<n>:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Suffix:

<n> irrelevant

Parameters:

<Comment> String containing the comment.

Example: `MMEM:STOR:IQ:COMM 'Device test 1b'`
Creates a description for the export file.
`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores I/Q data and the comment to the specified file.

MMEMory:STORe<n>:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:
<n> irrelevant

Parameters:
1

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores the captured I/Q data to the specified file.

Example: See Chapter 11.13.1, "Programming Example: Determining the EVM", on page 366.

11.10 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, e.g. information on errors or limit violations which 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 IEC bus.

The GSM application uses the standard status registers of the R&S FSW. However, some registers are used differently. Only those differences are described in the following sections.

For details on the common R&S FSW status registers refer to the description of remote control basics in the R&S FSW User Manual.

*RST does not influence the status registers.

Description of the Status Registers

All the status registers are the same as those provided by the base system, with the exception of the following registers, which are provided by the R&S FSW and are not available from the R&S FSW GSM application command tree:

- `STATus:QUEStionable:ACPLimit`
- `STATus:QUEStionable:LMARgin<1|2>`

The commands to query the contents of the following status registers are described in Chapter 11.10.4, "Querying the Status Registers", on page 353.

11.10.1 STATus:QUEStionable:SYNC Register

The `STATus:QUEStionable:SYNC` register contains application-specific information about synchronization errors or errors during symbol detection. If any errors occur in this register, the status bit #11 in the `STATus:QUEStionable` register is set to 1.

Each active channel uses a separate `STATus:QUEStionable:SYNC` register. Thus, if the status bit #11 in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific `STATus:QUEStionable:SYNC` registers. In this case, you must check the register of each channel to determine which channel caused the error. By default, querying the status of a register always returns the result for the currently selected channel. However, you can specify any other channel name as a query parameter.

Table 11-8: Meaning of the bits used in the STATus:QUEStionable:SYNC register

Bit No.	Meaning
0	BURSt not found This bit is set if no burst is found in the measurements/premeasurements for phase/frequency error or carrier power vs time.
1	SYNC not found This bit is set if the synchronization sequence (or training sequence) of the TSC is not found in the measurements/premeasurements for phase/frequency error or carrier power vs time.
2	No carrier This bit is set when no carriers are found by the auto frequency sequence.
3 to 14	These bits are not used
15	This bit is always 0

11.10.2 STATus:QUEStionable:LIMit Register

The `STATus:QUEStionable:LIMit` register contains application-specific information about limit line checks. Various bits are set based on the measurement result configured for a window. If any errors occur in this register, the status bit #9 in the `STATus:QUEStionable` register is set to 1.

Each active channel uses a separate `STATus:QUEStionable:LIMit` register. Thus, if the status bit #9 in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific `STATus:QUEStionable:LIMit` registers. In this case, you must check the register of each channel to determine which channel caused the error. By default, querying the status of a register always returns the result for the currently selected channel. However, you can specify any other channel name as a query parameter.

Table 11-9: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	**For PvT, Modulation and Transient** measurement results: indicates the upper limit check result (pass/failure) For **MCWN Spectrum** measurement result: wideband noise limit line check (including exceptions if activated)
1	For **PvT** measurement result: indicates the lower limit check result (pass/failure) For **MCWN Spectrum** measurement result: IM 100 kHz limit line (including exceptions if activated)
2	For **MCWN Spectrum** measurement result: IM 300 kHz limit line
3	For **MCWN Spectrum** measurement result: Narrowband Noise limit line
4	For **MCWN Spectrum** measurement result: Exception Range A (only `FAIL?` result, no limit line)
5	For **MCWN Spectrum** measurement result: Exception Range B (only `FAIL?` result, no limit line)
6 to 14	These bits are not used
15	This bit is always 0

11.10.3 STATus:QUEStionable:DIQ Register

This register contains information about the state of the digital I/Q input and output. This register is used by the optional Digital Baseband Interface.

The status of the `STATus:QUEStionable:DIQ` register is indicated in bit 14 of the `STATus:QUEStionable` register.

You can read out the state of the register with `STATus:QUEStionable:DIQ:CONDition?` on page 352 and `STATus:QUEStionable:DIQ[:EVENt]?` on page 353.

Bit No.	Meaning
0	**Digital I/Q Input Device connected** This bit is set if a device is recognized and connected to the Digital Baseband Interface of the analyzer.
1	**Digital I/Q Input Connection Protocol in progress** This bit is set while the connection between analyzer and digital baseband data signal source (e.g. R&S SMW, R&S Ex-I/Q-Box) is established.

Bit No.	Meaning
2	**Digital I/Q Input Connection Protocol error** This bit is set if an error occurred during establishing of the connect between analyzer and digital I/Q data signal source (e.g. R&S SMW, R&S Ex-I/Q-Box) is established.
3	**Digital I/Q Input PLL unlocked** This bit is set if the PLL of the Digital I/Q input is out of lock due to missing or unstable clock provided by the connected Digital I/Q TX device. To solve the problem the Digital I/Q connection has to be newly initialized after the clock has been restored.
4	**Digital I/Q Input DATA Error** This bit is set if the data from the Digital I/Q input module is erroneous. Possible reasons: ● Bit errors in the data transmission. The bit will only be set if an error occurred at the current measurement. ● Protocol or data header errors. May occur due to data synchronization problems or vast transmission errors. The bit will be set constantly and all data will be erroneous. To solve the problem the Digital I/Q connection has to be newly initialized. NOTE: If this error is indicated repeatedly either the Digital I/Q LVDS connection cable or the receiving or transmitting device might be defect.
5	Not used
6	**Digital I/Q Input FIFO Overload** This bit is set if the sample rate on the connected instrument is higher than the input sample rate setting on the R&S FSW. Possible solution: ● Reduce the sample rate on the connected instrument ● Increase the input sample rate setting on the R&S FSW
7	Not used
8	**Digital I/Q Output Device connected** This bit is set if a device is recognized and connected to the Digital I/Q Output.
9	**Digital I/Q Output Connection Protocol in progress** This bit is set while the connection between analyzer and digital I/Q data signal source (e.g. R&S SMW, R&S Ex-I/Q-Box) is established.
10	**Digital I/Q Output Connection Protocol error** This bit is set if an error occurred while the connection between analyzer and digital I/Q data signal source (e.g. R&S SMW, R&S Ex-I/Q-Box) is established.
11	**Digital I/Q Output FIFO Overload** This bit is set if an overload of the Digital I/Q Output FIFO occurred. This happens if the output data rate is higher than the maximal data rate of the connected instrument. Reduce the sample rate to solve the problem.
12-14	Not used
15	This bit is always set to 0.

