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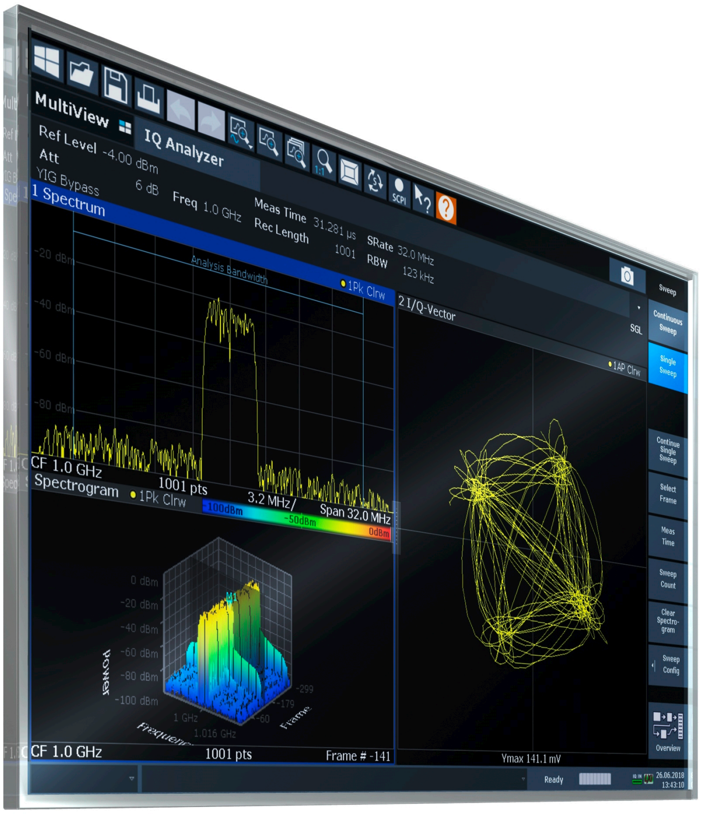
R&S®FSW I/Q Analyzer and I/Q Input Interfaces
User Manual



1175644902
Version 36

ROHDE&SCHWARZ
Make ideas real

This manual applies to the following R&S®FSW models with firmware version 4.70 and later:

- R&S®FSW8 (1331.5003K08 / 1312.8000K08)
- R&S®FSW13 (1331.5003K13 / 1312.8000K13)
- R&S®FSW26 (1331.5003K26 / 1312.8000K26)
- R&S®FSW43 (1331.5003K43 / 1312.8000K43)
- R&S®FSW50 (1331.5003K50 / 1312.8000K50)
- R&S®FSW67 (1331.5003K67 / 1312.8000K67)
- R&S®FSW85 (1331.5003K85 / 1312.8000K85)

In addition to the base unit, the following options are described:

- R&S®FSW-B10 (1313.1622.02)
- R&S®FSW-B13 (1313.0761.02)
- R&S®FSW-B17 (1313.0784.02)
- R&S®FSW-B21 (1313.1100.XX)
- R&S®FSW-B24 (1313.0832.XX)
- R&S®FSW-B25 (1313.0990.02)
- R&S®FSW-B28 (1313.1645.02)
- R&S®FSW-B40 (1313.0861.02) / R&S®FSW-U40 (1313.52505.02)
- R&S®FSW-B71 (1313.1651.XX, 1313.6547.02) / R&S®FSW-B2071 (1331.8302.XX)
- R&S®FSW-B80 (1313.0878.02) / R&S®FSW-U80 (1313.5211.02)
- R&S®FSW-B106 (1331.6451.02) / R&S®FSW-B108 (1331.6751.02) / R&S®FSW-B124 (1338.5273.02)
- R&S®FSW-B160 (1313.1668.02 / 1325.4850.04) / R&S®FSW-U160 (1313.3754.02 / 1325.5357.04)
- R&S®FSW-B320 (1313.7172.02 / 1325.4867.04) / R&S®FSW-U320 (1313.7189.02)
- R&S®FSW-B512 (1313.4296.xx) / R&S®FSW-U512 (1321.6320.xx)
- R&S®FSW-B1200 (1331.6400.xx)
- R&S®FSW-B2000 (1325.4750.xx) / R&S®FSW-U2000 (1325.5405.xx)
- R&S®FSW-B2001 (1331.6916.xx) / R&S®FSW-U2001 (1331.7070.xx)
- R&S®FSW-B4001 (1338.5215.xx) / R&S®FSW-U4001 (1338.5244.xx)
- R&S®FSW-B5000 (1331.6997.xx) / R&S®FSW-U5000 (1331.7629.xx)
- R&S®FSW-B6001 (1338.5221.xx) / R&S®FSW-U8001 (1338.5250.xx)
- R&S®FSW-B8001 (1338.5238.xx) / R&S®FSW-U6001 (1338.5267.xx)

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1175.6449.02 | Version 36 | R&S®FSW I/Q Analyzer and I/Q Input

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol, e.g. R&S®FSW is indicated as R&S FSW. R&S®FSW Multi-Standard Radio Analyzer is indicated as R&S FSW MSRA. Products of the R&S®SMW family, e.g. R&S®SMW200A, are indicated as R&S SMW.

Contents

1 Preface

This chapter provides safety-related information, an overview of the user documentation and the conventions used in the documentation.

1.1 Documentation Overview

This section provides an overview of the R&S FSW user documentation. Unless specified otherwise, you find the documents on the R&S FSW product page at:

www.rohde-schwarz.com/manual/FSW

1.1.1 Getting Started Manual

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.

A printed version is delivered with the instrument. A PDF version is available for download on the Internet.

1.1.2 User Manuals and Help

Separate user manuals are provided for the base unit and the firmware applications:

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Firmware application manual
  Contains the description of the specific functions of a firmware application, including remote control commands. Basic information on operating the R&S FSW is not included.

The contents of the user manuals are available as help in the R&S FSW. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

All user manuals are also available for download or for immediate display on the Internet.

1.1.3 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):

https://gloris.rohde-schwarz.com

1.1.4 Instrument Security Procedures

Deals with security issues when working with the R&S FSW in secure areas. It is available for download on the Internet.

1.1.5 Printed Safety Instructions

Provides safety information in many languages. The printed document is delivered with the product.

1.1.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S FSW. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/FSW

1.1.7 Release Notes and Open-Source Acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/FSW

1.1.8 Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/FSW

1.2 About this Manual

This R&S FSW I/Q Analyzer User Manual provides all the information **specific to the application and processing I/Q data**. All general instrument functions and settings common to all applications 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 I/Q Analyzer application**
  Introduction to and getting familiar with the application
- **Typical Applications for the I/Q Analyzer and optional input interfaces**
  Example measurement scenarios for I/Q data import and analysis
- **Measurements and Result Displays**
  Details on supported measurements and their result types
- **Basics on I/Q Data Acquisition**
  Background information on basic terms and principles in the context of the I/Q Analyzer application as well as processing I/Q data in general
- **Configuration and Analysis**
  A concise description of all functions and settings available to import, capture and analyze I/Q data in the I/Q Analyzer, with or without optional interfaces, with their corresponding remote control command
- **How to Work with I/Q Data**
  The basic procedure to perform an I/Q Analyzer measurement or capture data via the R&S Digital Baseband Interface with step-by-step instructions
- **Optimizing and Troubleshooting the Measurement**
  Hints and tips on how to handle errors and optimize the test setup
- **Remote Commands to perform Measurements with I/Q Data**
  Remote commands required to configure and perform I/Q Analyzer measurements or process digital I/Q data 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.
- **Annex**
  Reference material, e.g. I/Q file formats and a detailed description of the LVDS connector
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

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 and knob names are enclosed by square brackets.
`Filenames, commands, program code`	Filenames, 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 operating 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 many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

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 I/Q Analyzer Application

The R&S FSW I/Q Analyzer is a firmware application that adds functionality to perform I/Q data acquisition and analysis to the R&S FSW.

The R&S FSW I/Q Analyzer features:

- Acquisition of analog I/Q data
- Optionally, acquisition of digital I/Q data via the optional Digital Baseband Interface
- Optionally, acquisition of analog baseband data via the optional Analog Baseband Interface
- Import of stored I/Q data from other applications
- Spectrum, magnitude, I/Q vector and separate I and Q component analysis of any I/Q data on the instrument
- Export of I/Q data to other applications
- Optionally, direct output of digital I/Q data via the optional Digital Baseband Interface

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://www.rohde-schwarz.com/product/FSW.

Additional information

Several application notes discussing I/Q analysis are available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

1EF92: Wideband Signal Analysis

1MA257: Wideband mm-Wave Signal Generation and Analysis

1EF84: Differential measurements with Spectrum Analyzers and Probes

Installation

The R&S FSW I/Q Analyzer application is part of the standard base unit and requires no further installation.

The optional Digital Baseband Interface requires both hardware and firmware installation, which is described in the release notes provided with the option at delivery.

2.1 Starting the I/Q Analyzer Application

The I/Q Analyzer is an application on the R&S FSW.

To activate the I/Q Analyzer application

1. Select the [MODE] key.

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

2. Select the "I/Q Analyzer" item.

   The R&S FSW opens a new channel for the I/Q Analyzer application.

The measurement is started immediately with the default settings.

It can be configured in the I/Q Analyzer "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see Chapter 6.1, "Configuration Overview", on page 110).

Multiple Channels and Sequencer Function

When you activate an application, a new channel is created which determines the measurement settings for that application (channel). 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 can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

If activated, the measurements configured in the currently defined 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 well as the "MultiView") as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

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 I/Q Analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.

Figure 2-1: Screen elements in the I/Q Analyzer application

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

MSRA/MSRT operating mode

In MSRA and MSRT operating mode, additional tabs and elements are available. A colored background of the screen behind the channel tabs indicates that you are in MSRA/MSRT operating mode.

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 Realtime Spectrum Application and MSRT Operating Mode User Manual.

Channel bar information

In the I/Q Analyzer application, the R&S FSW shows the following settings:

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

Ref Level	Reference level
(m.+el.)**Att**	(Mechanical and electronic) RF attenuation
Ref Offset	Reference level offset

Freq	Center frequency
Meas Time	Measurement time
Rec Length	Defined record length (number of samples to capture)
SRate	Defined sample rate for data acquisition
RBW	(Spectrum evaluation only) Resolution bandwidth calculated from the sample rate and record length
Inp:Dig-IQ	Input source: digital I/Q data from the optional Digital Baseband Interface
Inp:Analog <I/Q mode>	Input source: analog baseband data from the optional Analog Baseband Interface <I/Q mode>: defines the processing mode (see Chapter 5.3.3, "I/Q Processing Modes", on page 51)
200 MHz	The 200 MHz filter for wideband processing is active (see "200 MHz Filter" on page 187)
Low Noise	Signal processing is optimized for low noise (rather than low distortion, see " Optimization " on page 166)

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 or trigger settings). This information is displayed only when applicable for the current measurement. For details see the R&S FSW Getting Started manual.

Window title bar information

For each diagram, the header provides the following information:

Figure 2-2: Window title bar information in the I/Q Analyzer application

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

Diagram footer information

The information in the diagram footer (beneath the diagram) depends on the evaluation:

- Center frequency
- Number of sweep points
- Range per division (x-axis)

- Span (Spectrum)

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.

For details see Chapter 9.1, "Error Messages", on page 257.

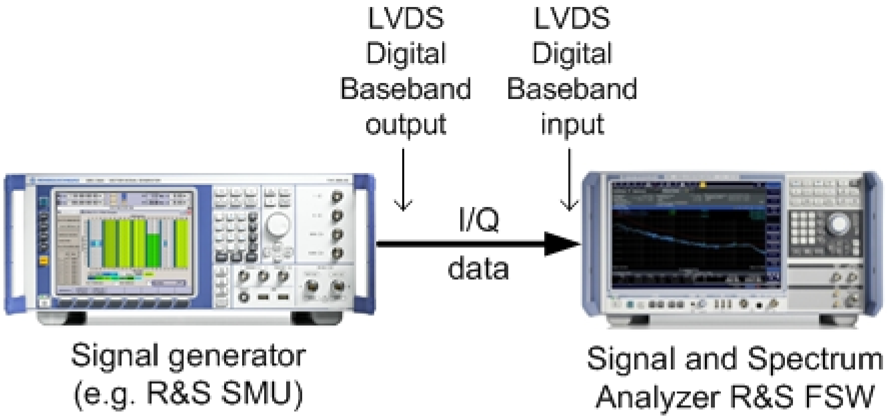
3 Typical Applications for the I/Q Analyzer and I/Q Input

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. I/Q signals are useful because the specific RF or IF frequencies are not needed. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband. Thus, the I/Q Analyzer is ideal for analyzing I/Q baseband signals.

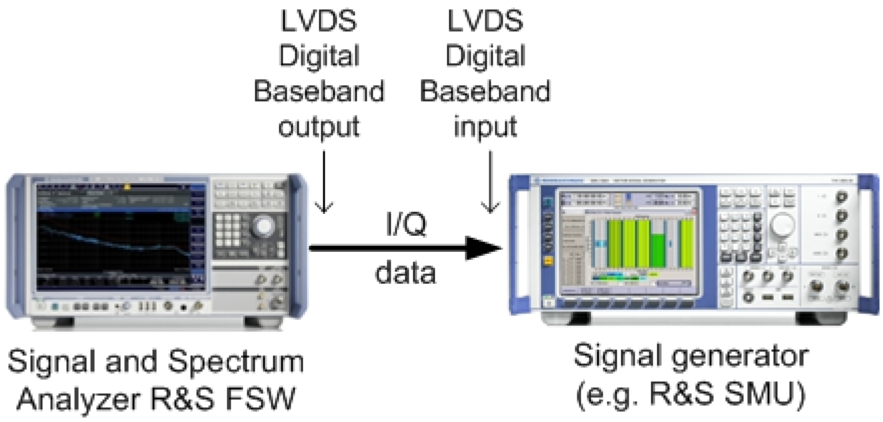
The optional Digital Baseband Interface can be used to capture or output the I/Q data.

The following typical applications use the R&S Digital Baseband Interface:

- Capturing and evaluating digital I/Q data in the I/Q Analyzer application of the R&S FSW base unit or other (optional) applications, e.g. R&S FSW-K70 (VSA). See also the description of the individual applications.



- Output of digital I/Q data to a selected receiver, e.g. to implement fading (simulating mobile radio communication participants) using a generator.



4 Measurement and Result Displays

Access: "Overview" > "Display Config"

Or: [MEAS] > "Display Config"

The I/Q Analyzer can capture I/Q data. The I/Q data that was captured by or imported to the R&S FSW can then be evaluated in various different result displays. Select the result displays using the SmartGrid functions.

Up to 6 evaluations can be displayed in the I/Q Analyzer at any time, including several graphical diagrams, marker tables or peak lists.

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

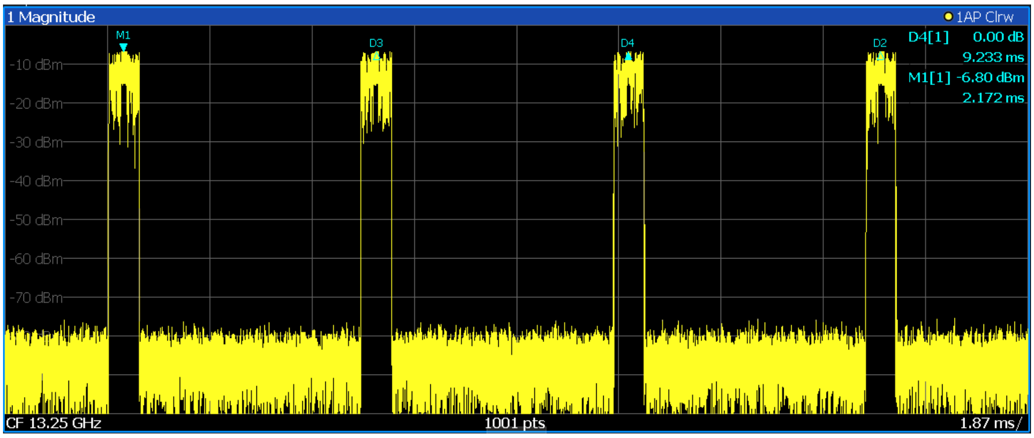
Measurements in the time and frequency domain

The I/Q Analyzer application (*not Master*) **in MSRA mode** can also perform measurements on the captured I/Q data in the time and frequency domain (see also Chapter 5.15, "I/Q Analyzer in MSRA/MSRT Operating Mode", on page 107). They are configured using the same settings and provide similar results. In addition, the analysis interval used for the measurement is indicated as in all multistandard applications.

The time and frequency domain measurements and the available results are described in detail in the R&S FSW User Manual.

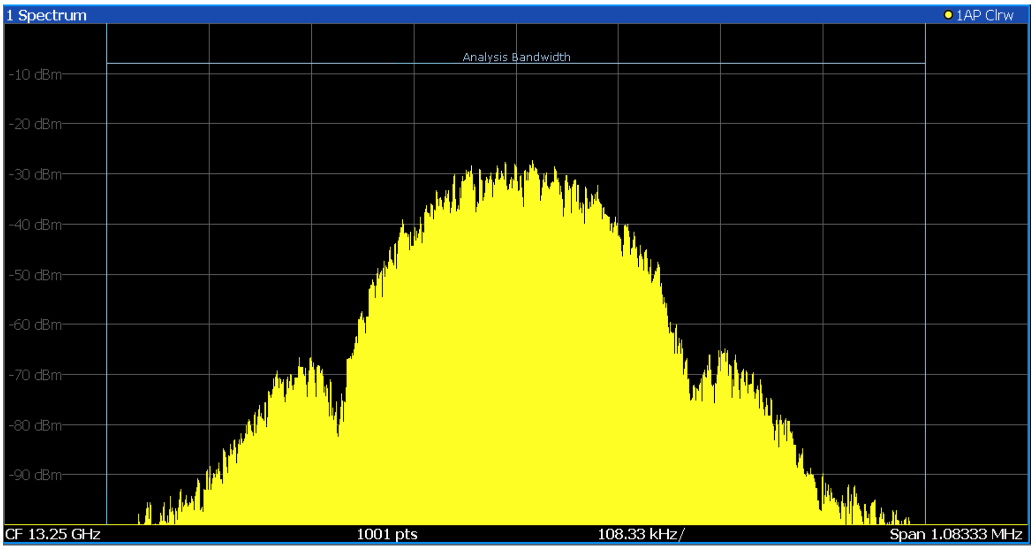
Result displays for I/Q data:

Magnitude
Shows the level values in time domain.