STATus:QUEStionable:DIQ:CONDition? <ChannelName>

This command reads out the CONDition section of the `STATus:QUEStionable:DIQ:CONDition` status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Example: `STAT:QUES:DIQ:COND?`

Usage: Query only

STATus:QUEStionable:DIQ:ENABle <BitDefinition>, <ChannelName>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:

<SumBit> Range: 0 to 65535

Usage: SCPI confirmed

STATus:QUEStionable:DIQ:NTRansition <BitDefinition>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:

<BitDefinition> Range: 0 to 65535

STATus:QUEStionable:DIQ:PTRansition <BitDefinition>,<ChannelName>

This command controls the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:

<BitDefinition> Range: 0 to 65535

STATus:QUEStionable:DIQ[:EVENt]? <ChannelName>

This command queries the contents of the "EVENt" section of the `STATus:QUEStionable:DIQ` register for IQ measurements.

Readout deletes the contents of the "EVENt" section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Example: `STAT:QUES:DIQ?`

Usage: Query only

11.10.4 Querying the Status Registers

The following commands are required to query the status of the R&S FSW and the GSM application.

For more information on the contents of the status registers see:

- Chapter 11.10.1, "STATus:QUEStionable:SYNC Register", on page 349
- Chapter 11.10.3, "STATus:QUEStionable:DIQ Register", on page 350

11.10.4.1 General Status Register Commands

STATus:PRESet

This command resets the edge detectors and `ENABle` parts of all registers to a defined value. All `PTRansition` parts are set to `FFFFh`, i.e. all transitions from 0 to 1 are detected. All `NTRansition` parts are set to 0, i.e. a transition from 1 to 0 in a `CONDition` bit is not detected. The `ENABle` part of the `STATus:OPERation` and `STATus:QUEStionable` registers are set to 0, i.e. all events in these registers are not passed on.

Usage: Event

STATus:QUEue[:NEXT]?

This command queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

Usage: Query only

11.10.4.2 Reading Out the EVENt Part

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:ACPLimit[:EVENt]? <ChannelName>
STATus:QUEStionable:DIQ[:EVENt]? <ChannelName>
STATus:QUEStionable:LIMit<n>[:EVENt]? <ChannelName>
STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Suffix:
<n> Window

<m> Marker

Query parameters:
<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

11.10.4.3 Reading Out the CONDition Part

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:ACPLimit:CONDition? <ChannelName>
STATus:QUEStionable:DIQ:CONDition? <ChannelName>

STATus:QUEStionable:LIMit<n>:CONDition? <ChannelName>
STATus:QUEStionable:SYNC:CONDition? <ChannelName>

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Suffix:

<n>	Window
<m>	Marker

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

11.10.4.4 Controlling the ENABle Part

STATus:OPERation:ENABle <SumBit>
STATus:QUEStionable:ENABle <SumBit>
STATus:QUEStionable:ACPLimit:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:ENABle <BitDefinition>, <ChannelName>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Note: if you switch between the IQ measurement and MCWN measurement, the transition is set to its default value. Thus, you must reconfigure the transition after switching measurements, if necessary.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

11.10.4.5 Controlling the Negative Transition Part

STATus:OPERation:NTRansition <SumBit>
STATus:QUEStionable:NTRansition <SumBit>
STATus:QUEStionable:ACPLimit:NTRansition <SumBit>,<ChannelName>

STATus:QUEStionable:LIMit<n>:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:NTRansition <BitDefinition>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Note: if you switch between the IQ measurement and MCWN measurement, the transition is set to its default value. Thus, you must reconfigure the transition after switching measurements, if necessary.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<BitDefinition>	Range: 0 to 65535
<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.

11.10.4.6 Controlling the Positive Transition Part

STATus:OPERation:PTRansition <SumBit>
STATus:QUEStionable:PTRansition <SumBit>
STATus:QUEStionable:ACPLimit:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:PTRansition <BitDefinition>,<ChannelName>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Note: if you switch between the IQ measurement and MCWN measurement, the transition is set to its default value. Thus, you must reconfigure the transition after switching measurements, if necessary.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<BitDefinition>	Range: 0 to 65535
<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.

11.11 Troubleshooting

If problems occur, the instrument generates error messages which in most cases will be sufficient for you to detect the cause of an error and find a remedy.

In addition, our customer support centers are there to assist you in solving any problems that you may encounter with your R&S FSW. We will find solutions more quickly and efficiently if you provide us with information on the system configuration.

An .xml file with information on the system configuration ("device footprint") can be created automatically.

DIAGnostic:SERVice:SINFo? <FileName>

This command creates a *.zip file with important support information. The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display (if available).

This data is stored to the `C:\R_S\Instr\user\` directory on the instrument.

As a result of this command, the created file name (including the drive and path) is returned.

You can use the resulting file name information as a parameter for the `MMEM:COPY` command to store the file on the controller PC.

If you contact the Rohde&Schwarz support to get help for a certain problem, send this file to the support in order to identify and solve the problem faster.

Return values:

<FileName> C:\R_S\Instr\user\<R&S Device ID>_<CurrentDate>_<CurrentTime>

String containing the drive, path and file name of the created support file, where the file name consists of the following elements:
<R&S Device ID>: The unique R&S device ID indicated in the "Versions + Options" information
<CurrentDate>: The date on which the file is created (<YYYYMMDD>)
<CurrentTime>: The time at which the file is created (<HHMMSS>)

Example:

```
DIAG:SERV:SINF?
```

Result:

```
"c:\R&S\instr\user\FSW-26_1312.8000K26-100005-xx_20130116_165858.zip"
```

```
MMEM:COPY "c:\R&S\instr\user\FSW-26_
1312.8000K26-100005-xx_20130116_165858.zip",
"S:\Debug\ESW-26_1312.8000K26-100005-xx_
20130116_165858.zip"
```

Usage: Query only

11.12 Deprecated Commands

Note that the following commands are maintained for compatibility reasons only. Use the specified alternative commands for new remote control programs.

CONFigure:BURSt:ETIMe[:IMMediate]
CONFigure:BURSt:MACCuracy[:IMMediate]
CONFigure:BURSt:MERRor[:IMMediate]
CONFigure:BURSt:PFERror[:IMMediate]
CONFigure:BURSt:PTEMplate[:IMMediate]
CONFigure:BURSt:PTEMplate:SELect <Value>
CONFigure:SPECtrum:MODulation[:IMMediate]
CONFigure:SPECtrum:SELect <Mode>
CONFigure:SPECtrum:SWITching[:IMMediate]
CONFigure:TRGS[:IMMediate]
CONFigure:WSPectrum:MODulation[:IMMediate]

These commands select a specific result display. They are maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see Chapter 11.7.1.2, "Working with Windows in the Display", on page 274).

Usage: Setting only

CONFigure[:MS]:MULTi:BURSt:CONStell <State>
CONFigure[:MS]:MULTi:BURSt:DEModulation <State>
CONFigure[:MS]:MULTi:BURSt:PTEMplate <State>
CONFigure[:MS]:MULTi:SPECtrum:MODulation <State>
CONFigure[:MS]:MULTi:SPECtrum:SWITching <State>
CONFigure[:MS]:MULTi:STATe <State>

These commands are maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see Chapter 11.7.1.2, "Working with Windows in the Display", on page 274).

Note: To be backwards compatible to R&S FSV-K10, activating multi-measurement mode (using `CONFigure[:MS]:MULTi:STATe`) sets the "Frequency List" parameter to "1.8 MHz" (see "Modulation Spectrum Table: Frequency List" on page 135). Deactivating this mode sets the frequency list to "1.8 MHz (sparse)".

CONFigure[:MS]:BSEarch <State>

This command toggles between active burst search and inactive burst search.

Note

This command is retained for compatibility with R&S FS-K5 only. Use `CONFigure:MS:SYNC:MODE BURSt` or `CONFigure:MS:SYNC:MODE ALL` instead (see `CONFigure[:MS]:SYNC:MODE` on page 254).

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

ON
Burst search on

OFF
Burst search off

*RST: 1

CONFigure[:MS]:BSTHreshold <Value>

This command changes the burst find threshold.

Note

This command is retained for compatibility with R&S FS-K5 only. Due to the improved measurement capabilities of this GSM analysis software, this remote control command (and the function behind) is not required any more.

Parameters for setting and query:

<Value> numeric value

Threshold for burst detection

Default unit: dB

Example: `CONF:BSTH 10 DB`

Mode: GSM

CONFigure[:MS]:MCARrier:ACTCarriers <NofActCarriers>

This parameter specifies the total number of active carriers of the multicarrier BTS to be measured. Its value affects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise"). The limit is changed by 10*log(N).

Note that this command is maintained for compatibility reasons only. For new remote control programs, the number of active carriers is determined by the `CONFigure[:MS]:MCARrier:CARRier<c>[:STATe]?` commands. The multicarrier device type is defined using the `CONFigure[:MS]:DEVice:TYPE` on page 203 command.

Parameters for setting and query:

<NofActCarriers> *RST: 1

Default unit: NONE

Example: New program:

```
CONFigure:MS:DEVice:TYPE MCBWide
CONFigure:MS:MCARrier:CARRier1:STATe ON
CONFigure:MS:MCARrier:CARRier2:STATe ON
...
CONFigure:MS:MCARrier:CARRier<NofActCarriers>:
STATe ON
```

CONFigure[:MS]:MCARrier:BTSClass <BTSClass>

This command defines the base station class. The specified BTS Class effects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise" and chapter 4.3.2 "Base Transceiver Station", search for "Multicarrier BTS").

Note that this command is maintained for compatibility reasons only.

Parameters for setting and query:

<BTSClass> Range: 1 to 2
*RST: 1
Default unit: NONE

Example: `CONF:MCAR:BTSClass`

CONFigure[:MS]:MCARrier:FILTer <Type>

This command controls the filter used to reduce the measurement bandwidth for multi-carrier "Power vs Time" measurements.

Parameters for setting and query:

<Type> MC400 | MC300

MC400
Recommended for measurements with multi channels of equal power.

MC300
Recommended for measurement scenarios where a total of six channels is active and the channel to be measured has a reduced power (e.g. 30 dB) compared to its adjacent channels. The PvT filter is optimized to get smooth edges after filtering burst signals and to suppress adjacent, active channels.

*RST: MC400

Example: `CONF:MCAR:FILT MC400`

CONFigure[:MS]:MCARrier[:STATe] <State>
CONFigure[:MS]:MCARrier:MCBTs <MultiCarrierBTS>

This command informs the R&S FSW-K10 that the measured signal is a multicarrier signal. If active, a special multicarrier filter is switched into the demodulation path and further multicarrier-specific parameters become available.

Note that this command is maintained for compatibility reasons only. For new remote control programs, select a multicarrier device type using `CONFigure[:MS]:DEVice:TYPE` on page 203.

Parameters for setting and query:

<MultiCarrierBTS> ON | OFF

ON
Sets the device type to "Multicarrier BTS Wide Area"

OFF
Sets the device type to "BTS Normal"

*RST: OFF

Example: `CONF:MCAR:MCBT ON`
New program (example):
`CONFigure:MS:DEVice:TYPE MCBWide`

Example: `CONF:MCAR:MCBT OFF`
New program (example):
`:CONFigure:MS:DEVice:TYPE BTSNormal`

CONFigure[:MS]:MTYPe <Value>

This command sets the modulation type of all slots.

Note: This command is retained for compatibility with R&S FS-K5 only.

Parameters for setting and query:

<Value> GMSK | EDGE

Modulation type

*RST: GMSK

Example:

```
// Enter the GSM option K10
INSTrument:SELect GSM
// Old FS-K5 commands
CONFigure:MS:MTYPe EDGE
// Please use the following K10 commands instead
// K5: 'GMSK' -> K10: 'GMSK'
// K5: 'EDGE' -> K10: 'PSK8'
CONFigure:MS:CHANnel:SLOT0:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT1:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT2:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT3:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT4:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT5:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT6:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT7:MTYPe PSK8
// Old FS-K5 commands
CONFigure:MS:CHANnel:SLOT1:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT1:MTYPe?
// -> GMSK
// Please use the following K10 commands instead
CONFigure:MS:CHANnel:MSLots:MEASure?
// -> 0 This is the slot number of the 'slot to measure'
// Set and query the modulation of the 'slot to measure'
CONFigure:MS:CHANnel:SLOT0:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT0:MTYPe?
// -> GMSK
```

Mode: GSM

CONFigure[:MS]:POWer:AUTO ONCE

This command is used to perform an auto level measurement immediately.

Note that this command is maintained for compatibility reasons only. Use `CONFigure[:MS]:AUTO:LEVel ONCE` on page 265 for new remote control programs.

CONFigure[:MS]:SSEarch <State>

This command is retained for compatibility with R&S FSW-K5 only. In new K10 remote scripts use `CONFigure:MS:SYNC:MODE TSC` or `CONFigure:MS:SYNC:MODE ALL` instead (see `CONFigure[:MS]:SYNC:MODE` on page 254).

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

ON
TSC search on

OFF
TSC search off

*RST: 1

Example: `CONF:SSE ON`

CONFigure:WSPectrum:MODulation:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "(Wide) Modulation Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit. This command is only available when the "Wide Modulation Spectrum" measurement is selected (see `CONFigure:WSPectrum:MODulation[:IMMediate]` on page 359).