Remote command:
`LAY:ADD:WIND? '1',RIGH,MAGN`, see `LAYout:ADD[:WINDow]?` on page 394
Results:
`TRACe<n>[:DATA]?` on page 474

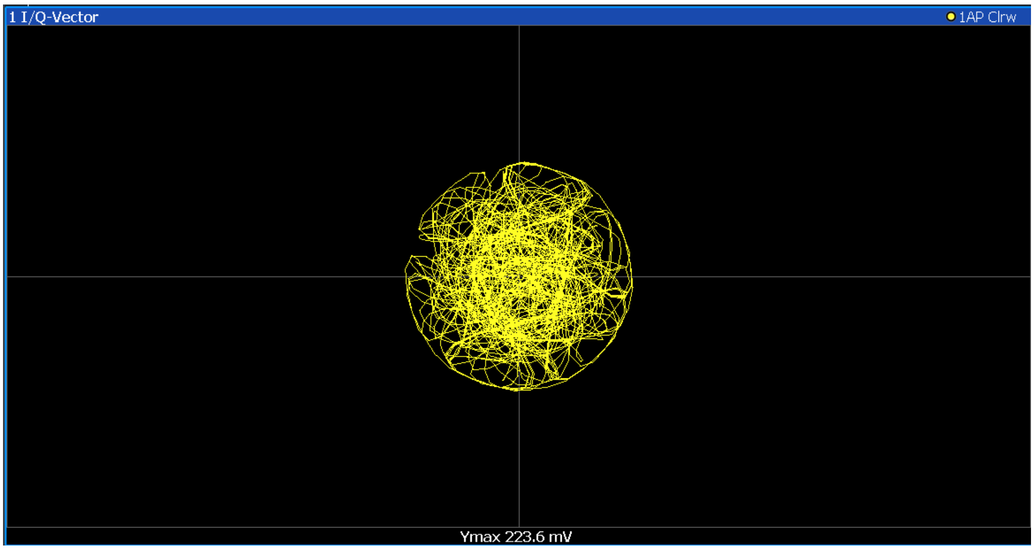
Spectrum
Displays the frequency spectrum of the captured I/Q samples.



The specified Analysis Bandwidth is indicated by vertical blue lines.

Remote command:
`LAY:ADD:WIND? '1',RIGH,FREQ`, see `LAYout:ADD[:WINDow]?` on page 394
Results:
`TRACe<n>[:DATA]?` on page 474

I/Q-Vector
Displays the captured samples in an I/Q-plot. The samples are connected by a line.



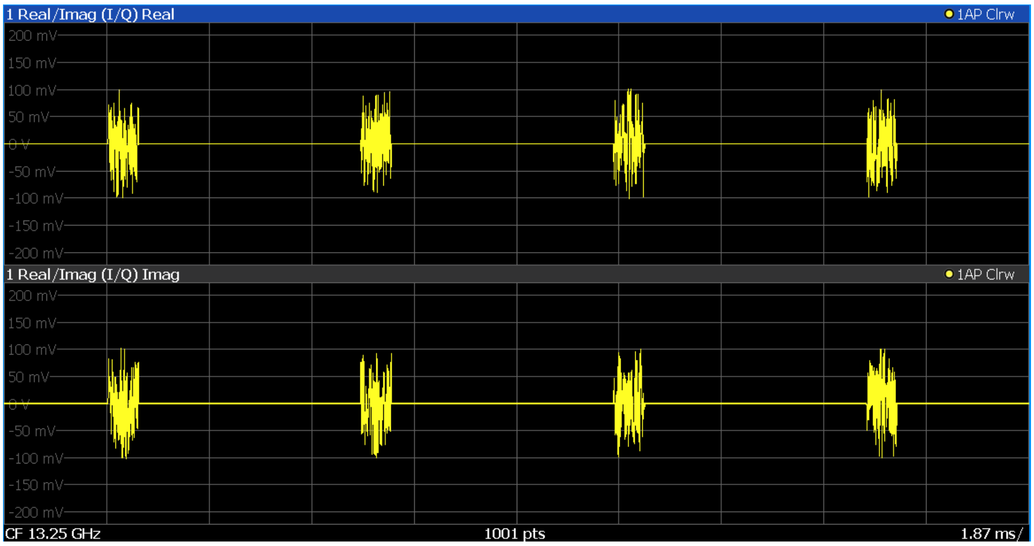
Note: For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number of trace points to be displayed ("Sweep Points"; for I/Q Analyzer: 10001). For record lengths outside the valid range of sweep points the diagram does not show valid results.

For input from the optional Analog Baseband Interface in real baseband mode, the I/Q vector is a constant line (as one component is 0 for all sweep points).

For more information see Chapter 5.3.3, "I/Q Processing Modes", on page 51.

Remote command:
`LAY:ADD:WIND? '1',RIGH,VECT`, see `LAYout:ADD[:WINDow]?` on page 394
Results:
`TRACe<n>[:DATA]?` on page 474

Real/Imag (I/Q)
Displays the I and Q values in separate diagrams.



Note: For analog baseband input in Real Baseband mode, only one diagram is displayed (for the selected component).
For details, see "Real baseband mode (I or Q only)" on page 53.

Remote command:
`LAY:ADD:WIND? '1',RIGH,RIM`, see `LAYout:ADD[:WINDow]?` on page 394
Results:
`TRACe<n>[:DATA]?` on page 474

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

This table is displayed automatically if configured accordingly.

(See " Marker Table Display " on page 216).

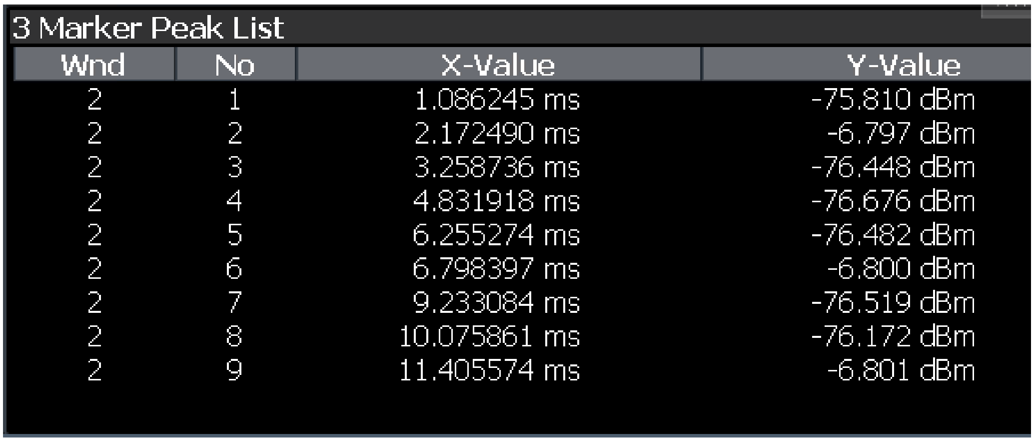

2 Marker

Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.197052
D1	N1	1	-7.942 GHz	-49.41 dB		
D2	N1	2	-3.918 GHz	-21.90 dB		
D3	N1	3	4.024 GHz	-21.99 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 394
Results:
`CALCulate<n>:MARKer<m>:X` on page 428
`CALCulate<n>:MARKer<m>:Y?` on page 481

Marker Peak List
The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.


3 Marker Peak List

Wnd	No	X-Value	Y-Value
2	1	1.086245 ms	-75.810 dBm
2	2	2.172490 ms	-6.797 dBm
2	3	3.258736 ms	-76.448 dBm
2	4	4.831918 ms	-76.676 dBm
2	5	6.255274 ms	-76.482 dBm
2	6	6.798397 ms	-6.800 dBm
2	7	9.233084 ms	-76.519 dBm
2	8	10.075861 ms	-76.172 dBm
2	9	11.405574 ms	-6.801 dBm

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

Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 394
Results:
`CALCulate<n>:MARKer<m>:X` on page 428
`CALCulate<n>:MARKer<m>:Y?` on page 481

I/Q 40G Recording
During a running I/Q data output recording, you can add marker information to the data stream at a user-definable time by selecting a button. The "I/Q 40G Recording" window provides such a button that remains visible throughout the measurement, without having to open a dialog box. Thus, you can insert a marker at any time during the measurement.

For more information, see Chapter 5.10, "Digital I/Q 40G Streaming Output", on page 95.

5 Basics on I/Q Data Acquisition and Processing

Some background knowledge on basic terms and principles used when describing I/Q data acquisition on the R&S FSW in general, and in the I/Q Analyzer application in particular, is provided here for a better understanding of the required configuration settings.

The I/Q Analyzer provides various possibilities to acquire the I/Q data to be analyzed:

- Capturing analog I/Q data from the "RF Input" connector
- Capturing digital I/Q data from the optional Digital Baseband Interface
- Capturing analog I/Q data from the optional Analog Baseband Interface, for example from active probes
- Capturing analog I/Q data from the optional Analog Baseband Interface and redirecting it to the RF input path
- Capturing analog I/Q data via the channel input of a connected oscilloscope and transferring the data to the R&S FSW via LAN
- Importing I/Q data from a file

Background information for all these scenarios and more is provided in the following sections.

5.1 Processing Analog I/Q Data from RF Input

Complex baseband data

In the telephone systems of the past, baseband data was transmitted unchanged as an analog signal. In modern phone systems and in radio communication, however, the baseband data is modulated on a carrier frequency, which is then transmitted. The receiver must demodulate the data based on the carrier frequency. When using modern modulation methods (e.g. QPSK, QAM etc.), the baseband signal becomes complex. Complex data (or: *I/Q* data) consists of an imaginary (I) and a real (Q) component.

Sweep vs sampling

The standard Spectrum application on the R&S FSW performs frequency sweeps on the input signal and measurements in the frequency and time domain. Other applications on the R&S FSW, such as the I/Q Analyzer, sample and process the individual I and Q components of the complex signal.

I/Q Analyzer - processing complex data from RF input

The I/Q Analyzer is a standard application used to capture and analyze I/Q data on the R&S FSW. By default, it assumes the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the R&S FSW.

The A/D converter samples the IF signal at a rate of 200 MHz. The digital signal is down-converted to the complex baseband, lowpass-filtered, and the sample rate is reduced. The analog filter stages in the analyzer cause a frequency response which adds to the modulation errors. An **equalizer filter** before the **resampler** compensates for this frequency response. The continuously adjustable sample rates are realized using an optimal decimation filter and subsequent resampling on the set sample rate.

A dedicated memory (**capture buffer**) is available in the R&S FSW for a maximum of 400 Msamples (400*1000*1000) of complex samples (pairs of I and Q data). The number of complex samples to be captured can be defined (for restrictions refer to Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24).

The block diagram in Figure 5-1 shows the analyzer hardware from the IF section to the processor.

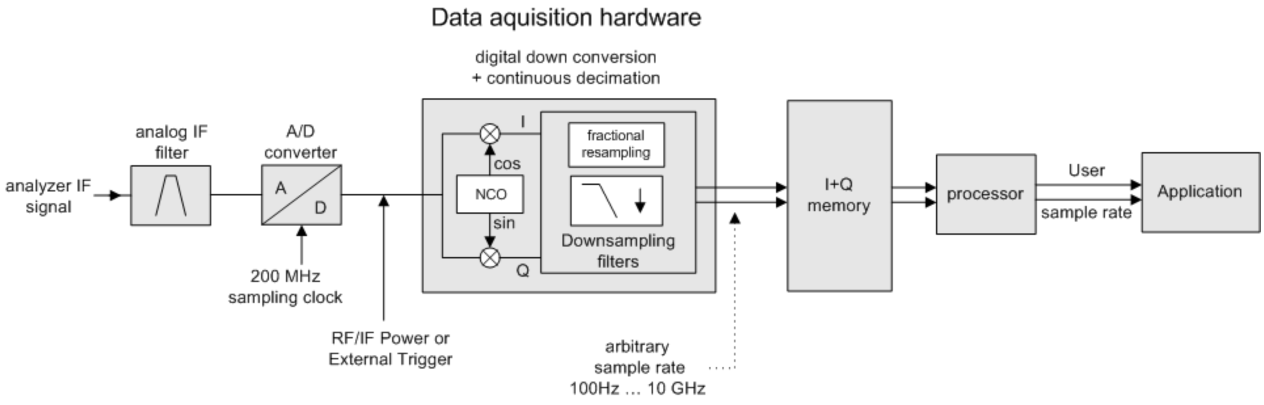


Figure 5-1: Block diagram illustrating the R&S FSW signal processing for analog I/Q data (without bandwidth extension options)

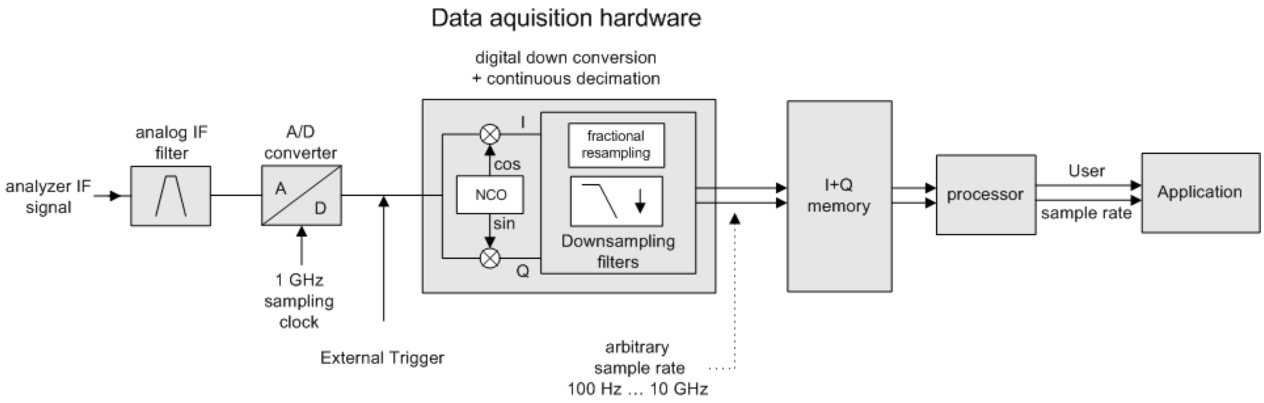


Figure 5-2: Block diagram illustrating the R&S FSW signal processing for analog I/Q data (with option B160)

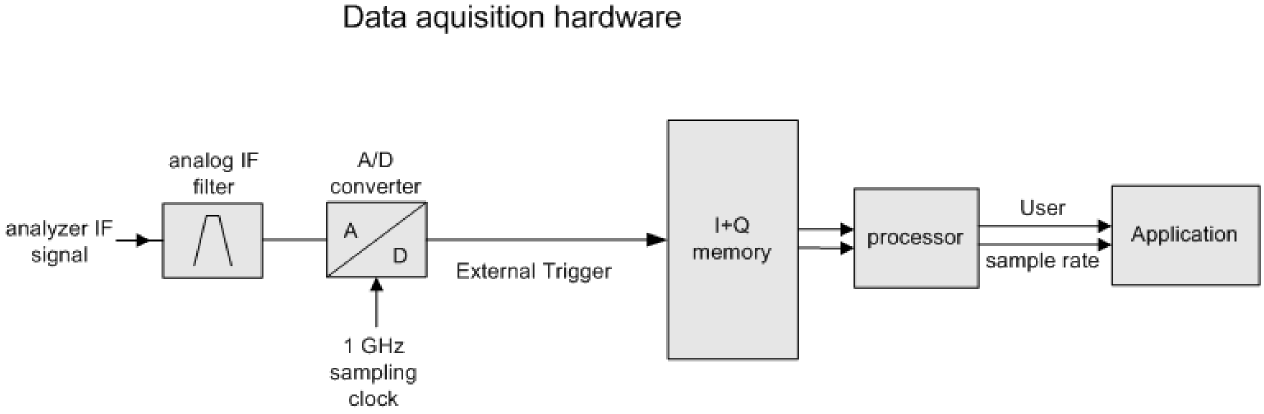


Figure 5-3: Block diagram illustrating the R&S FSW signal processing for analog I/Q data (with option B320)

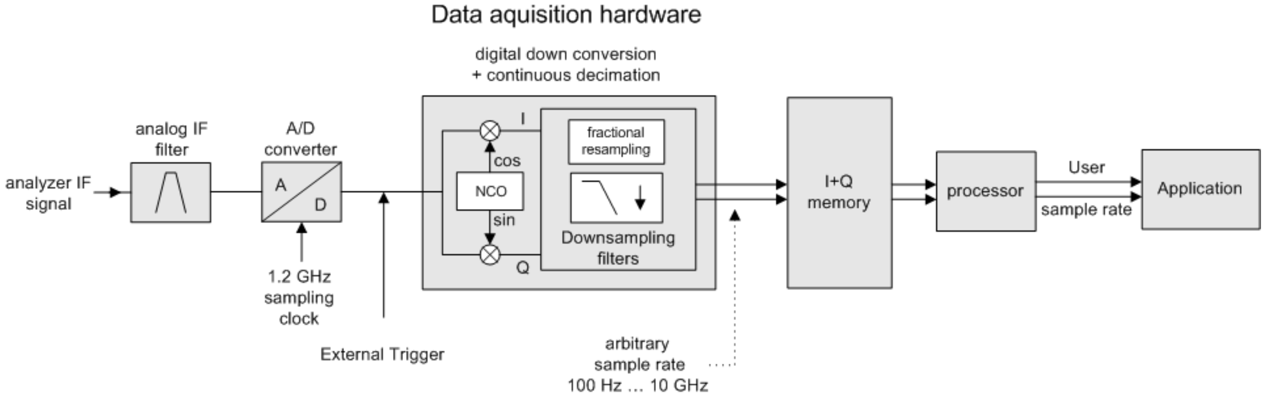


Figure 5-4: Block diagram illustrating the R&S FSW signal processing for analog I/Q data (with option B512)

5.1.1 Sample Rate and Maximum Usable I/Q Bandwidth for RF Input

Definitions

- **Input sample rate (ISR)**: the sample rate of the useful data provided by the device connected to the input of the R&S FSW
- (User, Output) **Sample rate (SR)**: the user-defined sample rate (e.g. in the "Data Acquisition" dialog box in the "I/Q Analyzer" application) which is used as the basis for analysis or output
- **Usable I/Q (Analysis) bandwidth**: the bandwidth range in which the signal remains undistorted in regard to amplitude characteristic and group delay; this range can be used for accurate analysis by the R&S FSW
- **Record length**: Number of I/Q samples to capture during the specified measurement time; calculated as the measurement time multiplied by the sample rate

For the I/Q data acquisition, digital decimation filters are used internally in the R&S FSW. The passband of these digital filters determines the *maximum usable I/Q bandwidth*. In consequence, signals within the usable I/Q bandwidth (passband) remain unchanged, while signals outside the usable I/Q bandwidth (passband) are suppressed. Usually, the suppressed signals are noise, artifacts, and the second IF side band. If frequencies of interest to you are also suppressed, try to increase the output sample rate, which increases the maximum usable I/Q bandwidth.

Bandwidth extension options

You can extend the maximum usable I/Q bandwidth provided by the R&S FSW in the basic installation by adding options. These options can either be included in the initial installation (B-options) or updated later (U-options). The maximum bandwidth provided by the individual option is indicated by its number, for example, B40 extends the bandwidth to 40 MHz.

Note that the U-options as of U40 always require all lower-bandwidth options as a prerequisite, while the B-options already include them.

As a rule, the usable I/Q bandwidth is proportional to the output sample rate. Yet, when the I/Q bandwidth reaches the bandwidth of the analog IF filter (at very high output sample rates), the curve breaks.

5.1.1.1 Bandwidth Extension Options

Max. usable I/Q BW	Required B-option	Required U-option(s)
10 MHz	-	-
28 MHz	B28	U28
40 MHz	B40	U28+U40 **or** B28+U40
80 MHz	B80	U28+U40+U80 **or** B28+U40+U80 **or** B40+U80
160 MHz	B160	U28+U40+U80+U160 **or** B28+U40+U80+U160 **or** B40+U80+U160 **or** B80+U160
320 MHz	B320	U28+U40+U80+U160+U320 **or** B28+U40+U80+U160+U320 **or** B40+U80+U160+U320 **or** B80+U160+U320 **or** B160+U320
512 MHz	B512	U28+U40+U80+U512 **or** B28+U40+U80+U512 **or** B40+U80+U512 **or** B80+U512**or**

Max. usable I/Q BW	Required B-option	Required U-option(s)
1200 MHz	B1200	U28 + U40 + U80 + U1200 **or** B28 + U40 + U80 + U1200 **or** B40 + U80 + U1200 **or** B80 + U1200
2000 MHz	B2000	U2000
2000 MHz	B2001	U2001
4000 MHz	B4001	U4001
5000 MHz	B5000	U5000
6000 MHz	B6001	U6001
8000 MHz	B8001	U8001

5.1.1.2 Relationship Between Sample Rate, Record Length and Usable I/Q Bandwidth

Up to the maximum bandwidth, the following rule applies:

*Usable I/Q bandwidth = 0.8 * Output sample rate*

Regarding the record length, the following rule applies:

*Record length = Measurement time * sample rate*

Maximum record length for RF input

The maximum record length, that is, the maximum number of samples that can be captured, depends on the sample rate.

For activated option B320 or U320 see Table 5-4.

For activated option -B512, see Table 5-5.

For activated option B1200, see Table 5-6.

For activated option B2001, see Chapter 5.1.1.11, "R&S FSW with Activated I/Q Bandwidth Extension Option B2001", on page 35.

For activated option B2000, see Chapter 5.1.1.12, "R&S FSW with Activated I/Q Bandwidth Extension Option B2000", on page 37.

For activated option B4001/B6001/B8001, see Chapter 5.1.1.14, "R&S FSW with Activated I/Q Bandwidth Extension Option B4001/B6001/B8001", on page 40.

Table 5-1: Maximum record length (without I/Q bandwidth extension options R&S FSW-B160/-B320/-B512/-B1200/-B2001/-B4001/-B6001/-B8001)

Sample rate	Maximum record length
100 Hz to 200 MHz	440 Msamples
200 MHz to 20 GHz (upsampling)	220 Msamples

The Figure 5-5 shows the maximum usable I/Q bandwidths depending on the output sample rates.

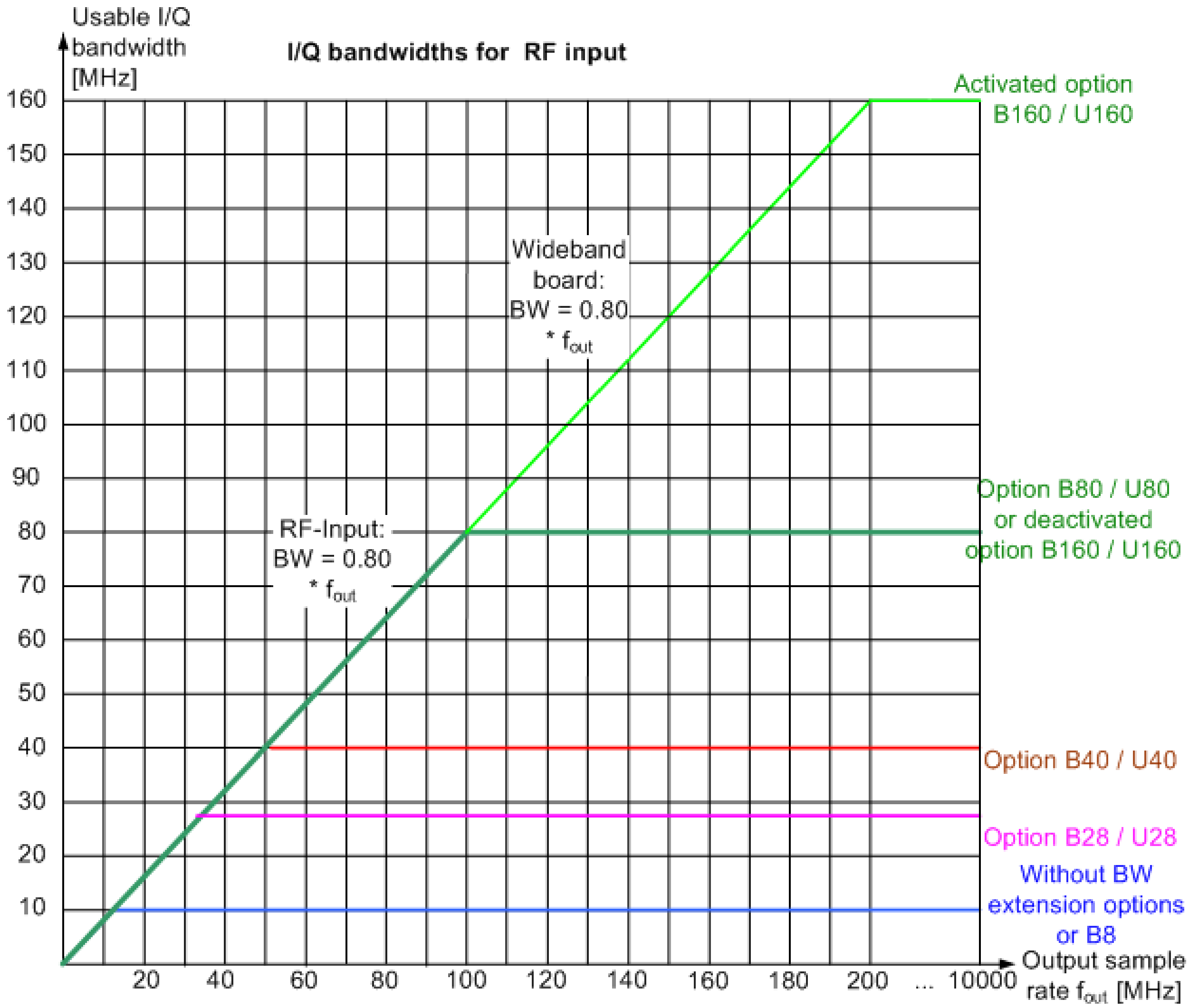


Figure 5-5: Relationship between maximum usable I/Q bandwidth and output sample rate with and without bandwidth extensions

Restricting the maximum bandwidth manually

By default, all installed bandwidth extension options are activated, allowing for the maximum bandwidth for measurements on the R&S FSW. However, sometimes the maximum bandwidth is not necessary. For example, due to the correlation of both parameters, high sample rates automatically lead to an extended analysis bandwidth. However, while a high sample rate may be necessary (for example due to postprocessing in an OFDM system), the wide bandwidth is not really required.

On the other hand, low sample rates lead to small usable I/Q bandwidths. To ensure the availability of the required bandwidth, the minimum required bandwidth for the specified sample rate can be selected (via remote command only).

Thus, if one of the bandwidth extension options is installed, the maximum bandwidth can be restricted manually to a value that can improve the measurement (see " Maximum Bandwidth " on page 186). In this case, the hardware of the "regular" RF path is used, rather than the hardware required by the bandwidth extension options.

The following improvements can be achieved:

- Longer measurement time for sample rates under 300 MHz
- Data processing becomes up to ten times faster
- Digital baseband output becomes available (with bandwidth extension options that do not support output)

General notes and restrictions

- The memory extension option R&S FSW-B106 is only available together with the R&S FSW-B160 or B320 bandwidth extension options.
- The memory extension option R&S FSW-B108 is only available together with the R&S FSW-B1200/-B2001/-B800R options.
- The memory extension option R&S FSW-B124 is only available together with the R&S FSW-B4001/B6001/B8001 options.
- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.
- If Digital Baseband output is active, the sample rate is restricted to 200 MHz (max. 80 MHz usable I/Q bandwidth).
  See " Digital Baseband Output " on page 160

5.1.1.3 R&S FSW Without Additional Bandwidth Extension Options

Sample rate: 100 Hz - 20 GHz

Maximum I/Q bandwidth: 10 MHz

Table 5-2: Maximum I/Q bandwidth

Sample rate	Maximum I/Q bandwidth
100 Hz to 10 MHz	Proportional up to maximum 10 MHz
10 MHz to 20 GHz	10 MHz

MSRA operating mode

In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.

5.1.1.4 R&S FSW with I/Q Bandwidth Extension Options B28 or U28

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 28 MHz

Sample rate	Maximum I/Q bandwidth
100 Hz to 35 MHz	Proportional up to maximum 28 MHz
35 MHz to 20 GHz	28 MHz

MSRA operating mode

In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.

5.1.1.5 R&S FSW with I/Q Bandwidth Extension Option B40 or U40

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 40 MHz

Sample rate	Maximum I/Q bandwidth
100 Hz to 50 MHz	Proportional up to maximum 40 MHz
50 MHz to 20 GHz	40 MHz

MSRA operating mode

In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.

5.1.1.6 R&S FSW with I/Q Bandwidth Extension Option B80 or U80

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 80 MHz

Sample rate	Maximum I/Q bandwidth
100 Hz to 100 MHz	Proportional up to maximum 80 MHz
100 MHz to 20 GHz	80 MHz

MSRA operating mode

In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.

5.1.1.7 R&S FSW with Activated I/Q Bandwidth Extension Option B160 or U160

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 160 MHz

Sample rate	Maximum I/Q bandwidth
100 Hz to 200 MHz	Proportional up to maximum 160 MHz
200 MHz to 20 GHz	160 MHz

Table 5-3: Maximum record length with activated I/Q bandwidth extension option B160 or U160

Sample rate	Maximum record length
100 Hz to 200 MHz	440 Msamples With R&S FSW-B106 option: 1400 Msamples
200 MHz to 20 GHz	220 Msamples With R&S FSW-B106 option: 700 Msamples With R&S FSW-B106 option: 700 Msamples

Notes and restrictions for R&S FSW-B160 or U160

- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.
- Digital Baseband output is not available for an active R&S FSW-B160 or U160 bandwidth extension. See " Digital Baseband Output " on page 160.

5.1.1.8 R&S FSW with Activated I/Q Bandwidth Extension Option B320/U320

Sample rate	Maximum I/Q bandwidth
100 Hz to 400 MHz	Proportional up to maximum 320 MHz
400 MHz to 20 GHz	320 MHz

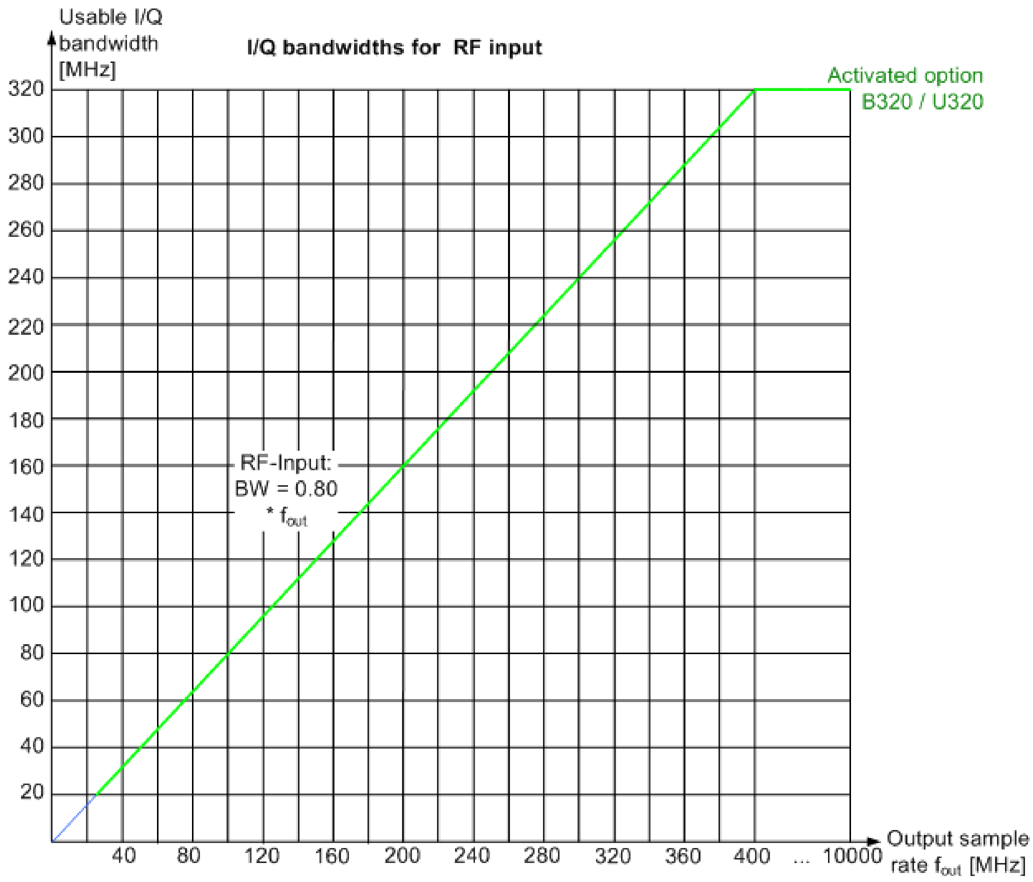


Figure 5-6: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B320

Table 5-4: Maximum record length with activated I/Q bandwidth extension option B320 or U320

Sample rate	Maximum record length
100 Hz to 200 MHz*)	440 Msamples With R&S FSW-B106 option: 1400 Msamples
200 MHz to 468 MHz	470 Msamples * sample rate / 1GHz With R&S FSW-B106 option: 1400 Msamples * sample rate / 1GHz
468 MHz to 20 GHz	220 Msamples With R&S FSW-B106 option: 700 Msamples
*) for sample rates up to 200 MHz the I/Q Bandwidth Extension B320 is not used	

Notes and restrictions for R&S FSW-B320

- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.
- Digital Baseband output is not available for an active R&S FSW-B320 bandwidth extension. See " Digital Baseband Output " on page 160.

5.1.1.9 R&S FSW with Activated I/Q Bandwidth Extension Option -B512

The bandwidth extension option R&S FSW-B512 provides measurement bandwidths up to 512 MHz.

Sample rate	Maximum I/Q bandwidth
100 Hz to 600 MHz	0.8 * sample rate (up to maximum 512 MHz)
600 MHz to 20 GHz	512 MHz

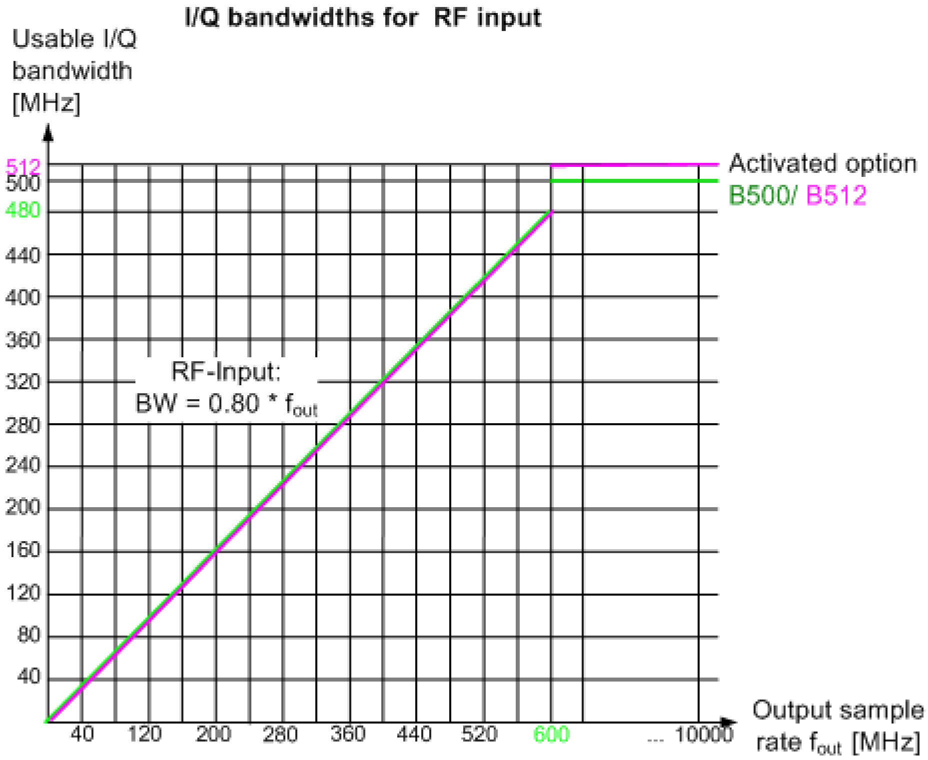


Figure 5-7: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B512

Table 5-5: Maximum record length with activated I/Q bandwidth extension option R&S FSW-B512

Sample rate	Maximum record length
100 Hz to 20 GHz	440 Msamples

Notes and restrictions for R&S FSW-B512

- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz and a maximum record length of 220 Msamples.
- The memory extension options R&S FSW-B106/-B108/-B124 are not available together with the -B512 option.