Note that this command is maintained for compatibility reasons only. Use the `CONFigure:SPECtrum:MODulation:LIMIT` command for new remote control programs.

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example:

// Select Wide Modulation Spectrum measurement
// (gated zero span measurement)
`CONFigure:WSPectrum:MODulation:IMMediate`
// Absolute power and limit results in dBm
`CONFigure:WSPectrum:MODulation:LIMit ABSolute`
// Run one measurement and query absolute list results
`READ:WSPectrum:MODulation:ALL?`
// -> 0,929200000,929200000,-104.41,-65.00,ABS,PASSED, ...

FETCh:BURSt[:MACCuracy]:FERRor:AVERage?
FETCh:BURSt[:MACCuracy]:FERRor:CURRent?
FETCh:BURSt[:MACCuracy]:FERRor:MAXimum?
FETCh:BURSt[:MACCuracy]:FERRor:SDEViation?
READ:BURSt[:MACCuracy]:FERRor:AVERage?
READ:BURSt[:MACCuracy]:FERRor:CURRent?

READ:BURSt[:MACCuracy]:FERRor:MAXimum?
READ:BURSt[:MACCuracy]:FERRor:SDEViation?

This command starts the measurement and reads out the result of the Frequency Error.

This command is retained for compatibility with R&S FS-K5 only. Use the `READ:BURSt[:MACCuracy]:FREQuency` or `FETCh:BURSt[:MACCuracy]:FREQuency` commands in newer remote control programs.

Return values:

<Result>	numeric value Frequency error Default unit: Hz
Example:	`READ:BURS:FERR:SDEV?`
Usage:	Query only

FETCh:WSPectrum:MODulation[:ALL]?
READ:WSPectrum:MODulation[:ALL]?

This command starts the measurement and reads out the result of the measurement of the "Modulation Spectrum" of the mobile or base station.

These commands are retained for compatibility with previous R&S signal and spectrum analyzers only. For newer remote control programs, use the `READ:SPECtrum:MODulation[:ALL]?` or `FETCh:SPECtrum:MODulation[:ALL]?` commands instead.

The result is a list of partial result strings separated by commas.

Return values:

<Placeholder>	currently irrelevant
<Freq1>	Absolute offset frequency in Hz
<Freq2>	Absolute offset frequency in Hz
<Level>	Measured level at the offset frequency in dB or dBm.
<Limit>	Limit at the offset frequency in dB or dBm.
<Abs/Rel>	Indicates whether relative (dB) or absolute (dBm) limit and level values are returned.
<Status>	Result of the limit check in character data form **PASSED** no limit exceeded **FAILED** limit exceeded

Example:
```
READ:WSP:MOD?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
...
```

Usage: Query only

FETCh:WSPectrum:MODulation:REFerence?
READ:WSPectrum:MODulation:REFerence[:IMMediate]?

This command starts the measurement and returns the measured reference power of the "Modulation Spectrum".

These commands are retained for compatibility with previous R&S signal and spectrum analyzers only. For newer remote control programs, use the `READ:SPECtrum:MODulation:REFerence[:IMMediate]?` or `FETCh:SPECtrum:MODulation:REFerence?` commands instead.

The result is a list of partial result strings separated by commas.

Return values:

<Level1>	measured reference power in dBm
<Level2>	measured reference power in dBm
<RBW>	resolution bandwidth used to measure the reference power in Hz

Example: `READ:WSPectrum:MODulation:REFerence:IMMediate?`

Usage: Query only

READ:AUTO:LEVTime?

This command is used to perform a single measurement to detect the required reference level and the trigger offset automatically.

Note that this command is maintained for compatibility reasons only. Use `CONFigure[:MS]:AUTO:LEVel ONCE` and `CONFigure[:MS]:AUTO:TRIGger ONCE` for new remote control programs.

Parameters:

PASSED	Fixed value; irrelevant
<Dummy>	Fixed value (0); irrelevant

Return values:

<ReferenceLevel>	The detected reference level Default unit: variable
<TriggerOffset>	The detected time offset between the trigger event and the start of the sweep
<TriggerLevel>	The detected trigger level Range: -50 dBm to 20 dBm

Example: `READ:AUTO:LEVT?`
`// --> PASSED,9.2404,-0.00000007695,1.4,0`

Usage: Query only

READ:SPECtrum:WMODulation:GATing?

This command reads out the gating settings for gated `Wide Modulation Spectrum` measurements. It is identical to `READ:SPECtrum:WMODulation:GATing?` and is maintained for compatibility reasons only.

Example: `READ:SPEC:WMOD:GAT?`

Usage: Query only

Mode: GSM

11.13 Programming Examples

The following examples demonstrate how to configure and perform GSM measurements in a remote environment.