Bandwidths between 480 MHz and 512 MHz with R&S FSW-B512 option

Note the irregular behavior of the sample rate/usable I/Q bandwidth relationship for bandwidths between 480 MHz and 512 MHz with the -B512 options, depending on which setting you change.

For compatibility reasons, the common relationship is maintained for bandwidths ≤ 480 MHz:

*Usable I/Q bandwidth = 0.8 * Output sample rate*

However, to make use of the maximum sample rate of 600 MHz at the maximum bandwidth of 512 MHz, if you **change the bandwidth** between 480 MHz and 500 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (500/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8333

When using option R&S FSW-**B512R**, if you **change the bandwidth** between 500 MHz and 512 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (512/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8533

On the other hand, if you **decrease the sample rate** under 600 MHz, the I/Q bandwidth is adapted according to the common relationship:

*Usable I/Q bandwidth = 0.8 * Output sample rate*.

5.1.1.10 R&S FSW with Activated I/Q Bandwidth Extension Option B1200

The bandwidth extension option R&S FSWB1200 provides measurement bandwidths up to 1200 MHz.

Sample rate	Maximum I/Q bandwidth
100 Hz to 600 MHz	0.8 * sample rate
600 MHz	0.8533 * sample rate (=512 MHz)
600 MHz to 1500 MHz	0.8 * sample rate
1500 MHz to 20 GHz	1200 MHz

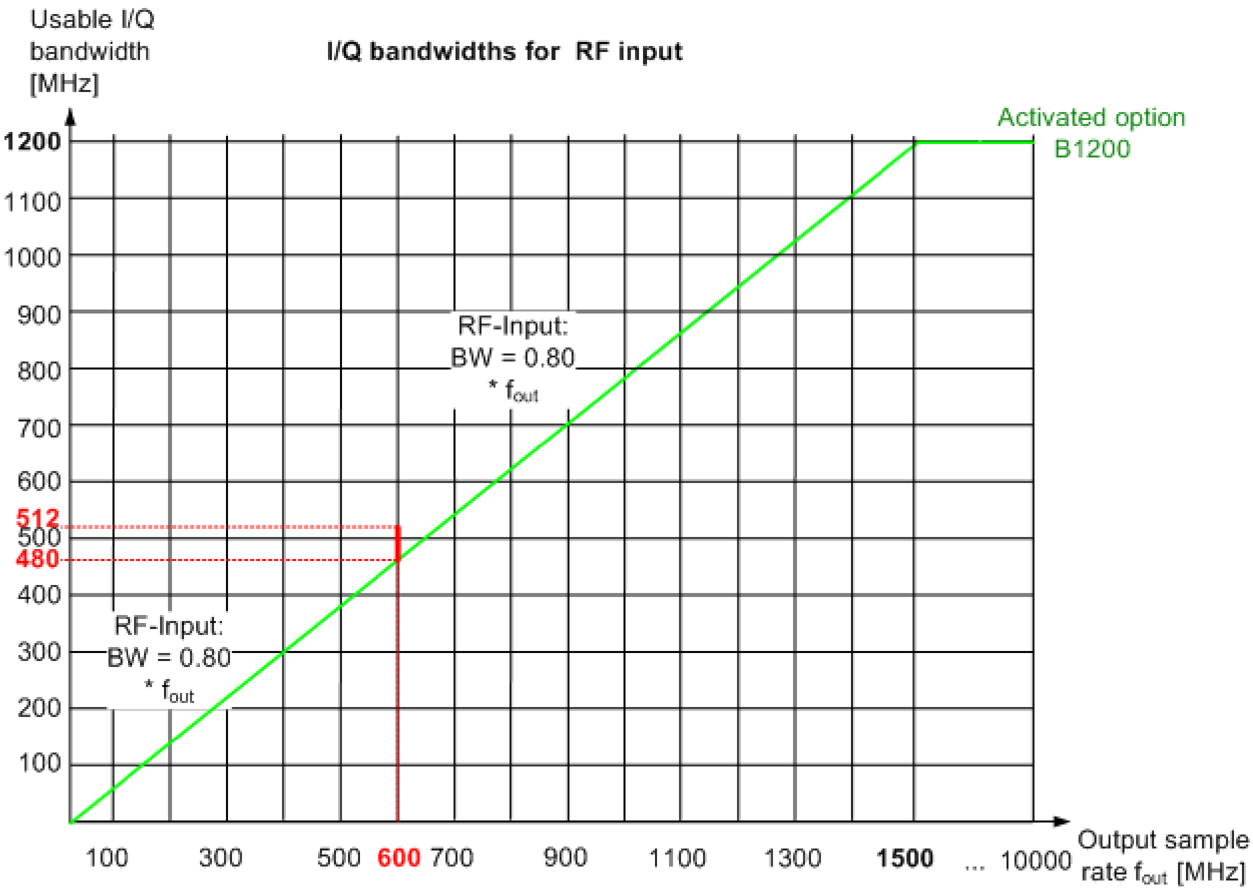


Figure 5-8: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B1200

Table 5-6: Maximum record length with activated I/Q bandwidth extension option R&S FSW-B1200

Sample rate	Maximum record length
100 Hz to 600 MHz	440 Msamples With R&S FSW-B108 option: max. 1800 Msamples
600 MHz to 1250 MHz	480 Msamples * (sample rate / 1250 MHz); max. 440 Msamples With R&S FSW-B108 option: 990 Msamples * (sample rate / 1250 MHz); max. 900 Msamples
1250 MHz to 20 GHz	max. 440 Msamples With R&S FSW-B108 option: 900 Msamples * (sample rate / 1250 MHz); max. 900 Msamples

Notes and restrictions for R&S FSW-B1200

- The memory extension option R&S FSW-B106 is not available together with the B1200 option.
- For an active R&S FSW-B1200 bandwidth extension, the maximum output sample rate is 200 MHz. See " Digital Baseband Output " on page 160.
- Real-Time measurements, and thus the entire MSRT operating mode, are not available if the R&S FSW-B1200 bandwidth extension option is installed.

- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.
- When the R&S FSW-B1200 option is active, only an external trigger (or no trigger) is available.

Irregular behavior in bandwidths between 480 MHz and 512 MHz with R&S FSW-B1200 option

Note that the B1200 bandwidth extension option has the same irregular behavior of the sample rate/usable I/Q bandwidth relationship for bandwidths between 480 MHz and 512 MHz as the -B512 options. This is due to the fact that the R&S FSW uses the same hardware for both options up to 512 MHz.

For compatibility reasons, the common relationship is maintained for bandwidths ≤ 480 MHz:

Output sample rate = Usable I/Q bandwidth / 0.8

However, to make use of the maximum sample rate of 600 MHz at the maximum bandwidth of 500 MHz, if you **change the bandwidth** between 480 MHz and 500 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (500/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8333

If you **change the bandwidth** between 500 MHz and 512 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (512/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8533

If you increase the bandwidth above 512 MHz, the common relationship is maintained again:

Output sample rate = Usable I/Q bandwidth / 0.8

On the other hand, if you **set the sample rate** to **600 MHz**, the I/Q bandwidth is set to:

*Output sample rate * 0.8533 =* ***512 MHz***

However, if you **decrease the sample rate** under 600 MHz or **increase the sample rate** above 600 MHz, the I/Q bandwidth is adapted according to the common relationship:

*Usable I/Q bandwidth = 0.8 * Output sample rate*.

5.1.1.11 R&S FSW with Activated I/Q Bandwidth Extension Option B2001

The (internal) bandwidth extension option R&S FSW-B2001 provides measurement bandwidths up to 2 GHz, with no additional devices required.

Sample rate	Maximum I/Q bandwidth
100 Hz to 600 MHz	0.8 * sample rate
600 MHz	0.8533 * sample rate (=512 MHz)

Sample rate	Maximum I/Q bandwidth
600 MHz to 2500 MHz	0.8 * sample rate
2500 MHz to 20 GHz	2000 MHz

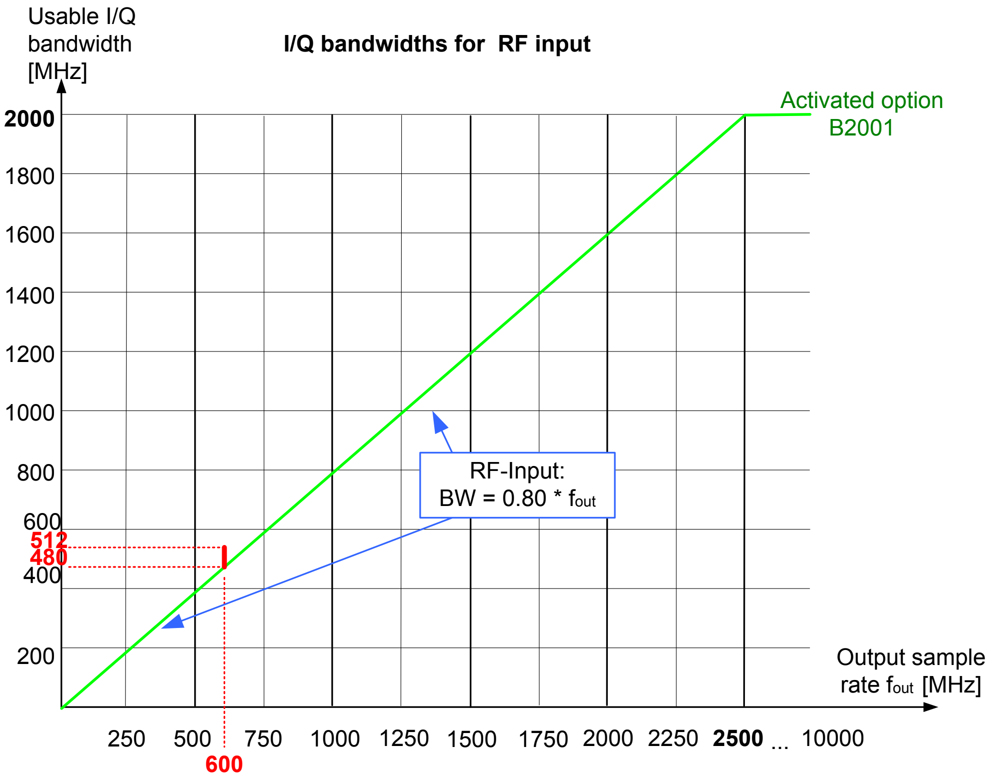


Figure 5-9: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B2001

Table 5-7: Maximum record length with activated I/Q bandwidth extension option R&S FSW-B2001

Sample rate	Maximum record length
100 Hz to 600 MHz	440 Msamples With R&S FSW-B108 option: max. 1800 Msamples
600 MHz to 1250 MHz	440 Msamples * (sample rate / 1250 MHz); max. 900 Msamples With R&S FSW-B108 option: 900 Msamples * (sample rate / 1250 MHz); max. 900 Msamples
1250 MHz to 20 GHz	440 Msamples * (sample rate / 2500 MHz); max. 900 Msamples With R&S FSW-B108 option: 900 Msamples * (sample rate / 1250 MHz); max. 900 Msamples

Notes and restrictions for R&S FSW-B2001

- The memory extension option R&S FSW-B106 is not available together with the B2001 option.

- For an active R&S FSW-B2001 bandwidth extension, the maximum output sample rate is 200 MHz. See " Digital Baseband Output " on page 160.
- Real-Time measurements, and thus the entire MSRT operating mode, are not available if the R&S FSW-B2001 bandwidth extension option is installed.
- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 600 MHz.
- When the R&S FSW-B2001 option is active, only an external trigger (or no trigger) is available.

Irregular behavior in bandwidths between 480 MHz and 512 MHz with R&S FSW-B2001 option

Note that the B2001 bandwidth extension option has the same irregular behavior of the sample rate/usable I/Q bandwidth relationship for bandwidths between 480 MHz and 512 MHz as the -B512 options. This is due to the fact that the R&S FSW uses the same hardware for both options up to 512 MHz.

For compatibility reasons, the common relationship is maintained for bandwidths ≤ 480 MHz:

Output sample rate = Usable I/Q bandwidth / 0.8

However, to make use of the maximum sample rate of 600 MHz at the maximum bandwidth of 500 MHz, if you **change the bandwidth** between 480 MHz and 500 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (500/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8333

If you **change the bandwidth** between 500 MHz and 512 MHz, the sample rate is adapted according to the relationship:

Output sample rate = Usable I/Q bandwidth / (512/600)

Or

Output sample rate = Usable I/Q bandwidth / 0.8533

If you increase the bandwidth above 512 MHz, the common relationship is maintained again:

Output sample rate = Usable I/Q bandwidth / 0.8

On the other hand, if you **set the sample rate** to **600 MHz**, the I/Q bandwidth is set to:

*Output sample rate * 0.8533 =* ***512 MHz***

However, if you **decrease the sample rate** under 600 MHz or **increase the sample rate** above 600 MHz, the I/Q bandwidth is adapted according to the common relationship:

*Usable I/Q bandwidth = 0.8 * Output sample rate*.

5.1.1.12 R&S FSW with Activated I/Q Bandwidth Extension Option B2000

The bandwidth extension option R&S FSW-B2000 provides measurement bandwidths up to 2 GHz.

Sample rate	Maximum I/Q bandwidth
10 kHz to 20 GHz	Proportional up to maximum 2 GHz

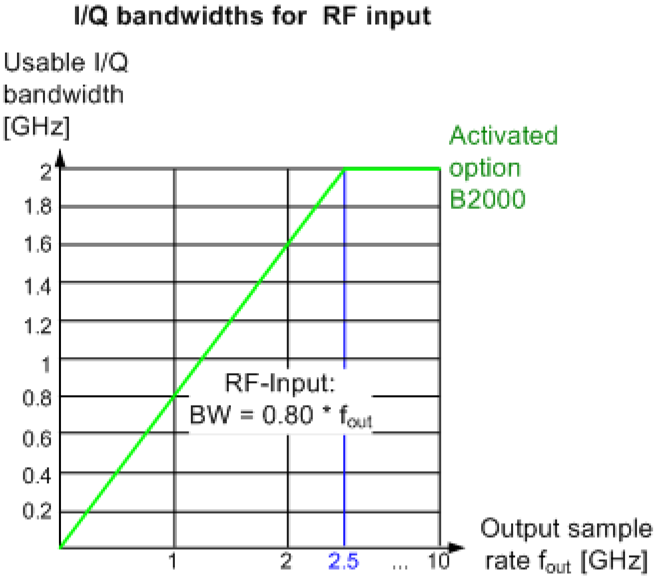


Figure 5-10: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B2000

Maximum record length with activated I/Q bandwidth extension option B2000

The maximum record length provided by the R&S FSW depends on the data rate that the oscilloscope can process, which in turn depends on the memory updates installed on it. Assuming the oscilloscope allows for the maximum of 400 MSamples and a sample rate of 10 GHz, the maximum record length can be estimated approximately as:

Table 5-8: Maximum record length with activated I/Q bandwidth extension option B2000

Sample rate	Maximum record length (approx.)
10 kHz to 5 GHz	((400 MSamples * SampleRate) / 10 GHz) - 100
5 GHz to 10 GHz	((400 MSamples * SampleRate) / 10 GHz) - 1000

Example:

For the maximum sample rate of 2.5 GHz and the maximum bandwidth of 2 GHz on the R&S FSW, the **maximum record length is approximately**:

((400 MSamples * 2.5 GHz) / 10 GHz) - 100 = **99.999900 MSamples**

(For the default oscilloscope sample rate of 10 GHz.)

Notes and restrictions for R&S FSW-B2000

- The memory extension options R&S FSW-B106/-B108/-B124 are not available together with the B2000 option.

- If the R&S FSW-B2000 bandwidth extension option is active, MSRA operating mode is not available.
- Digital Baseband output is not available for an active R&S FSW-B2000 bandwidth extension. See " Digital Baseband Output " on page 160.
- When using an external trigger in common B2000 mode (which uses another channel on the oscilloscope), or in power splitter mode (which uses two input channels on the oscilloscope), the maximum memory size, and thus record length, available for a single input channel may be reduced by half. For details see the oscilloscope's data sheet and documentation.
  For details on the power splitter mode see Chapter 5.9.8, "Power Splitter Mode", on page 93.

5.1.1.13 R&S FSW with Activated I/Q Bandwidth Extension Option B5000

The bandwidth extension option R&S FSW-B5000 provides measurement bandwidths up to 5 GHz.

Sample rate	Maximum I/Q bandwidth
10 kHz to 20 GHz	Proportional up to maximum 5 GHz

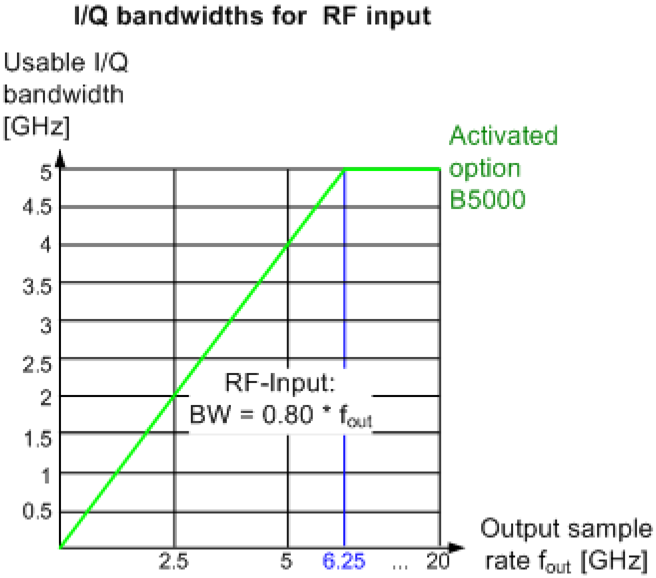


Figure 5-11: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B5000

Maximum record length with activated I/Q bandwidth extension option B5000

The maximum record length provided by the R&S FSW depends on the data rate that the oscilloscope can process, which in turn depends on the memory updates installed on it. Assuming the oscilloscope allows for the maximum of 400 MSamples, the maximum record length can be estimated approximately as:

Table 5-9: Maximum record length with activated I/Q bandwidth extension option B5000

Sample rate	Maximum record length (approx.)
10 kHz to 10 GHz	((400 MSamples * SampleRate) / 20 GHz) - 100
10 GHz to 20 GHz	((400 MSamples * SampleRate) / 20 GHz) - 1000

Example:

For the maximum sample rate of 20 GHz and the maximum bandwidth of 5 GHz on the R&S FSW, and the maximum memory depth of 400 MSamples and fixed sample rate of 20 GHz on the oscilloscope, the **maximum record length is approximately**:

((400 MSamples * 20 GHz) / 20 GHz) - 100 = **399.999900 MSamples**

Notes and restrictions for R&S FSW-B5000

- The memory extension options R&S FSW-B106/-B108/-B124 are not available together with the B5000 option.
- If the R&S FSW-B5000 bandwidth extension option is active, MSRA operating mode is not available.
- Digital Baseband output is not available for an active R&S FSW-B5000 bandwidth extension. See " Digital Baseband Output " on page 160.
- When using an external trigger in common B5000 mode (which uses another channel on the oscilloscope), or in power splitter mode (which uses two input channels on the oscilloscope), the maximum memory size, and thus record length, available for a single input channel may be reduced by half. For details see the oscilloscope's data sheet and documentation.
  For details on the power splitter mode see Chapter 5.9.8, "Power Splitter Mode", on page 93.

5.1.1.14 R&S FSW with Activated I/Q Bandwidth Extension Option B4001/B6001/B8001

The (internal) bandwidth extension options R&S FSW-B4001/B6001/B8001 provide measurement bandwidths up to 4 GHz, 6 GHz or 8 GHz, respectively, with no additional devices required. The B4001 option is activated automatically for bandwidths larger than 80 MHz, if installed. The B6001 and B8001 options are activated automatically for bandwidths larger than 80 MHz and center frequencies above 18 GHz, if installed.

The memory extension option R&S FSW-B124 supports an extended record length when using R&S FSW-B4001/B6001/B8001.

The memory extension options R&S FSW-B106/-B108 are not available together with the B4001/B6001/B8001 options.

Option	Sample rate	Maximum I/Q bandwidth
B4001	100 Hz to 5500 MHz	0.8 * sample rate
	5500 MHz to 20 GHz	4400 MHz
B6001	100 Hz to 8000 MHz	0.8 * sample rate

Option	Sample rate	Maximum I/Q bandwidth
	8000 MHz to 20 GHz	6400 MHz
B8001	100 Hz to 10390 MHz	0.8 * sample rate
	10390 MHz to 20 GHz	8312 MHz

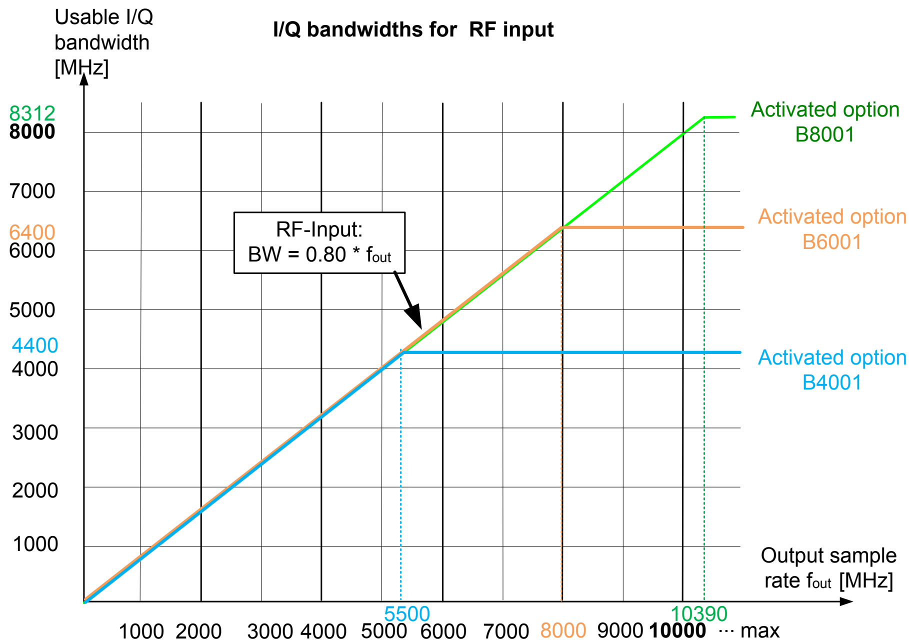


Figure 5-12: Relationship between maximum usable I/Q bandwidth and output sample rate for active R&S FSW-B4001/B6001/B8001

Table 5-10: Maximum record length with activated I/Q bandwidth extension option R&S FSW-B4001/ B6001/B8001

Sample rate	Maximum record length
100 Hz to 100 MHz	440 Msamples
100 MHz to 5.32 GHz	1039 Msamples With R&S FSW-B124 option: max. 5600 Msamples
5.32 GHz to 10.64 GHz	1039 Msamples With R&S FSW-B124 option: max. 6440 Msamples
10.64 GHz to 20 GHz	1039 Msamples With R&S FSW-B124 option: max. 2800 Msamples

Notes and restrictions for R&S FSW-B4001/B6001/B8001

- In MSRA operating mode, the MSRA Master is restricted to a sample rate of 200 MHz and a maximum bandwidth of 80 MHz.
- If a R&S FSW-B4001/B6001/B8001 option is active, only an external trigger (or no trigger) is available.

- Real-Time measurements, and thus the entire MSRT operating mode, are not available if any of the R&S FSW-B4001/B6001/B8001 bandwidth extension options are installed.
- Digital Baseband output is not available for an active R&S FSW-B4001/B6001/ B8001 bandwidth extension. See " Digital Baseband Output " on page 160.

5.2 Processing Data from the Digital Baseband Interface

Alternatively to capturing (analog) I/Q data from the standard RF Input connector on the R&S FSW, digital I/Q data can be captured from the optional **Digital Baseband Interface**, if installed.

Furthermore, the I/Q data processed by the I/Q Analyzer can also be output to this interface.

The digital input and output cannot be used simultaneously.

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.

5.2.1 Digital Input

Digital I/Q data can be used as an alternative data input source for measurements with the R&S FSW.

Connecting the digital input instrument

The instrument that provides digital input must be connected to the R&S Digital Baseband Interface on the R&S FSW. Information on the detected input instrument is shown in the "Digital I/Q Input Source" configuration dialog. You can configure the basic connection settings, e.g. the input sample rate.

It is recommended that you use the R&S®SMU-Z6 (1415.0201.02) cable to connect other devices to the Digital Baseband Interface of the R&S FSW.

Processing digital input

The digital I/Q data stream is fed into the analyzer via the connector of the optional digital baseband interface. There is no need to equalize any IF filter or mix the signal into the complex baseband. The digital hardware just has to ensure that the final I/Q data stored in the record buffer has the correct sample rate.

The digital input signal is brought to the desired sample rate using a downsampling filter and fractional resampling. The word length of the data is 18 bits fixed point for each I and Q. The resulting data can be processed by the selected application. As illustrated in Figure 5-13, the usable sample rate for analysis is dependent on the input sample rate.

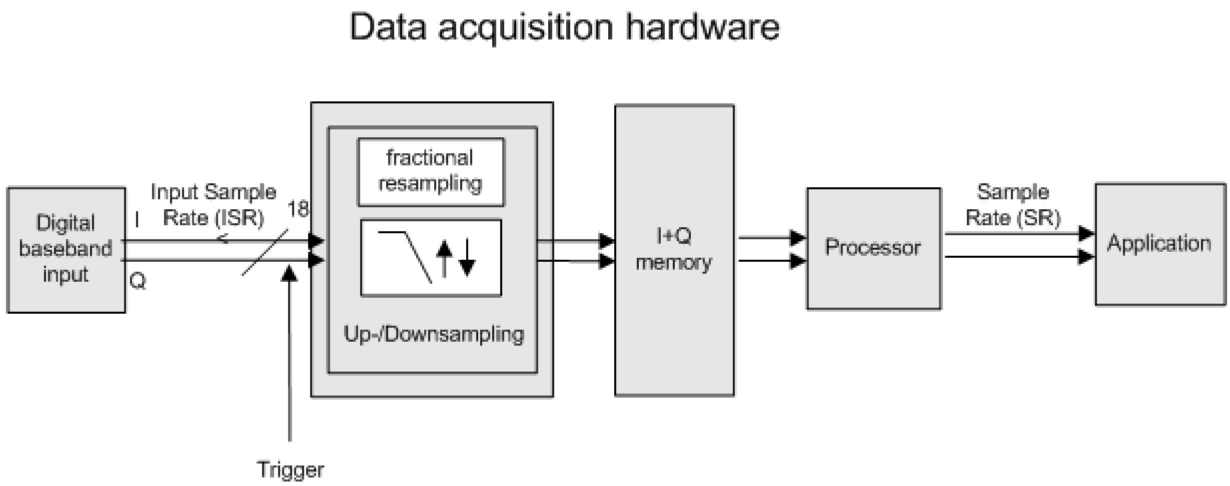


Figure 5-13: Signal path using digital input

Full scale level

The "Full Scale Level" defines the level that corresponds to an I/Q sample with the magnitude "1" and can be defined in various units. When converting the measured power into dBm, an impedance of 50 Ω is assumed.

Triggering

The following trigger sources are supported:

- External (see "External Trigger 1/2/3" on page 176)
- BB Power (see " Baseband Power " on page 178)
- Time (see " Time " on page 179)
- Digital I/Q general purpose trigger (see " Digital I/Q " on page 178)

If external triggering is used, the external trigger must be applied via the connector on the rear panel of the instrument (as for analog input).

Gating

Gating is not supported for digital input.

5.2.2 Digital Output

Processing digital output

Digital output is processed almost identically to RF input in I/Q mode (see Chapter 5.1, "Processing Analog I/Q Data from RF Input", on page 22).

I/Q data is sampled blockwise, according to the defined sample rate, and stored in the I/Q memory. From the memory, the I/Q data is processed in the I/Q Analyzer mode. Simultaneously, the data is written to the R&S Digital Baseband Interface continuously. Using this interface, the I/Q data can be processed in an external instrument as an alternative to internal processing in the R&S FSW.

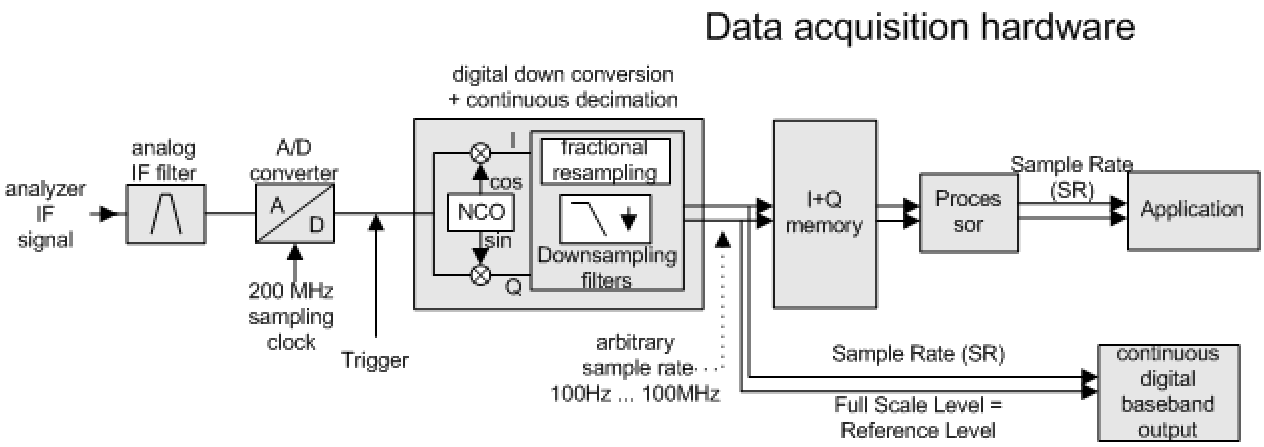


Figure 5-14: Signal path using the digital output

Sample rate

The **sample rate** at the digital output corresponds to the sample rate defined by the user and which is used as the basis for analysis. The current sample rate is displayed in the Digital I/Q "Output" dialog box (read-only) when the digital output is enabled (see "Output Settings Information" on page 160). A maximum sample rate of 200 MHz is allowed for digital output.

For digital output, the full scale level corresponds to the defined reference level (without the reference level offset and transducer).

General notes and restrictions

- The digital input and output cannot be used simultaneously.
- The only data source that can be used for digital baseband output is RF input.
- It is recommended that you use the R&S®SMU-Z6 (1415.0201.02) cable to connect other devices to the Digital Baseband Interface of the R&S FSW.
- Digital output provides raw I/Q data, without any transducer or user correction data applied.
- Digital output is not available with bandwidth extension options R&S FSW-B160/-B320/B4001/B6001/B8001. To provide digital output with any of those bandwidth

extension options installed, you must restrict the maximum bandwidth to 80 MHz manually to prevent using the extension hardware. See "Restricting the maximum bandwidth manually" on page 27. For bandwidths larger than 80 MHz, digital output is automatically deactivated.

Digital I/Q output and R&S FSW-B512/-B1200/-B2001 options

Digital I/Q output is also available with the bandwidth extension options R&S FSWB512/-B1200/-B2001. In these cases, for output sample rates between 100 MHz and 200 MHz, the B512 hardware provides the digital output.

Note that for technical reasons, under the following conditions, the continuous data stream from the B512 hardware is interrupted briefly each time a new measurement (single sweep or new sweep start in continuous sweep mode) is started:

- One of the bandwidth extension options R&S FSW-B512/-B1200/-B2001 is installed
- Digital output is activated
- A trigger is activated
- An output sample rate greater than 100 MHz is used

5.2.3 Sample Rates and Bandwidths for Digital I/Q Data

Definitions

- **Clock rate**: the rate at which data is physically transmitted between the R&S FSW and the connected device; both instruments must be able to process data at this rate; the clock rate of the R&S FSW at the output connector is 142.9 MHz; using the Digital I/Q enhanced mode, a data transfer rate of up to 200 Msps is possible
- **Input sample rate (ISR)**: the sample rate of the useful data provided by the connected instrument to the digital input
- (User, Output) **Sample rate (SR)**: the sample rate that is defined by the user (e.g. in the "Data Aquisition" dialog box in the "I/Q Analyzer" application) and which is used as the basis for analysis or sent to the digital output
- **Usable I/Q (Analysis) bandwidth**: the bandwidth range in which the signal remains unchanged by the digital decimation filter and thus remains undistorted; this range can be used for accurate analysis by the R&S FSW

Slow I/Q measurements

When captured data is transferred and further processed with a slower rate than the rate with which the signal was sampled, this is referred to as a *Slow I/Q measurement*.

For example, assume an analog signal is sampled by an oscilloscope with a sample rate of 10 GHz. This data is stored in a memory temporarily and then transferred to the R&S FSW via the Digital I/Q Interface with a sample rate of 100 Msps. Then the input sample rate on the R&S FSW must be set to 10 GHz so the signal is displayed correctly.

Digital I/Q enhanced mode

An enhanced mode for processing data from the Digital Baseband Interface is available. This enhanced mode enables data transfer via the Digital I/Q interface with a data rate of up to 200 Msps (160 MHz bandwidth, compared to the previous 100 Msps/ 80 MHz bandwidth).

The Digital I/Q enhanced mode is automatically used if the following prerequisites are fulfilled:

- **Digital Input:** The connected device must support data transfer rates up to 200 Msps.
- **Digital Output:**
  – The R&S FSW must supply the required bandwidth, i.e. a bandwidth extension option greater than 160 MHz must be installed and active.
  – The connected device must support data transfer rates up to 200 Msps.

Restrictions for digital in- and output

The following table describes the restrictions for digital in- and output:

Table 5-11: Restrictions for digital in- and output

Parameter	Minimum	Maximum
Record length	2 complex samples	200*1000*1000 complex samples With R&S FSW-B106 option: 660*1000*1000 complex samples With R&S FSW-B108 option: 900*1000*1000 complex samples
Input sample rate (ISR)	100 Hz	20 GHz
Sample Rate (SR) - Digital input	Max(100 Hz; ISR/8388608)	Min(20 GHz; 2*ISR)
Sample Rate (SR) - Digital output	100 Hz	200 MHz
Usable I/Q bandwidth (Digital input and filter active)	Min(0.8*SR; 0.8*ISR)	

Unfiltered I/Q data input

The values in Table 5-11 apply for the default data processing using the decimation filter and resampler. If the filter is deactivated (see "Omitting the Digital Decimation Filter (No Filter)" on page 186, the analysis sample rate is identical to the input sample rate. In this case, the usable I/Q bandwidth is not restricted by the R&S FSW.

Bandwidths

Depending on the sample rate, the following bandwidths are available:

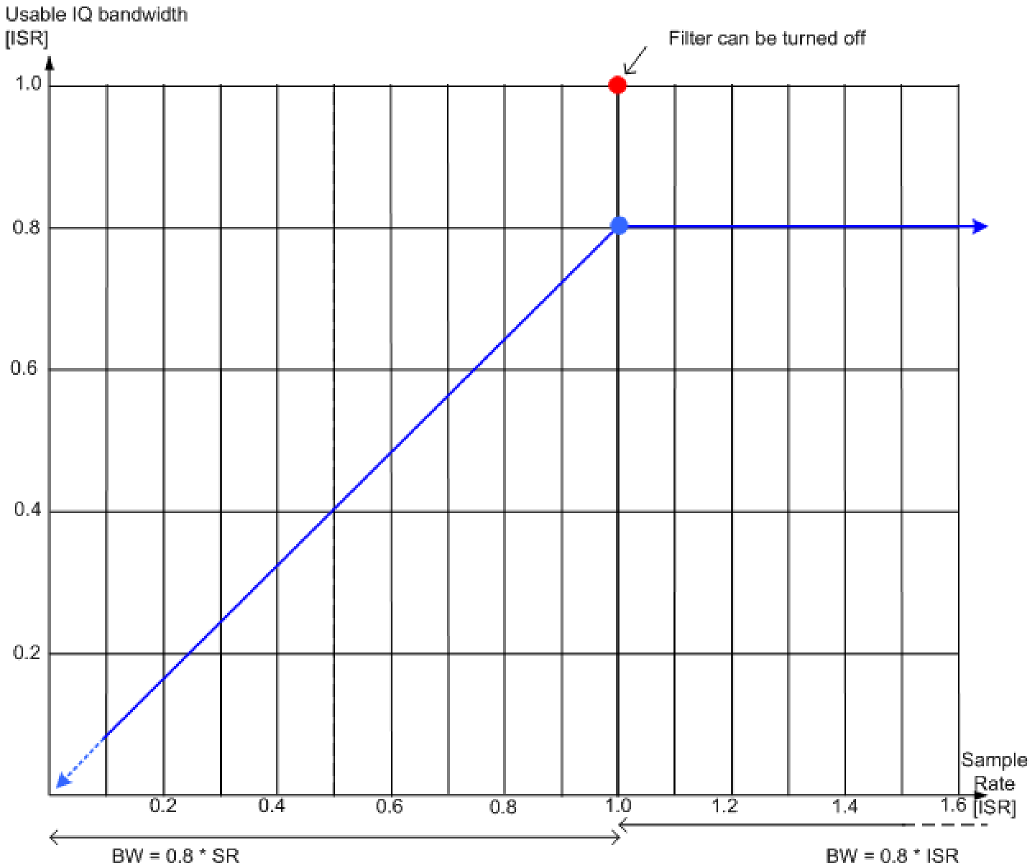


Figure 5-15: Bandwidths depending on sample rate for active digital input

5.2.4 Interface Status Information

When a digital input or output instrument is connected to the R&S Digital Baseband Interface, the "Input" or "Output" dialog boxes provide information on the status of the connection (see " Connected Instrument " on page 134, " Connected Instrument " on page 160, "Output Settings Information" on page 160).