11.13.1 Programming Example: Determining the EVM

This example demonstrates how to configure an EVM measurement in a remote environment.

```
//---------- Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ

// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM
```

```
//---------- Trigger settings --------------------
// Use these settings only if an external trigger is connected
// to the TRIGGER INPUT connector of the analyzer.
// Otherwise ignore these commands.
// Define the use of an external trigger.
TRIGger:SOURce EXT
// Determine the offset from the trigger event to the frame start
// (start of active part of slot 0).
// Define a trigger offset of 2 µs.
TRIGger:HOLD 2us


//---------- Configuring Data Acquisition ---------------------
// Define a capture time of 1 second (>200 GSM frames)
SENSe:SWEep:TIME 1 s
// Define a statistic count of 200, i.e. 200 GSM frames are evaluated statistically.
SENSe:SWEep:COUNt 200


//---------- Configuring the result display ------------
// Delete result display 3 and 4 and
// activate the following result displays:
// 1: Magnitude Capture (default, upper left)
// 2: PvT Full burst (default, below Mag Capt)
// 3: Modulation Accuracy (next to Mag Capt)
// 4: Modulation Spectrum Table (next to PvT)
// 5: EVM vs Time measurement (full width, bottom)
LAYout:REMove '3'
LAYout:REMove '4'
LAYout:ADD:WINDow? '1',RIGH,MACC
LAYout:ADD:WINDow? '2',RIGH,MST
LAYout:ADD:WINDow? '2',BEL,ETIMe

//---------- Signal Description ------------
// Configure a base station DUT with normal power class 1
CONFigure:MS:DEV:TYPE BTSNormal
CONFigure:MS:NETWORK PGSM
CONFigure:MS:NETWORK:FREQ:BAND 900
CONFigure:MS:POW:CLAS 1

//---------- Frame/slot configuration ------------
CONFigure:MS:CHANnel:FRAM:EQU OFF
// Set slot 1: On, Higher Symbol Rate burst, 16QAM, Wide Pulse, TSC 0
CONFigure:MS:CHANnel:SLOT1:STATe ON
CONFigure:MS:CHANnel:SLOT1:TYPE HB
CONFigure:MS:CHANnel:SLOT1:MTYPe QAM16
CONFigure:MS:CHANnel:SLOT1:FILTer WIDE
CONFigure:MS:CHANnel:SLOT1:TSC 0
```

```
// Set slot 2: On, Normal burst, GMSK modulation, TSC 3 (Set 1)
CONFigure:MS:CHANnel:SLOT2:STATe ON
CONFigure:MS:CHANnel:SLOT2:TYPE NB
CONFigure:MS:CHANnel:SLOT2:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT2:TSC 3,1
// Query TSC number
CONFigure:MS:CHANnel:SLOT2:TSC? TSC
// -> 3
// Query Set number
CONFigure:MS:CHANnel:SLOT2:TSC? SET
// -> 1

// Set slot 3: On, Normal burst, GMSK modulation, User-defined TSC
CONFigure:MS:CHANnel:SLOT3:STATe ON
CONFigure:MS:CHANnel:SLOT3:TYPE NB
CONFigure:MS:CHANnel:SLOT3:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT3:TSC USER
CONFigure:MS:CHANnel:SLOT3:TSC?
// -> USER
// Set User TSC bits
CONFigure:MS:CHANnel:SLOT3:TSC:USER '10111101100110010000100001'
// Query User TSC bits
CONFigure:MS:CHANnel:SLOT3:TSC:USER?
// -> 10111101100110010000100001

// Set slot 4: Off
CONFigure:MS:CHANnel:SLOT4:STATe OFF

// Set slot 5: Off
CONFigure:MS:CHANnel:SLOT5:STATe OFF

// Set slot 6: Off
CONFigure:MS:CHANnel:SLOT6:STATe OFF

// Set slot 7: Off
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 1 (slot to measure) for single-slot measurements,
// (e.g. EVM, modulation spectrum).
CONFigure:MS:CHANnel:MSLots:MEASure 1
// Configure slots 0-3 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure = 4
CONFigure:MS:CHANnel:MSLots:NOFSlots 4
CONFigure:MS:CHANnel:MSLots:OFFSet 0
// Use 'sequence estimator' for the symbol decision
CONFigure:MS:DEMod:DECision SEQuence
```

```
// Replace detected Tail & TSC bits by the standard bits
CONFigure:MS:DEMod:STDBits STD

//---------- PvT Measurement settings -----------------
// Use Gaussian PvT filter with 500 kHz for single-carrier BTS
CONFigure:BURSt:PTEMplate:FILTer G500
// Align the limit line to mid of TSC for each slot.
CONFigure:BURSt:PTEMplate:TALign PSL

//---------- Spectrum Measurement settings -----------------
// Absolute power and limit (remote) results in dBm
CONFigure:SPECtrum:MODulation:LIMit ABSolute
// Use compact version of narrow frequency list to save time
CONFigure:WSPectrum:MODulation:LIST:SELect NSParse


//---------- Performing the Measurements-----
INITiate:IMMediate;*WAI

//---------- Retrieving Results-------------

// Read trace data in binary format
FORMat:DATA REAL,32

// Query current magnitude capture trace data
TRACe1:DATA? TRACe1
//-> trace data

// Query the current power vs time trace
TRACe2:DATA? TRACe4
//-> trace data

// Query the result of the power vs time limit check for max trace
CALCulate2:LIMit1:FAIL?
// -> 1

// Query max EVM trace data
TRACe5:DATA? TRACe2
//-> trace data

// Query the maximum EVM value for slot 1 (slot to measure) in current measurement
FETCh:BURSt:MACCuracy:EVM:PEAK:CURR?
// -> 0.62063819169998169

// Query the maximum EVM value for slot 1 (slot to measure) in all 200
// measured GSM frames
FETCh:BURSt:MACCuracy:EVM:PEAK:MAX?
// -> 0.76938760280609131

// Query the averaged EVM RMS value for slot 1 (slot to measure) in all 200
```

```
// measured GSM frames
FETCh:BURSt:MACCuracy:EVM:RMS:AVERage?
// -> 0.19639170169830322

// Query the absolute mod spectrum table results
FETCH:SPECtrum:MODulation:ALL?
// -> 00,933200000,933200000,-86.36,-70.23,ABS,PASSED, ...
// Query the reference power of the mod spectrum
FETCh:SPECtrum:MODulation:REFerence?
// -> -11.13,-11.13,30000

//---------- Exporting Captured I/Q Data-------------

// Query the sample rate for the captured I/Q data
// Note: The returned value depends on
// - Capture time: SENSe:SWEep:TIME?
// - Mod frequency list: CONFigure:WSPectrum:MODulation:LIST:SELect?
// Therefore only query the sample rate afterwards.
TRACe:IQ:SRATe?
// -> 6500000

// The number of samples can be calculated as follows
// floor((CaptureTime + 577 us) * SampleRate) =
// = floor((1s + 577 us) * 6.5 MHz)
// = floor(6503750.5)
// = 6503750 samples
// Query the captured I/Q data
TRACe1:IQ:DATA:MEMory? 0,6503750

// Alternatively store the captured I/Q data to a file.
MMEMory:STORe:IQ:STATe 1, 'C:\R_S\Instr\user\data.iq.tar'
```