You can query the information in these dialog boxes using remote commands, see `INPut<ip>:DIQ:CDEVice` on page 284 and `OUTPut<up>:DIQ:CDEVice?` on page 287.

Status icons

The status of the connection to the Digital Baseband Interface is also indicated as icons in the status bar. The status icons have the following meaning:

Table 5-12: Status information for digital baseband connections

Icon	Status
Digital input	
	Connection setup in progress
	Connection established
	• Connection error • No cable connected although Digital I/Q input source state = "ON"
-	Digital I/Q input source state = "OFF" and no cable connected
Digital output	
	Connection setup in progress
	Connection established
	• Connection error • No cable connected although Digital I/Q output state = "ON"
-	Digital I/Q output source state = "OFF" and no cable connected

Error messages

If an error occurs, a message is displayed in the status bar and a status bit is set in one of the status registers. For details on the message, select it on the status bar.

(See Chapter 10.10, "Querying the Status Registers", on page 484)

5.3 Processing Data from the Analog Baseband Interface

By default, (analog) I/Q data is captured from the standard "RF Input" connector on the front panel of the R&S FSW. Alternatively, analog baseband signals can also be captured via the optional **Analog Baseband Interface**, if installed.

5.3.1 (Analog) Baseband Input 50 Ω Connectors (Optional)

The Analog Baseband Interface option provides four "Baseband input" BNC connectors on the front panel of the R&S FSW for analog I and Q signals (R&S FSW85: two connectors).

The upper BNC connectors BASEBAND INPUT I and BASEBAND INPUT Q are used to input:

- Single-ended signals
- The positive signal input for differential signals
- Input from active Rohde & Schwarz probes (see data sheet)

The lower BNC connectors Ī and Q̄ are used to input the negative signal for differential signals.

R&S FSW85

The R&S FSW85 provides only two connectors; differential input is not supported.

Complex signal input (I+jQ)

For complex signal input (I+jQ), always use two identical cables for the I and Q connectors (same length, same type, same manufacturer). Otherwise, time delay or gain imbalance can occur between the different cables, which cannot be calibrated.

All connectors have a fixed impedance of 50 Ω. Do not overload the input. For maximum allowed values, see the data sheet.

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 can cause a short delay in data transfer after switching the input source.

Input via the Analog Baseband Interface can be enabled in the I/Q Analyzer, the Analog Demodulation application, or in one of the optional applications that process I/Q data (where available).

5.3.2 Analog Baseband Input

The Analog Baseband Interface can be used as an alternative data input source for measurements with the R&S FSW in one of the following ways:

- An analog baseband signal is input at the "Baseband Input I" and "Baseband Input Q" connectors and processed from there.
- An RF signal is input at the "Baseband Input I" connector and redirected from there to the RF input path.

The "Baseband Input I" connector cannot be used to input RF signals on the R&S FSW67 or R&S FSW85.

Complex spectrum analysis

If the input is already available as a complex baseband signal (I and Q signals), the Analog Baseband Interface allows you to analyze the complex spectrum of the baseband signal. This is useful for measurements in the early stages of signal processing or radio transmission, when the analog baseband signal has not yet been modulated.

Low IF signals

I/Q input that has already been modulated ("Low IF signal") is down-converted digitally.

Data acquisition

The Analog Baseband Interface of the R&S FSW can process both single-ended (unbalanced) and differential (balanced) input. The signal is input to the R&S FSW via the connectors of the Analog Baseband Interface. If necessary, the I and Q values in the input can be swapped. This is useful, for instance, if the connections are mixed up or the data is inverted by the device under test. The A/D converter samples the input at a rate of 200 MHz. As a result, 200 Msamples of I values and 200 Msamples of Q values are obtained per second.

Voltage levels - full scale level

For RF input, the maximum expected voltage level is defined by the reference level. For analog baseband input, the maximum expected voltage level *for each component* (I or Q) is defined by the **full scale level**. The full scale level defines the maximum power you can input at the "Baseband Input" connectors without clipping the signal.

The full scale level can be defined manually or automatically, such that the power of I and Q does not exceed the reference level.

If probes are connected, the possible full scale values are adapted according to the probe's attenuation and maximum allowed voltage.

For details on probes, see Chapter 5.5, "Using Probes", on page 60.

When converting the measured voltage into dBm, an impedance of 50 Ω is assumed.

Triggering

The following trigger sources are supported for analog baseband input (see " Trigger Source " on page 175):

- External
- Baseband power
- Time
- Power sensor

Gating

Gating is not supported for analog baseband input.

Calibration

A special calibration signal is available for analog baseband input and can be activated in the general instrument settings. If activated, an internal DC or AC calibration signal is input to the Analog Baseband Interface.

For details, see the R&S FSW User Manual.

High-accuracy timing

Some measurements require a timing precision of the analog baseband signals related to the external trigger signal and the RF signal. In this case, activate the "High Accuracy Timing Trigger - Baseband - RF" option for analog baseband input (see " High Accuracy Timing Trigger - Baseband - RF " on page 136).

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. When you confirm this prompt, the cable must be in place.

5.3.3 I/Q Processing Modes

The Analog Baseband Interface provides different methods of processing the baseband input (I/Q modes), depending on the measurement requirements.

Complex baseband mode (I+jQ)

In the (default) *complex baseband mode*, the analog input signal is assumed to be a complex baseband signal. There is no need to equalize any IF filter or mix the signal into the complex baseband. The analog hardware just has to ensure that the final I/Q data stored in the capture buffer has the correct sample rate for the application.

The analog baseband input signal is brought to the desired sample rate using a down-sampling filter and fractional resampling. No level compensation is necessary. The resulting data can be processed by the selected application.

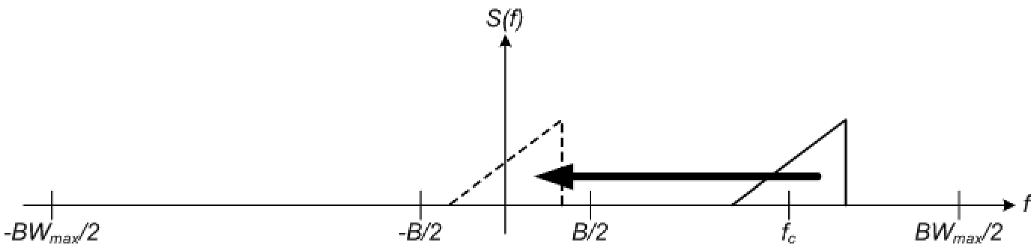


Figure 5-16: Spectrum in complex baseband (I+jQ) mode

The complex spectrum of the input signal is displayed. The center frequency does not need to be moved. However, it can be, as long as the selected spectrum remains within the maximum analysis bandwidth (see Chapter 5.3.4, "Sample Rates and Bandwidths for Analog Baseband Signals", on page 53).

Low IF mode (I or Q)

In *low IF mode*, the real signal from the selected input component (I or Q) is assumed to be a modulated carrier with a specific center frequency. The signal is down-converted to a selected center frequency (= low IF frequency) using an NCO. The center frequency must be higher than 0 Hz so that no part of the negative mirrored spectrum lies within the analysis bandwidth. (The center frequency must be different to 0 Hz, as in this case real baseband mode is assumed, see "Real baseband mode (I or Q only)" on page 53.) Furthermore, select the center frequency such that the displayed spectrum remains within the maximum analysis bandwidth (see Chapter 5.3.4, "Sample Rates and Bandwidths for Analog Baseband Signals", on page 53).

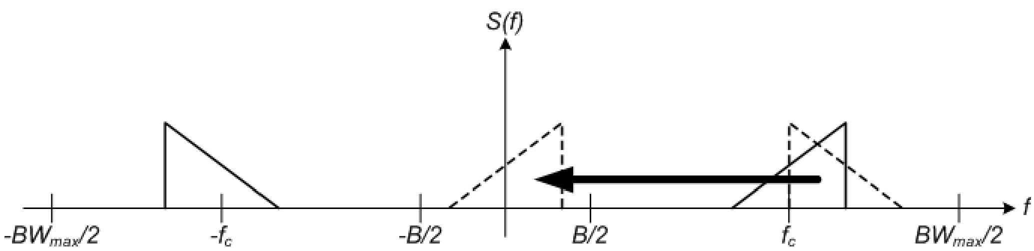


Figure 5-17: Spectrum in low IF mode

Compared to the initial complex baseband signal that was input, the down-converted I or Q component contains only half the spectrum (i.e. one sideband less) after passing the filter. The power is thus reduced by one half (or: -3 dB). This power loss is compensated for by increasing the power of the resulting spectrum by +3 dB.

The digitized data is brought to the desired sample rate using a downsampling filter and fractional resampling.

This processing mode corresponds to the common RF spectrum analysis, applied to the analog baseband input.

Real baseband mode (I or Q only)

As mentioned above, a center frequency of 0 Hz is not allowed for low IF mode. In this case, the input signal is assumed to be a real baseband signal, so no down-conversion is performed. Thus, this mode resembles an oscilloscope. The spectrum result display always starts at 0 and has a maximum span of half the sample rate. (Half of the captured samples are from the other component, which is not displayed in this mode.) The Real/Imag result display shows only one diagram (namely the one for the selected component).

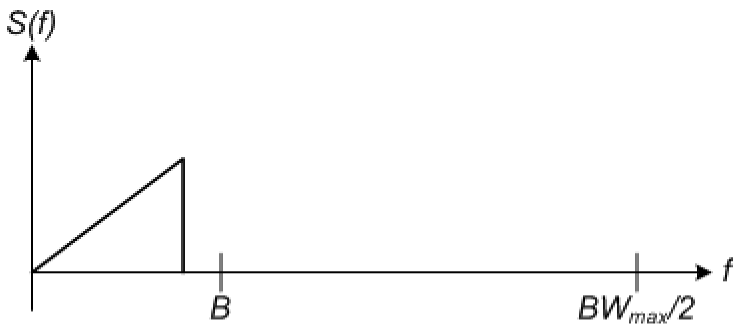


Figure 5-18: Spectrum in real baseband mode

This mode is useful for pulse measurements, for example.

5.3.4 Sample Rates and Bandwidths for Analog Baseband Signals

The analog baseband input is sampled internally by the R&S FSW at a rate of 200 MHz. As a result, 200 megasamples of I values and 200 megasamples of Q values can be obtained per second. The actual sample rate required by the application, however, can be lower, in which case the data is downsampled. Depending on the application used to process the data, the required sample rate is defined by the application itself or by the user. The sample rate also determines the analysis bandwidth. The analysis bandwidth is the range in which the signal remains undistorted in regard to amplitude characteristic and group delay which and can be used for accurate analysis by the R&S FSW. The sample rate and the analysis bandwidth are interdependant and are adapted according to the following formula in the I/Q Analyzer (see also Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24):

*Analysis bandwidth = 0.8 * sample rate*

(For I or Q only: *Analysis bandwidth = 0.4 * sample rate*)

Bandwidth extension options

The standard R&S FSW equipped with the optional Analog Baseband Interface can analyze a maximum bandwidth of 40 MHz input *per connector*. That makes an 80 MHz analysis bandwidth for a complex baseband signal.

The bandwidth extension options for RF input have no effect on analog baseband input.

However, a special bandwidth extension option for the Analog Baseband Interface is available. This option allows the R&S FSW to analyze a maximum bandwidth of 80 MHz input *per connector*. That makes a 160 MHz analysis bandwidth.

Spectrum limits

The analog baseband spectrum to be analyzed depends both on the analysis bandwidth and on the center frequency, which defines the middle of the spectrum. The spectrum should always remain within an ideal span (see Table 5-13) to avoid effects from unwanted signal components (e.g. mirrored sidebands). Thus, always select the maximum analysis bandwidth and the position of the center frequency such that the spectrum remains within the specified limits. You are not forced by the R&S FSW to do so, but a warning message is displayed if the limits are exceeded.

Table 5-13: Spectrum limits depending on I/Q mode

I/Q Mode	Complex baseband (I+jQ)	Low-IF (I / Q)	Real Baseband (I / Q)
Analysis bandwidth BW	BW_{max} = +80 MHz (default) BW_{max} = +160 MHz (with B71E option) $-BW_{max}/2 + BW/2 \leq f_c \leq BW_{max}/2 - BW/2$ ***)**	BW_{max} = +40 MHz (default) BW_{max} = +80 MHz (with B71E option) $-BW_{max}/2 + BW/2 \leq f_c \leq BW_{max}/2 - BW/2$ ***)**	BW_{max} = +40 MHz (default) BW_{max} = +80 MHz (with B71E option)
Center frequency f_c	$-BW_{max}/2 < f_c < BW_{max}/2$ i.e.: -40 MHz to +40 MHz (default) -80 MHz to +80 MHz (with B71E option)	$0 < f_c < BW_{max}$ i.e.: +10 Hz to +40 MHz (default) +10 Hz to +80 MHz (with B71E option)	f_c = 0 Hz
Span	= Sample rate	= Sample rate	= Sample rate / 2
*) not forced by R&S FSW			

5.3.5 RF Input from the Analog Baseband Connector

If the optional Analog Baseband Interface is installed and active for input, an RF signal can be input at the "BASEBAND INPUT I" connector and redirected from there to the RF input path. In this case, the signal from the Analog Baseband Interface is processed in the same manner as for other RF input (see Chapter 5.1, "Processing Analog I/Q Data from RF Input", on page 22). However, a transducer is activated before the common process to compensate for the additional path of the redirected signal.

The signal is then processed as usual in the frequency and time domain as for any other RF input.

This is useful, for example, to perform frequency sweep measurements with (single-ended or differential) active probes, which can also be connected to the "BASEBAND INPUT I" connector (see Chapter 5.5, "Using Probes", on page 60).

Furthermore, the modulated signals can be converted to any frequency in the analysis bandwidth.

5.3.6 Average Power Consumption

The Analog Baseband interface can be used to capture two different signals: one proportional to the voltage and one proportional to the current of a DUT. The *average power consumption* can then be calculated from the captured I/Q signal. To avoid processing large amounts of I/Q data, the R&S FSW provides an internal calculation of the average power consumption for remote operation according to the following equation:

$$P_{avg} = \frac{1}{NofSamples} \sum_{n=0}^{NofSamples-1} P(n)$$

*P(n) = A * V(n) * I(n) - B * V(n) * V(n)*

with:

- V(n): I data of the instrument
- I(n): Q data of the instrument
- A: conversion factor A
- B: conversion factor B

Remote commands:

`TRACe:IQ:APCon[:STATe]` on page 293

`TRACe:IQ:APCon:A` on page 294

`TRACe:IQ:APCon:B` on page 294

`TRACe:IQ:APCon:RESult?` on page 294

5.4 Processing Oscilloscope Baseband Input

In order to obtain analog baseband data directly from the R&S FSW, you require additional hardware provided by the Analog Baseband Interface option (see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48)

Alternatively, a Rohde & Schwarz oscilloscope (e.g. R&S RTO) can capture the I and Q (baseband) values via its channel input connectors. If you then connect the R&S FSW to the oscilloscope via LAN, it receives the captured I/Q data. This measurement setup only requires a software option on the R&S FSW, in addition to the oscilloscope.

This method is useful for measurement setups with the B2000/B5000 option, for which the oscilloscope is also required. However, a bandwidth extension option is not required for Oscilloscope Baseband Input. For details on prerequisites and supported Rohde & Schwarz oscilloscopes, see the data sheet.

Basic principle of Oscilloscope Baseband Input

The oscilloscope samples the signal at a rate of 10 Gigasamples or 20 Gigasamples, using an external frequency reference. The A/D converted data is then sent to the R&S FSW via LAN connection. The R&S FSW resamples the data to the sample rate required by the R&S FSW measurement application. The entire measurement and both instruments are controlled by the R&S FSW.

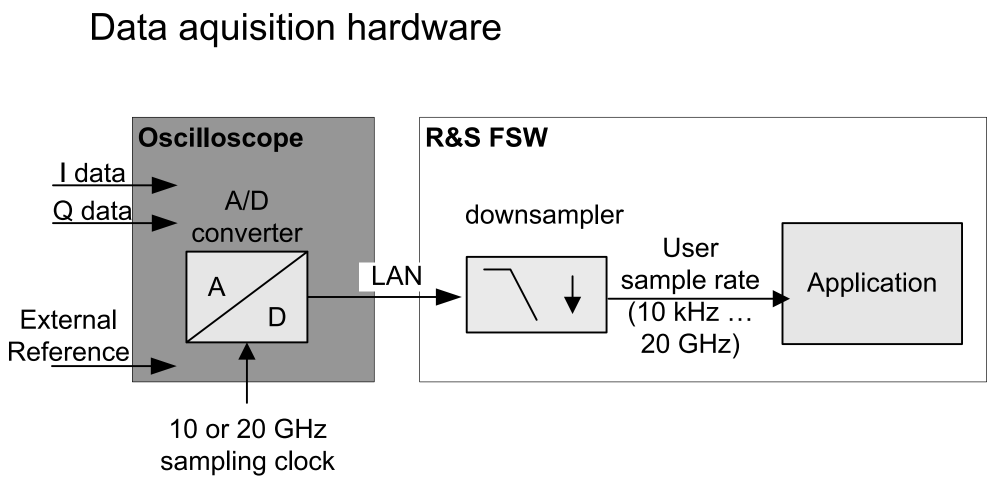


Figure 5-19: Signal processing using the optional Oscilloscope Baseband Input

Since the Oscilloscope Baseband Input requires no additional hardware on the R&S FSW, the connection to the oscilloscope cannot be aligned from the R&S FSW. Thus, the analyzed baseband data on the R&S FSW reflects the accuracy of the oscilloscope. It is recommended that you perform a self-alignment on the oscilloscope before connecting it to the R&S FSW. See the oscilloscope documentation for details.