11.13.2 Programming Example: Measuring an AQPSK Signal

This example demonstrates how to configure a GSM measurement of an AQPSK modulated signal in a remote environment.

```
//------------ Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ
```

```
// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM


//----------- Slot 0 configuration ------------
// Setup slot 0 for VAMOS AQPSK modulation
// Activate slot
CONFigure:MS:CHANnel:SLOT0:STATe ON
// Normal burst
CONFigure:MS:CHANnel:SLOT0:TYPE NB
// AQPSK (VAMOS) modulation
CONFigure:MS:CHANnel:SLOT0:MTYPe AQPSk
// Subchannel Power Imbalance Ratio (SCPIR) = 4 dB
CONFigure:MS:CHANnel:SLOT0:SCPir 4
// Subchannel 1: User TSC
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC USER
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?
// -> USER
// Subchannel 1: Set User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC:USER '10111101100110010000100001'
// Subchannel 1: Query User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC:USER?
// -> 10111101100110010000100001
// Subchannel 2: User TSC
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC USER
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC?
// -> USER
// Subchannel 2: Set User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC:USER '11010111111101011001110100'
// Subchannel 2: Query User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC:USER?
// -> 11010111111101011001110100

//----------- Slot 1 configuration ------------
// Activate slot 1
CONFigure:MS:CHANnel:SLOT1:STATe ON
// Normal Burst
CONFigure:MS:CHANnel:SLOT1:TYPE NB
// AQPSK (VAMOS) modulation
CONFigure:MS:CHANnel:SLOT1:MTYPe AQPSk
// Subchannel 1: TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC 0,1
// Subchannel 1: Query TSC number and Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC?
// -> 0,1
// Subchannel 1: Query TSC number
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC? TSC
// -> 0
// Subchannel 1: Query Set number
```

```
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC? SET
// -> 1
// Subchannel 2: TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC 0,2
// Subchannel 2: Query TSC number and Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC?
// -> 0,2
// Subchannel 2: Query TSC number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC? TSC
// -> 0
// Subchannel 2: Query Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC? SET
// -> 2

//----------- Slot 2-7 configuration ------------
CONFigure:MS:CHANnel:SLOT2:STATe OFF
CONFigure:MS:CHANnel:SLOT3:STATe OFF
CONFigure:MS:CHANnel:SLOT4:STATe OFF
CONFigure:MS:CHANnel:SLOT5:STATe OFF
CONFigure:MS:CHANnel:SLOT6:STATe OFF
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 0 (slot to measure) for single-slot measurements,
// (e.g. EVM, modulation spectrum).
CONFigure:MS:CHANnel:MSL:MEASure 0
// Configure slots 0-1 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure =2
CONFigure:MS:CHANnel:MSL:NOFS 2
CONFigure:MS:CHANnel:MSL:OFFSet 0
// Use 'sequence estimator' for the symbol decision
CONFigure:MS:DEMod:DECision SEQuence


//---------- Configuring Data Acquisition ---------------------
// Define a statistic count of 10, i.e. 10 GSM frames are evaluated statistically.
SENSe:SWEep:COUNt 10

// Define a capture time for 10 (statistic count) + 2 (headroom) GSM frames
// Capture Time = (10+2) frames * 4.615 ms/frame = 0.0554 s
// Thus all 10 (statistic count) frames can be analyzed with a single capture.
SENSe:SWEep:TIME 0.0554 s


//--------------Performing the Measurement-----
// Initiates a new measurement and waits until the sweep has finished.
INITiate:IMMediate;*WAI
```

```
//---------------Retrieving Results-------------
// Query the maximum EVM value for slot 0 (slot to measure) in current GSM frame
FETCh:BURSt:MACCuracy:EVM:PEAK:CURR?
// -> 0.62063819169998169
// Query the maximum EVM value for slot 0 (slot to measure) in all 10
//(statistic count) GSM frames
FETCh:BURSt:MACCuracy:EVM:PEAK:MAX?
// -> 0.76938760280609131
// Query the averaged EVM RMS value for slot 1 (slot to measure) in all 10
// (statistic count) GSM frames
FETCh:BURSt:MACCuracy:EVM:RMS:AVERage?
// -> 0.19639170169830322
```

11.13.3 Programming Example: Measuring the Power for Access Bursts

This example demonstrates how to configure a GSM power measurement of a GMSK modulated signal with access bursts in a remote environment.

```
//------------ Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ

// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM


//----------- Slot 0 configuration ------------
// Activate slot 0
CONFigure:MS:CHANnel:SLOT0:STATe ON
// Normal Burst
CONFigure:MS:CHANnel:SLOT0:TYPE NB
// GMSK modulation
CONFigure:MS:CHANnel:SLOT0:MTYPe GMSK
// TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT0:TSC 0,1


//----------- Slot 1 configuration ------------
```

```
// Activate slot 1
CONFigure:MS:CHANnel:SLOT1:STATe ON
// Access Burst
CONFigure:MS:CHANnel:SLOT1:TYPE AB
// Set TS0
CONFigure:MS:CHANnel:SLOT1:TSC TS0
// Query TS
CONFigure:MS:CHANnel:SLOT1:TSC?
// -> TS0
// Access burst has a timing advance (offset) from slot start of 1 symbol
CONFigure:MS:CHANnel:SLOT1:TADV 1


//----------- Slot 2-7 configuration ------------
CONFigure:MS:CHANnel:SLOT2:STATe OFF
CONFigure:MS:CHANnel:SLOT3:STATe OFF
CONFigure:MS:CHANnel:SLOT4:STATe OFF
CONFigure:MS:CHANnel:SLOT5:STATe OFF
CONFigure:MS:CHANnel:SLOT6:STATe OFF
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 1 (slot to measure) for single-slot measurements,
// (e.g. phase error, modulation spectrum).
CONF:CHAN:MSL:MEAS 1
// Configure slot 0-1 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure = 2
CONF:CHAN:MSL:NOFS 2
CONF:CHAN:MSL:OFFS 0


//---------- PvT Measurement settings -----------------
// Check PvT filter
CONF:BURS:PTEM:FILT?
// -> G1000

// Align the limit line to mid of TSC/TS for each slot.
CONF:BURS:PTEM:TAL PSL


//--------------Performing the Measurement-----
// Initiates a new measurement and waits until the sweep has finished.
INITiate:IMMediate;*WAI


//---------------Retrieving Results-------------
```

```
// In PvT limits are checked against the max in min traces.
// Query the max power vs time trace
TRAC2:DATA? TRACe2
// Query the result of the power vs time limit check for max trace
CALCulate2:LIMit1:FAIL?
// -> 0
// Query the min power vs time trace
TRAC2:DATA? TRACe3
// Query the result of the power vs time limit check for min trace
CALCulate2:LIMit2:FAIL?
// -> 0
// Query the result of the power vs time limit check for slot 0
FETCh:BURSt:SPOWer:SLOT0:LIM:FAIL?
// -> 0
// Query the result of the power vs time limit check for slot 1
FETCh:BURSt:SPOWer:SLOT1:LIM:FAIL?
// -> 0

// Query the maximum phase error value for slot 1 (slot to measure) in
// current GSM frame
FETCh:BURSt:MACCuracy:PERRor:PEAK:CURR?
// -> -0.21559642255306244
// Query the maximum phase error value for slot 1 (slot to measure) in
// all 200 GSM frames
FETCh:BURSt:MACCuracy:PERRor:PEAK:MAX?
// -> 0.35961171984672546
// Query the averaged phase error RMS value for slot 1 (slot to measure) in
// all 200 GSM frames
FETCh:BURSt:MACCuracy:PERRor:RMS:AVERage?
// -> 0.082186274230480194
```

11.13.4 Programming Example: Measuring Statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment.

```
-----------Configuring the measurement ------------
*RST
//Reset the instrument
CALC:MARK:FUNC:POW:SEL OBW
//Activate occupied bandwidth measurement.


--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
```

```
---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? OBW
//Returns the results for the OBW measurement.
```