Complex signal input (I+Q)

Complex signal input must be provided to the R&S FSW by a connected oscilloscope. The I and Q signal components are input in different channels, and transferred to the R&S FSW via a LAN connection.

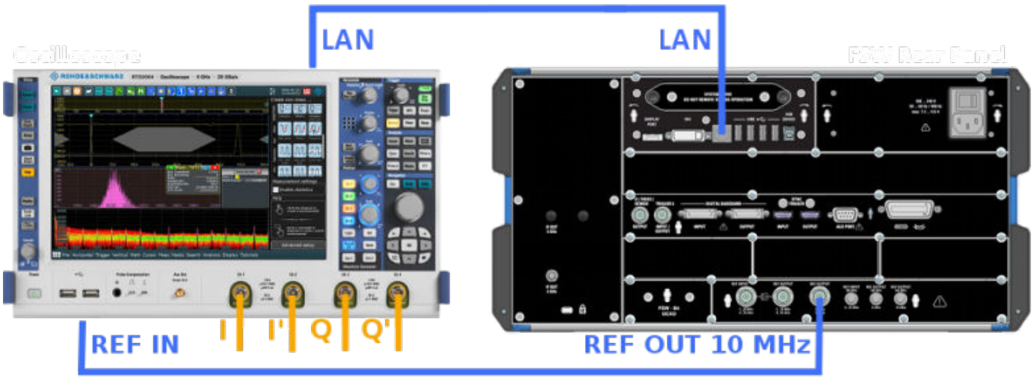


Figure 5-20: Measurement setup with the optional Oscilloscope Baseband Input

The R&S FSW can process both single-ended (unbalanced) and differential (balanced) input.

For single-ended data, the following input at the oscilloscope is required:

- "Ch1": I
- "Ch3": Q

For differential data, four input channels on the oscilloscope are required.

- "Ch1": I
- "Ch2": Ī
- "Ch3": Q
- "Ch4": Q̄

Distortion due to different cables

For complex signal input (I+Q), it is recommended that you use two identical cables for the I and Q connectors (same length, same type, same manufacturer). Otherwise, time delay or gain imbalance may occur between the different cables. If necessary, you can define fixed deskew values for individual channels.

Applications supporting Oscilloscope Baseband Input

Currently, the following applications support Oscilloscope Baseband Input in the R&S FSW software:

- I/Q Analyzer

Voltage levels - full scale level

For RF input, the maximum expected voltage level is defined by the reference level. For Oscilloscope Baseband Input, the maximum expected voltage level *for each component* (I or Q) is defined by the **full scale level**. The full scale level defines the maximum power you can input without clipping the signal.

Triggering

The following trigger sources are supported for Oscilloscope Baseband Input (see " Trigger Source " on page 175):

- " Baseband Power " on page 178 (on Input Channel 1)
- External Analog

I/Q Processing Modes

The Oscilloscope Baseband Input provides different methods of processing the baseband input, depending on the measurement requirements.

The used processing mode is indicated in the channel bar, for example "Inp: Oscilloscope-I/Q" for "I/Q Mode": "IQ".

Complex baseband mode (I+Q)

In the (default) *complex baseband mode*, the analog input signal is assumed to be a complex baseband signal. There is no need to equalize any IF filter or mix the signal into the complex baseband. The software just has to ensure that the final I/Q data stored in the capture buffer has the correct sample rate for the application. No level compensation is necessary. The resulting data can be processed by the selected application.

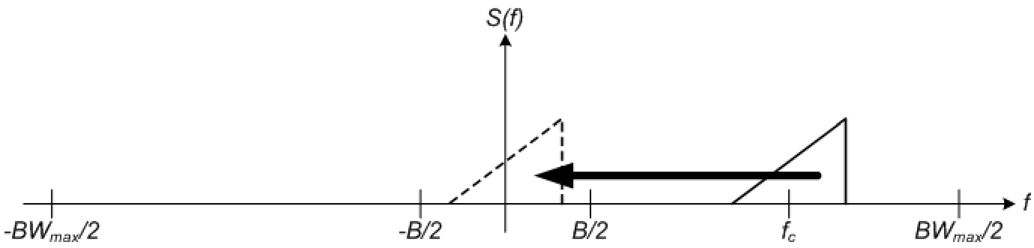


Figure 5-21: Spectrum in complex baseband (I+Q) mode

The complex spectrum of the input signal is displayed. You do not have to move the center frequency, but you can, as long as the selected spectrum remains within the maximum analysis bandwidth (see Chapter 5.4.1, "Sample Rates and Bandwidths for Oscilloscope Baseband Input", on page 59).

Low IF mode (I only)

In *low IF mode*, the real signal from the in-phase (I) component is assumed to be a modulated carrier with a specific center frequency. The signal is down-converted to the selected center frequency (= low IF frequency). The center frequency must be higher than 0 Hz so that no part of the negative mirrored spectrum lies within the analysis bandwidth. Select the center frequency such that the displayed spectrum remains within the maximum analysis bandwidth (see Chapter 5.4.1, "Sample Rates and Bandwidths for Oscilloscope Baseband Input", on page 59).

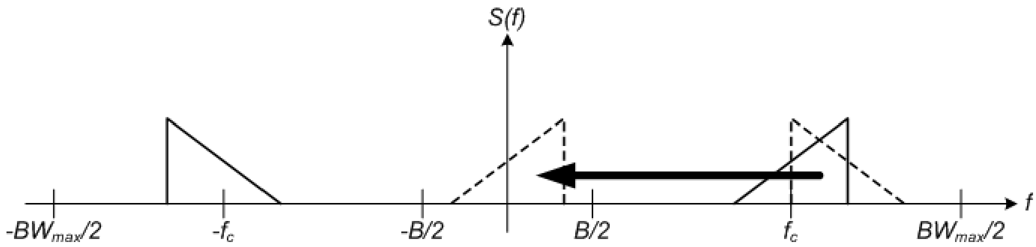


Figure 5-22: Spectrum in low IF mode

Compared to the initial complex baseband signal that was input, the down-converted I component contains only half the spectrum (i.e. one sideband less) after passing the filter. The power is thus reduced by one half (or: -3 dB). This power loss is compensated for by increasing the power of the resulting spectrum by +3 dB.

The digitized data is brought to the desired sample rate using a downsampling filter and fractional resampling.

Restrictions

If the Oscilloscope Baseband Input is active, the following restrictions apply:

- Manual operation on the oscilloscope, or remote operation other than by the R&S FSW controlling the option, is not possible.
- MSRA mode is not available.
- The record length may be restricted by the number of samples provided by the oscilloscope (see its data sheet).
- Baseband power and (analog) external are the only supported trigger sources. For the external trigger, a drop-out time cannot be defined.
- When querying the trace data remotely, the I/Q data can only be transferred in interleaved format (I,Q,I,Q...), see `TRACe:IQ:DATA:FORMat` on page 471).
- The I/Q data cannot be stored using the `TRACe<n>[:DATA]:MEMory?` remote command.

5.4.1 Sample Rates and Bandwidths for Oscilloscope Baseband Input

For Oscilloscope Baseband Input, the I and Q data is input using 1, 2 or 4 channels of the oscilloscope. Thus, the usable I/Q bandwidth in the R&S FSW depends on the bandwidth provided by the oscilloscope.

max. BW_{SA} = max. BW_{osci} (I-channel) + max. BW_{osci} (Q-channel) = **2 * max. BW_{osci}**

The usable I/Q bandwidth is the bandwidth range in which the signal remains undistorted in regard to amplitude characteristic and group delay. It is also the range that can be used for accurate analysis by the R&S FSW. The analysis bandwidth and the sample rate are interdependent and are adapted according to the following formula in the I/Q Analyzer:

Sample rate = Analysis bandwidth / 0.8

(For I only: *Sample rate = Analysis bandwidth / 0.4*)

However, the maximum user sample rate on the R&S FSW is restricted to 20 GHz.

Furthermore, the actual sample rate required by the application can be lower, in which case the data is downsampled. Depending on the application used to process the data, the required sample rate is defined by the application itself or by the user.

Spectrum limits

The spectrum of the Oscilloscope Baseband Input to be analyzed depends both on the analysis bandwidth and on the center frequency, which defines the middle of the spectrum. Thus, always select the maximum analysis bandwidth and the position of the center frequency such that the spectrum remains within the available limits. You are not forced by the R&S FSW to do so, but a warning message is displayed if the limits are exceeded.

5.5 Using Probes

Probes allow you to perform voltage measurements very flexibly and precisely on all sorts of devices to be tested, without interfering with the signal. The R&S FSW base unit and some (optional) applications support input from probes.

Probe connectors

Probes can be connected to the following connectors on the R&S FSW:

- BASEBAND INPUT connectors, if the Analog Baseband Interface (option R&S FSW-B71) is installed;
  Allows you to perform I/Q analysis or frequency sweeps on data from all active probes up to a frequency of 5 GHz. The power supply for the probe is integrated in the connector.
  Supported only by applications that can process I/Q data.
- "RF Input" connector using an R&S RT-ZA9 adapter;
  Allows you to perform I/Q analysis or frequency sweeps on data from active modular probes directly on the RF input up to the maximum frequency of the probe and analyzer. Does not require the optional Analog Baseband Interface (R&S FSW-B71).
  Supported by all R&S FSW applications, in particular the Spectrum application.
  The R&S RT-ZA9 provides an interface between the probe's BNC socket and the analyzer's N-socket. The USB connection provides the necessary supply voltages for the probe.

Active probes

When using active probes from the R&S RT family, consider the following:

- Active probes require operating power from the instrument and have a proprietary interface to the instrument.
- The probe is automatically recognized by the instrument, no adjustment is required.
- Connections should be as short as possible to keep the usable bandwidth high.
- Observe the operating voltage range.

Microbutton action

You can define an action to be performed by the R&S FSW when the probe's microbutton (if available) is pressed. Currently, a single data acquisition via the probe can be performed simply by pressing the microbutton.

5.5.1 Analog Baseband Probes

Probes are automatically detected when you plug them into the upper BASEBAND INPUT connectors on the front panel of the R&S FSW. The detected information on the probe is displayed in the "Probes" tab of the "Input" dialog box, individually for each connector.

To determine whether the probe has been connected properly and recognized by the R&S FSW, use the `[SENSe:]PROBe<pb>:SETup:STATe?` remote control command.

Analog baseband input from connected probes can only be analyzed in applications that support I/Q data processing and the optional Analog Baseband Interface (R&S FSW-B71), such as the I/Q Analyzer, the Analog Demodulation application, or one of the optional applications.

However, probes can also provide RF input to the R&S FSW via the BASEBAND INPUT I connector. In this case, the input is redirected to the RF input path. Then the probe data can also be analyzed in the Spectrum application, allowing you to perform measurements in the time or frequency domain on the input from a probe.

For details see Chapter 5.3.5, "RF Input from the Analog Baseband Connector", on page 54.

As opposed to common RF input processing, a transducer is activated before the common process to compensate for the additional path of the redirected signal.

Impedance and attenuation

The measured signal from the probe is attenuated internally by the probe's specific attenuation. For probe signals that are redirected to the RF path, the attenuation is compensated by the transducer. The reference level is adjusted automatically.

For analog baseband input, the attenuation is compensated without a transducer. In this case, higher levels are available for the full scale level.

A fixed impedance of 50 Ω is used for all probes to convert voltage values to power levels.

Additional information

An application note discussing differential measurements with spectrum analyzers is available from the Rohde & Schwarz website:

1EF84: Differential measurements with Spectrum Analyzers and Probes

5.5.1.1 Common Mode Offset (for Differential Probes)

Common mode offset compensation is available for R&S®RT-ZD10/20/30 probes with serial number ≥ 200 000. It can compensate a common DC voltage applied to both input sockets (referenced to the ground socket). This is particularly helpful for measurements on differential signals with high common mode levels, for example, current measurements using a shunt resistor.

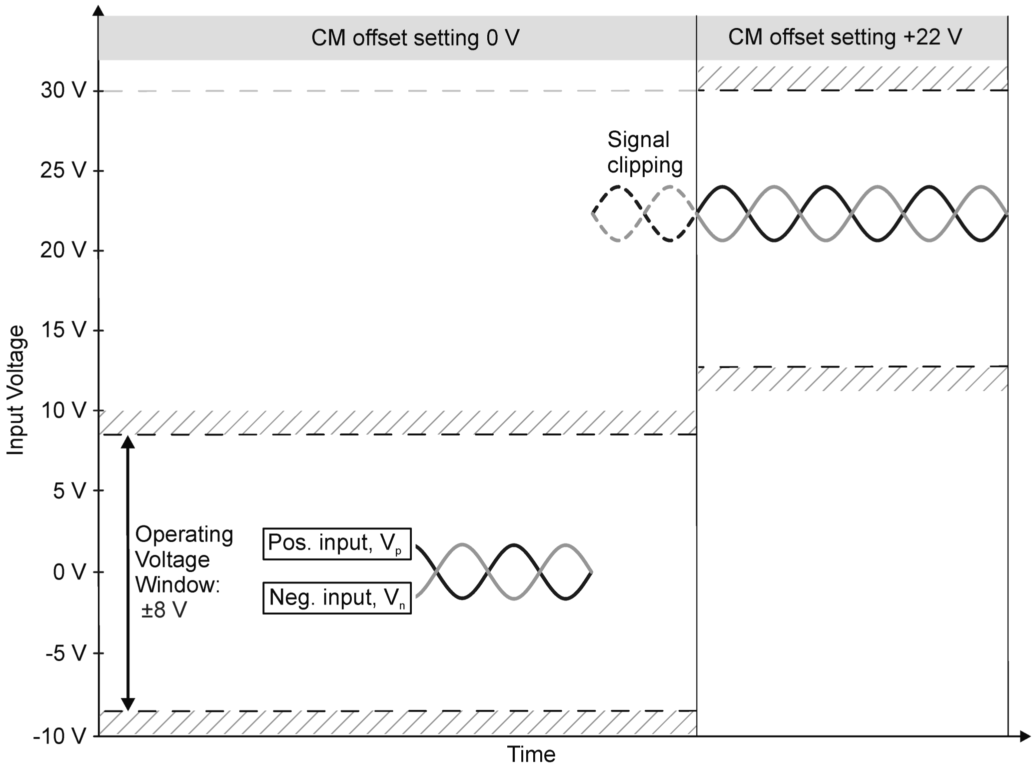


Figure 5-23: Common mode (CM) offset compensation for a differential measurement

If the input signals fit into the operating voltage window of the R&S®RT-ZD10/20/30, it is not necessary to set a common mode offset compensation.

Clipping effects due to incorrect common mode offset

The R&S®RT-ZD10/20/30 probe measures only differential input signals. Common mode signals are suppressed by the probe. Therefore, the common mode offset compensation is not directly visible in the result display. An incorrect common mode offset compensation can lead to unwanted clipping effects. Measuring the common mode input voltage using the R&S ProbeMeter is a convenient way to detect breaches of the operating voltage window.

For more information on common mode offset see the R&S®RT-ZD10/20/30 User Manual.

5.5.2 RF Probes

Generally, you can perform frequency sweeps on active probes connected to the BASEBAND INPUT connectors by redirecting the input to the RF Input path (see Chapter 5.5.1, "Analog Baseband Probes", on page 61). However, this measurement setup is restricted to a maximum frequency of 5 GHz by the BASEBAND INPUT connectors. Furthermore, this setup is restricted to applications that can process I/Q data.

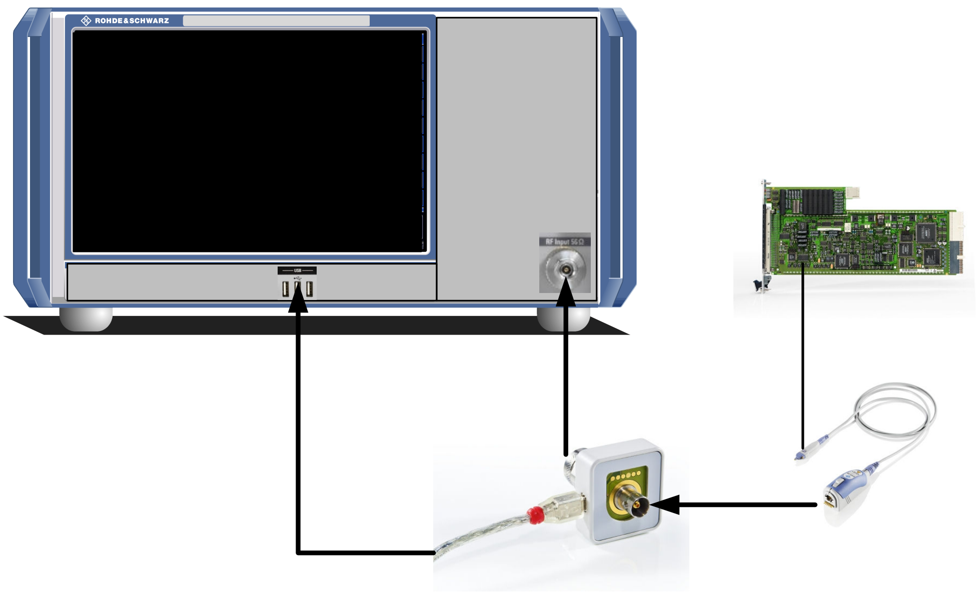
Connecting probes directly to the RF Input connector allows you to make use of the maximum frequency range provided by the probe and the R&S FSW, which can be much higher than 5 GHz.

Furthermore, input from probes at the RF Input connector can be analyzed in all R&S FSW applications, including applications that do not process I/Q data, and do not support the optional Analog Baseband Interface (R&S FSW-B71).

Only active modular probes can be connected to the RF Input connector via the optional R&S RT-ZA9 adapter.

To connect an active probe to the RF Input

1. Connect the R&S RT-ZA9 adapter to the RF Input connector on the R&S FSW.
2. Connect the R&S RT-ZA9 adapter's USB cable to a USB connector on the R&S FSW.
3. Connect the probe to the adapter.