11.13.5 Programming Example: Measuring the Wideband Noise for Multiple Carriers

This example demonstrates how to configure a GSM wideband noise measurement of a GMSK modulated signal with multiple carriers in a remote environment.

```
//------------ Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
//Select the multicarrier wideband noise measurement
CONF:MEAS MCWN
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt

//---------- Signal Description ------------
// Configure a multicarrier base station wide area DUT without power classes
CONFigure:MS:DEV:TYPE MCBW
CONFigure:MS:NETWORK PGSM
CONFigure:MS:NETWORK:FREQ:BAND 900
CONFigure:MS:POW:CLAS NONE

// Configure 2 subblocks of carriers with 3 carriers each and a gap of 5 MHz
CONF:MS:MCAR:FALL NCON

CONF:MS:MCAR:CARR1:FREQ 935 MHZ
CONF:MS:MCAR:CARR2:FREQ 935.6 MHZ
CONF:MS:MCAR:CARR3:FREQ 936.2 MHZ

CONF:MS:MCAR:CARR4:FREQ 941.2 MHZ
CONF:MS:MCAR:CARR5:FREQ 941.8 MHZ
CONF:MS:MCAR:CARR6:FREQ 942.4 MHZ

CONF:MS:MCAR:FALL:NCON:GSAC 3

// Normal burst 8PSK modulation
CONF:MS:MCAR:CARR1:MTYP N8PS
CONF:MS:MCAR:CARR2:MTYP N8PS
CONF:MS:MCAR:CARR3:MTYP N8PS
CONF:MS:MCAR:CARR4:MTYP N8PS
CONF:MS:MCAR:CARR5:MTYP N8PS
CONF:MS:MCAR:CARR6:MTYP N8PS
```

```
//---------- Span and Level ---------------------
// Set Ref. Level to 30 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 0 DBM
// Set Ref. Level Offset to 38 dB
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:OFFSet 38 DB


// Set frequency span to the Tx band +/- 10 MHz automatically
SENS:FREQ:SPAN:MODE TXB
SENS:FREQ:SPAN?
SENS:FREQ:STAR?
SENS:FREQ:STOP?
// Result: span = 45.0 MHz (925 MHZ to 970 MHz)

//---------- Configuring the reference measurement -----------
// Configure the reference levels manually according to table 5-8
// power level is 35 dBm
CONF:SPEC:MOD:REF:MEAS OFF
CONF:SPEC:MOD:REF:PLEV 35
CONF:SPEC:MOD:REF:RPOW 30e3,27.3
CONF:SPEC:MOD:REF:RPOW 100e3,31.2
CONF:SPEC:MOD:REF:RPOW 300e3,33.3

//----------- Configuring the noise measurement --------------
// Define an average count of 200
SENS:SWE:COUN 200

// Determine wideband noise, narrowband noise, and intermodulation products of orders 3 and 5
CONF:SPEC:NWID ON
CONF:SPEC:NNAR ON
CONF:SPEC:IMP 3,5
// Apply exceptions to limit check
CONF:SPEC:LIM:EXC ON

//---------- Configuring the result display ------------

// Activate the following result displays:
// 1: Spectrum graph (default, top)
// 2: Inner IM Table (replaces Carrier Power table)
// 3: Outer IM Table (bottom)
// 4: Outer narrow band table (bottom left)
// 5: Outer wide band table, (bottom right)
LAYout:REPL:WINDow '2',IIMP
LAYout:ADD:WINDow? '2',BEL,OIMP
LAYout:ADD:WINDow? '3',BEL,ONAR
LAYout:ADD:WINDow? '4',RIGH,OWID

//--------------Performing the Measurement-----
// Initiate a new measurement and wait until the sweep has finished.
INITiate:IMMediate;*WAI
```

```
//---------------Retrieving Results-------------
// Query trace data for Spectrum graph
TRAC1:DATA? TRACE1
// Query intermodulation results
FETC:WSP:IMPR:INN?
FETC:WSP:IMPR:OUT?
// Query outer narrowband table results and outer wideband table results
FETC:WSP:NARR:OUT?
FETC:WSP:WID:OUT?

// Query wideband noise limit line (including exceptions)
// x-values:
CALC1:LIM1:CONT:DATA?
// y-values:
CALC1:LIM1:UPP:DATA?

// Query limit line trace values for intermodulation
// measured with 100 kHZ RBW
// x-values:
CALC1:LIM2:CONT:DATA?
// y-values:
CALC1:LIM2:UPP:DATA?

// Query limit line trace values for intermodulation
// measured with 300 kHZ RBW
// x-values:
CALC1:LIM3:CONT:DATA?
// y-values:
CALC1:LIM3:UPP:DATA?

// Query number of exceptions of range A:
// Counted number of exceptions:
CALC1:LIM5:EXC:COUN:CURR?
// Maximum number of exceptions allowed to pass the exception check
CALC1:LIM5:EXC:COUN:MAX?

// Query number of exceptions of range B:
// Counted number of exceptions:
CALC1:LIM6:EXC:COUN:CURR?
// Maximum number of exceptions allowed to pass the exception check
CALC1:LIM6:EXC:COUN:MAX?

// Query limit check results
// Overall:
FETC:SPEC:MOD:LIM:FAIL?
// Wideband noise:
CALC1:LIM1:FAIL?
// Intermodulation (100 kHz RBW):
```

```
CALC1:LIM2:FAIL?
// Intermodulation (300 kHz RBW):
CALC1:LIM3:FAIL?
// Exception counting range A:
CALC1:LIM5:FAIL?
// Exception counting range B:
CALC1:LIM6:FAIL?
```

Annex

A Annex: Reference

A.1 List of abbreviations

16QAM	16-ary Quadrature Amplitude Modulation
32QAM	32-ary Quadrature Amplitude Modulation
3GPP	3rd Generation Partnership Project
8PSK	Phase Shift Keying with 8 phase states
AQPSK	Adaptive Quadrature Amplitude Modulation
ARFCN	Absolute Radio Frequency Channel Number
BTS	Base Transceiver Station
DL	Downlink (MS to BTS)
DUT	Device Under Test
EDGE	Enhanced Data Rates for GSM Evolution
EGPRS	Enhanced General Packet Radio, synonym for EDGE.
EGPRS2	Enhanced General Packet Radio and support of additional modulation/coding schemes and higher symbol rate.
FDMA	Frequency Division Multiplex Access
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSCSD	High-Speed Circuit-Switch Data
IF	Intermediate Frequency
MS	Mobile Station
NSP	Normal Symbol Period
PCL	Power Control Level
PDF	Probability Density Function

PvT	Power vs Time
QPSK	Quadrature Phase Shift Keying
SCPIR	Subchannel Power Imbalance Ratio
SFH	Slow Frequency Hopping
TDMA	Time Division Multiplex Access
TSC	Training Sequence Code
UL	Uplink (BTS to MS)
VAMOS	Voice services over Adaptive Multi-user Channels on One Slot
YIG	Yttrium Iron Garnet

A.2 I/Q Data File Format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An iq-tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the iq-tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include user-specific data.

The iq-tar container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see http://en.wikipedia.org/wiki/Comparison_of_file_archivers) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

Sample iq-tar files

If you have the optional R&S FSW VSA application (R&S FSW-K70), some sample iq-tar files are provided in the `C:/R_S/Instr/user/vsa/DemoSignals` directory on the R&S FSW.

Contained files

An iq-tar file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an iq-tar file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an iq-tar file.

Optionally, an iq-tar file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.
  A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

A.2.1 I/Q Parameter XML File Specification

The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: http://www.rohde-schwarz.com/file/RsIqTar.xsd.

In particular, the order of the XML elements must be respected, i.e. iq-tar uses an "ordered XML schema". For your own implementation of the iq-tar file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>R&S FSW</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
<DataFilename>xyz.complex.float32</DataFilename>
<UserData>
  <UserDefinedElement>Example</UserDefinedElement>
</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Element	Description
RS_IQ_TAR_File-Format	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition. Currently, `fileFormatVersion` "2" is used.
Name	Optional: describes the device or application that created the file.

Element	Description
Comment	Optional: contains text that further describes the contents of the file.
DateTime	Contains the date and time of the creation of the file. Its type is `xs:dateTime` (see `RsIqTar.xsd`).
Samples	Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be: ● A complex number represented as a pair of I and Q values ● A complex number represented as a pair of magnitude and phase values ● A real number represented as a single real value See also `Format` element.
Clock	Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute `unit` must be set to "Hz".
Format	Specifies how the binary data is saved in the I/Q data binary file (see `DataFilename` element). Every sample must be in the same format. The format can be one of the following: ● `complex`: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless ● `real`: Real number (unitless) ● `polar`: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires `DataType` = `float32` or `float64`
DataType	Specifies the binary format used for samples in the I/Q data binary file (see `DataFilename` element and Chapter A.2.2, "I/Q Data Binary File", on page 385). The following data types are allowed: ● `int8`: 8 bit signed integer data ● `int16`: 16 bit signed integer data ● `int32`: 32 bit signed integer data ● `float32`: 32 bit floating point data (IEEE 754) ● `float64`: 64 bit floating point data (IEEE 754)
ScalingFactor	Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the `ScalingFactor`. For polar data only the magnitude value has to be multiplied. For multi-channel signals the `ScalingFactor` must be applied to all channels. The attribute `unit` must be set to "`V`". The `ScalingFactor` must be > 0. If the `ScalingFactor` element is not defined, a value of 1 V is assumed.
NumberOfChannels	Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see Chapter A.2.2, "I/Q Data Binary File", on page 385). If the `NumberOfChannels` element is not defined, one channel is assumed.

Element	Description
DataFilename	Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> ● <xyz> = a valid Windows file name ● <Format> = complex, polar or real (see `Format` element) ● <Channels> = Number of channels (see `NumberOfChannels` element) ● <Type> = float32, float64, int8, int16, int32 or int64 (see `DataType` element) Examples: ● xyz.complex.1ch.float32 ● xyz.polar.1ch.float64 ● xyz.real.1ch.int16 ● xyz.complex.16ch.int8
UserData	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
PreviewData	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. R&S FSW). For the definition of this element refer to the `RsIqTar.xsd` schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet `open_IqTar_xml_file_in_web_browser.xslt` is available.

Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

`ScalingFactor` = 1 V / maximum int16 value = 1 V / 2^{15} = 3.0517578125e-5 V

Scaling Factor	Numerical value	Numerical value x ScalingFactor
Minimum (negative) int16 value	$-2^{15} = -32768$	-1 V
Maximum (positive) int16 value	$2^{15}-1= 32767$	0.999969482421875 V

Example: PreviewData in XML

```
<PreviewData>
    <ArrayOfChannel length="1">
      <Channel>
        <PowerVsTime>
          <Min>
            <ArrayOfFloat length="256">
              <float>-134</float>
              <float>-142</float>
              ...
              <float>-140</float>
            </ArrayOfFloat>
          </Min>
          <Max>
            <ArrayOfFloat length="256">
              <float>-70</float>
              <float>-71</float>
```

```
          ...
          <float>-69</float>
        </ArrayOfFloat>
      </Max>
    </PowerVsTime>
    <Spectrum>
      <Min>
        <ArrayOfFloat length="256">
          <float>-133</float>
          <float>-111</float>
          ...
          <float>-111</float>
        </ArrayOfFloat>
      </Min>
      <Max>
        <ArrayOfFloat length="256">
          <float>-67</float>
          <float>-69</float>
          ...
          <float>-70</float>
          <float>-69</float>
        </ArrayOfFloat>
      </Max>
    </Spectrum>
    <IQ>
      <Histogram width="64" height="64">0123456789...0</Histogram>
    </IQ>
  </Channel>
 </ArrayOfChannel>
</PreviewData>
```

A.2.2 I/Q Data Binary File

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `Format` element and `DataType` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `NumberOfChannels` element is not defined, one channel is presumed.

Example: Element order for real data (1 channel)

```
I[0],                         // Real sample 0
I[1],                         // Real sample 1
I[2],                         // Real sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

```
I[0], Q[0],                   // Real and imaginary part of complex sample 0
I[1], Q[1],                   // Real and imaginary part of complex sample 1
I[2], Q[2],                   // Real and imaginary part of complex sample 2
...
```

Example: Element order for complex polar data (1 channel)

```
Mag[0], Phi[0],               // Magnitude and phase part of complex sample 0
Mag[1], Phi[1],               // Magnitude and phase part of complex sample 1
Mag[2], Phi[2],               // Magnitude and phase part of complex sample 2
...
```

Example: Element order for complex cartesian data (3 channels)

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],            // Channel 0, Complex sample 0
I[1][0], Q[1][0],            // Channel 1, Complex sample 0
I[2][0], Q[2][0],            // Channel 2, Complex sample 0

I[0][1], Q[0][1],            // Channel 0, Complex sample 1
I[1][1], Q[1][1],            // Channel 1, Complex sample 1
I[2][1], Q[2][1],            // Channel 2, Complex sample 1

I[0][2], Q[0][2],            // Channel 0, Complex sample 2
I[1][2], Q[1][2],            // Channel 1, Complex sample 2
I[2][2], Q[2][2],            // Channel 2, Complex sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

This example demonstrates how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
  fwrite(fid,single(real(iq(k))),'float32');
  fwrite(fid,single(imag(iq(k))),'float32');
end
fclose(fid)
```

List of Remote Commands (GSM)

Index

Symbols

A

B

C

F

G

H

I

N

O

T