4. In the "Input source" settings, select the "Input connector": "RF Probe".

   Probes are automatically detected when you plug them into the R&S FSW. The detected information on the probe is displayed in the "Probes" tab of the "Input" dialog box.

To determine whether the probe has been connected properly and recognized by the R&S FSW, use the `[SENSe:]PROBe<pb>:SETup:STATe?` remote control command.

Impedance and attenuation

The measured signal from the probe is attenuated internally by the probe's specific attenuation. For RF probes, the attenuation is compensated using a pre-defined "Probe on RF Input" transducer factor. This special transducer factor is automatically activated before the common RF data processing when you select "RF probe" as the input connector. The reference level is adjusted automatically.

A fixed impedance of 50 Ω is used for all probes to convert voltage values to power levels.

5.5.2.1 MultiMode Function and Offset Compensation for Modular RF Probes

The R&S RT-ZM probe family features the MultiMode function which allows you to switch between single-ended, differential, and common mode measurements without reconnecting or resoldering the probe.

Four different input voltages can be measured with the MultiMode feature:

- **P-Mode**: (pos.) Single-ended input voltage (V_p)
  Voltage between the positive input terminal and ground
- **N-Mode**: (neg.) Single-ended input voltage (V_n)
  Voltage between the negative input terminal and ground

- **DM-Mode**: Differential mode input voltage (V_{dm})
  Voltage between the positive and negative input terminal
  $$V_{dm} = V_p - V_n$$
- **CM-Mode**: Common mode input voltage (V_{cm})
  Mean voltage between the positive and negative input terminal vs. ground
  $$V_{cm} = \frac{V_p + V_n}{2}$$

The R&S FSW supports all probe modes. The mode is configured in the Chapter 6.3.1.7, "Probe Settings", on page 141.

Offset compensation

The R&S RT-ZM probes feature a comprehensive offset compensation function. The compensation of DC components directly at the probe tip even in front of the active probe amplifier is possible with an extremely wide compensation range of ±16 V (±24 V for P and N modes).

The offset compensation feature is available for every MultiMode setting:

MultiMode setting	Offset compensation	Offset compensation range	Application
DM-Mode	Differential DC voltage	±16 V	Probing single-ended signals, e.g. power rails with high DC component and small AC signal.
CM-Mode	Common mode DC voltage	±16 V	Measurements of signals with high common mode levels, e.g. current measurements with a shunt resistor.
P-Mode	DC voltage at positive input terminal	±24 V	Measurement of single-ended AC signals with high superimposed DC component at the positive input terminal. **Note**: The maximum voltage difference between the positive and negative input terminals is 16 V.
N-Mode	DC voltage at negative input terminal	±24 V	Measurement of single ended AC signals with high superimposed DC component at the negative input terminal. **Note**: The maximum voltage difference between the positive and negative input terminals is 16 V.

If the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

5.6 Basics on External Mixers

Some background knowledge on basic terms and principles used with external mixers is provided here for a better understanding of the required configuration settings.

5.6.1 Frequency Ranges

In a common spectrum analyzer, rather than providing one large (and thus inaccurate) filter, or providing several filters to cover the required frequency range of the input signal (at a high cost), a single, very accurate filter is used. Therefore, the input signal must be converted to the frequencies covered by the single accurate filter. This is done by a mixer, which converts and multiplies the frequency of the input signal with the help of the local oscillator (LO). The result is a higher and lower intermediate frequency (IF). The local oscillator can be tuned within the supported frequency range of the input signal.

In order to extend the supported frequency range of the input signal, an external mixer can be used. In this case, the LO frequency is output to the external mixer, where it is mixed with the RF input from the original input signal. In addition, the *harmonics* of the LO are mixed with the input signal, and converted to new intermediate frequencies. Thus, a wider range of frequencies can be obtained. The IF from the external mixer is then returned to the spectrum analyzer.

The frequency of the input signal can be expressed as a function of the LO frequency and the selected harmonic of the first LO as follows:

$f_{in} = n * f_{LO} + f_{IF}$

Where:

f_{in}: Frequency of input signal

n: Order of harmonic used for conversion

f_{LO}: Frequency of first LO: 7.65 GHz to 17.45 GHz

f_{IF}: Intermediate frequency (variable; defined internally depending on RBW and span)

Thus, depending on the required frequency band, the appropriate order of harmonic must be selected. For commonly required frequency ranges, predefined bands with the appropriate harmonic order setting are provided. By default, the lowest harmonic order is selected that allows conversion of input signals in the whole band.

For the band "USER", the order of harmonic is defined by the user. The order of harmonic can be between 2 and 128, the lowest usable frequency being 16.88 GHz.

The frequency ranges for pre-defined bands are described in Table 10-3.

Changes to the band and mixer settings are maintained even after using the [PRESET] function. A "Preset band" function allows you to restore the original band settings.

Extending predefined ranges

In some cases, the harmonics defined for a specific band allow for an even larger frequency range than the band requires. By default, the pre-defined range is used. However, you can take advantage of the extended frequency range by overriding the defined start and stop frequencies by the maximum possible values ("RF Overrange" option).

Additional ranges

If due to the LO frequency the conversion of the input signal is not possible using one harmonic, the band must be split. An adjacent, partially overlapping frequency range can be defined using different harmonics. In this case, the sweep begins using the harmonic defined for the first range, and at a specified frequency in the overlapping range ("handover frequency"), switches to the harmonic for the second range.

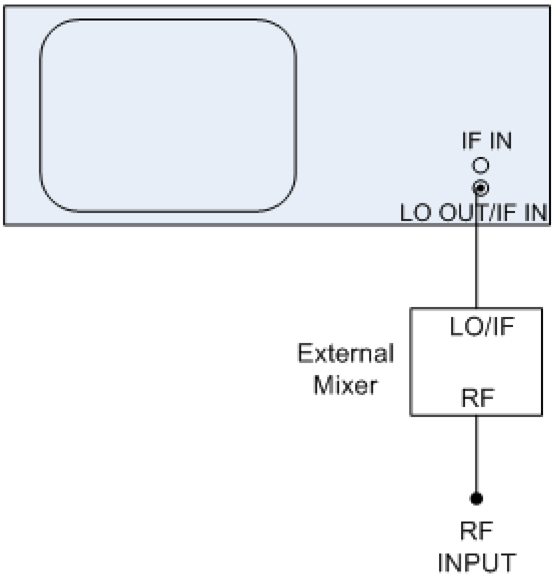
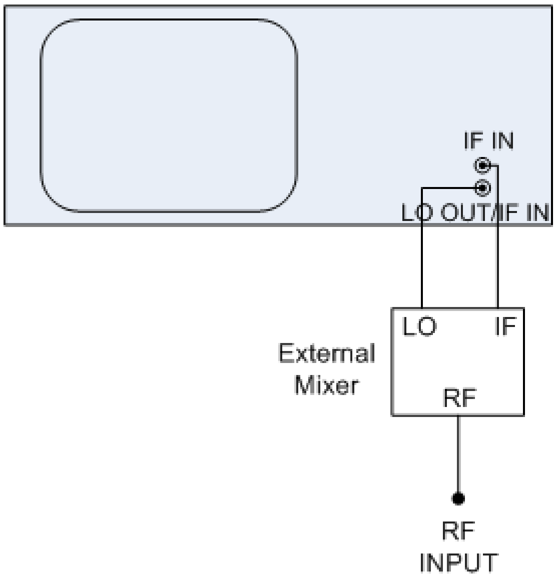
5.6.2 Two-port and Three-port Mixers

External mixers are connected to the R&S FSW at the LO OUT/IF IN and IF IN connectors.

When using three-port mixers, the LO signal output from the R&S FSW and the IF input from the mixer are transmitted on separate connectors, whereas for two-port mixers, both signals are exchanged via the same connector (LO OUT/IF IN). Because of the diplexer contained in the R&S FSW, the IF signal can be tapped from the line which is used to feed the LO signal to the mixer.

For measurements with a bandwidth larger than 2 GHz and an external mixer, only 3-port mixers are supported.

For more information see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

<table>
<tr><th>Two-port mixer</th><th>Three-port mixer</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

In both cases, the nominal LO level is 15.5 dBm.

5.6.3 Bias Current

Single-diode mixers generally require a DC voltage which is applied via the LO line. This DC voltage is to be tuned to the minimum conversion loss versus frequency. Such a DC voltage can be set via the "BIAS" function using the D/A converter of the R&S FSW. The value to be entered is not the voltage but the short-circuit current. The current is defined in the "Bias Settings" or set to the value of the conversion loss table.

See " Bias Value " on page 127 and " Bias " on page 131.

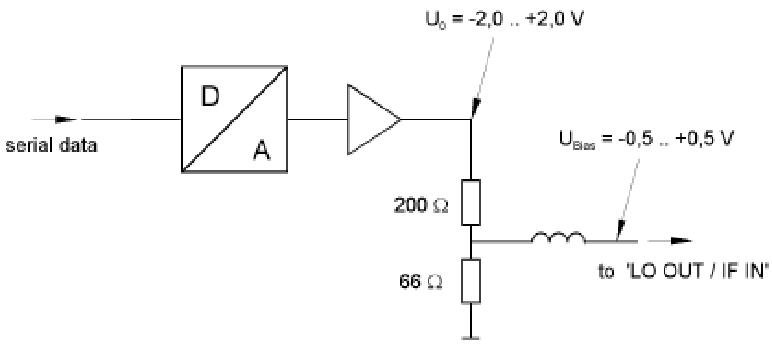


Figure 5-24: Bias circuit of the R&S FSW

The voltage U_0 at the output of the operational amplifier can be set in the range –2.0 to +2.0 V. An open-circuit voltage U_{bias} of –0.5 to +0.5 V is obtained accordingly at the output of the voltage divider. A short-circuit current of $I_{short} = U_0 / 200\ \Omega = 10$ mA to + 10 mA is obtained for a short circuit at the output of the voltage divider. In order to use biasing it is not important to know the exact current flowing through the diode since the conversion loss must be set to a minimum with the frequency. Therefore, it makes no difference whether the setting is performed by an open-circuit voltage or by a short-circuit current. A DC return path is ensured via the 66 Ω resistor, which is an advantage in some mixers.

5.6.4 Conversion Loss Tables

Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. Correction values for frequencies between the reference values are obtained by interpolation. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table the conversion loss is assumed to be the same as that for the first and last reference value (see Figure 5-25).

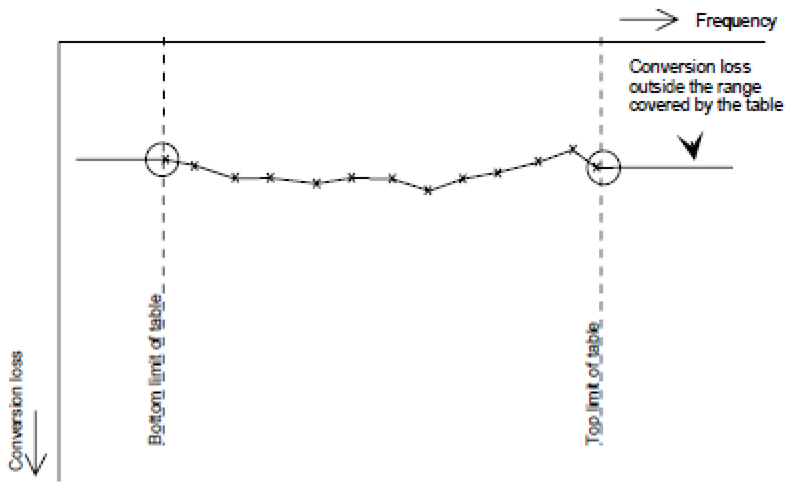


Figure 5-25: Conversion loss outside the band's frequency range

Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S FSW.

Alternatively, you can define your own conversion loss tables. Conversion loss tables are configured and managed in the "Conversion loss Table Settings" tab of the "External Mixer Configuration" dialog box.

When using external mixers with optional bandwidth extensions larger than 512 MHz, special conversion loss tables are required, see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

Importing CVL tables

The conversion loss table to be used for a particular measurement range is also defined in the "External Mixer Configuration" dialog box.

The frequency range that the cvl table must cover depends on the used IF, which varies depending on the instrument and installed bandwidth extension options. Thus, external mixers from Rohde & Schwarz provide multiple conversion loss table files. When you select a storage path containing cvl files, or a particular cvl file from a Rohde & Schwarz mixer for import, all available files are copied to the `C:\R_S\INSTR\USER\cvl\` directory on the R&S FSW. Provided `.acl` files are renamed according to the following syntax:

`<serial_number>_<harmonic_order>_<IF>.acl`,

e.g. `12345_2_1330M.acl`

To select a conversion loss table for use in a measurement, you merely have to select the serial number for the external mixer in use. The R&S FSW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (`.acl` file).

Before copying any files to the `C:\R_S\INSTR\USER\cvl\` directory, the R&S FSW firmware moves any existing user-defined cvl tables to a `backup` subdirectory. To use a user-defined cvl table later, select the file in the `C:\R_S\INSTR\USER\cvl\backup` directory.

A validation check is then performed on the selected table to ensure that it complies with the settings. In particular, the following is checked:

- The assigned band name
- The harmonic order
- The mixer type
- The table must contain at least one frequency that lies within the frequency range for the band

Reference level

The maximum possible reference level depends on the maximum used conversion loss value. Thus, the reference level can be adjusted for each range according to the used conversion loss table or average conversion loss value. If a conversion loss value is used which exceeds the maximum reference level, the reference level is adjusted to the maximum value permitted by the firmware.

5.6.5 External Mixers and Large Bandwidth Extension Options

If the bandwidth extension options R&S FSW-B1200/-B2001/-B2000 are active, external mixers with a bandwidth up to 2 GHz are supported. For information on which mixers are supported for these bandwidth options, see the R&S FSW data sheet. Two-port mixers are not supported.

If the bandwidth extension option R&S FSW-B5000 is active, some external (three-port) mixers with a bandwidth up to 5 GHz are supported. For information on which mixers are supported for these bandwidth options, see the R&S FSW data sheet. Two-port mixers are not supported. Instrument models 1312.8000Kxx require an additional hardware option,R&S FSW-U21 or R&S FSW-U85.

If the bandwidth extension options R&S FSW-B4001/B6001/B8001 are active, external mixers are supported for an analysis bandwidth up to 4 GHz. For information on which mixers are supported for these bandwidth options, see the R&S FSW data sheet.

Depending on the installed and active bandwidth extension options and used measurement bandwidth, special conversion loss tables are required.

Table 5-14: Required conversion loss tables depending on measurement bandwidth

BW extension option	Used meas bandwidth	Required conversion loss table format
B1200/B2001	<=512 MHz	*.ACL
	>512 MHz	*_B1200_B2001.B2G
B2000 (active)	<=2 GHz	*_B2000.B2G
B5000 (active)	<=4.4 GHz	*_B5000_2G8.B5G
	>4.4 GHz	*_B5000_3G5.B5G
B4001/B6001/B8001	<=80 MHz	*.ACL
	80 MHz< bw <=4 GHz	*_B5000_2G8.B5G

While the common `.acl` files can be used, data acquisition with larger bandwidths using such conversion loss tables leads to substantial inaccuracy. Using an average conversion loss for the entire range (instead of a conversion loss table) during data acquisition with the large bandwidth extension options causes even more inaccuracy. In both cases, the `UNCAL` status message indicates that the measurement can have inaccurate results.

Special conversion loss tables (in `.b2g` or `.b5g` files) cannot be edited within the R&S FSW firmware; they can only be imported and deleted.

B2000-specific conversion loss tables

A B2000 conversion loss table consists of 43 magnitude correction values (as opposed to 1 for `.acl` files). To each side of the specific frequency, 21 reference values are defined with an offset of 25 MHz to 1025 MHz. Thus, correction levels are measured with a spacing of 50 MHz.

Example:

For example, for the level measured at the frequency 50 GHz, 43 correction levels are defined:

- 21 for the frequencies 48.075 GHz, 49.125 GHz, 49.175 GHz, ..., 49.975 GHz
- 1 for the frequency 50 GHz
- 21 for the frequencies 50.025 GHz, 50.075 GHz, 50.125 GHz, ..., 51.025 GHz

B2000-specific conversion loss tables are provided in files according to the following syntax:

<serial_no.>_MAG_<harmonic>_B2000.b2g

Phase correction tables

In addition to the magnitude correction tables, B2000 phase correction tables with the same layout are defined in a separate file. Both files are always delivered as a pair by the manufacturer of the external mixer. Currently, the R&S FSW uses only the magnitude correction files for external mixers; the phase is assumed to be ideal (correction values are all 0).

B2000-specific phase conversion loss tables are provided in files according to the following syntax:

<serial_no.>_PHASE_<harmonic>_B2000.b2g

B5000-specific conversion loss tables

For bandwidths larger than 2 GHz, two different types of conversion loss tables are available, depending on the required bandwidth:

- For bandwidths ≤4.4 GHz: table consists of 91 correction values per frequency, for an IF of 2.8 GHz
  The tables are provided in files according to the following syntax:
  <serial_no.>_MAG|PHASE_<harmonic>_B5000_2G8.b5g
- For bandwidths between 4.4 GHz and 5 GHz: table consists of 103 correction values per frequency, for an IF of 3.5 GHz
  The tables are provided in files according to the following syntax:
  <serial_no.>_MAG|PHASE_<harmonic>_B5000_3G5.b5g

Currently, the R&S FSW uses only the magnitude correction files; the phase is assumed to be ideal (correction values are all 0).

5.7 Basics on External Generator Control

Some background knowledge on basic terms and principles used for external generator control is provided here for a better understanding of the required configuration settings.

External generator control is only available in the following applications.

- Spectrum Analyzer
- I/Q Analyzer
- Analog Demodulation
- Noise Figure Measurements

5.7.1 External Generator Connections

The external generator is controlled either via a LAN connection or via the EXT. GEN. CONTROL GPIB interface of the R&S FSW supplied with the option.

For more information on configuring interfaces see the "Remote Control Interfaces and Protocols" section in the R&S FSW User Manual.

TTL synchronization

In addition, TTL synchronization can be used with some Rohde & Schwarz generators connected via GPIB. The TTL interface is included in the AUX control connector of the External Generator Control option.

Using the TTL interface allows for considerably higher measurement rates than pure GPIB control, because the frequency stepping of the R&S FSW is directly coupled with the frequency stepping of the generator. For details see Chapter 5.7.7, "Coupling the Frequencies", on page 81.

In Figure 5-26 the TTL connection is illustrated using an R&S SMU generator, for example.

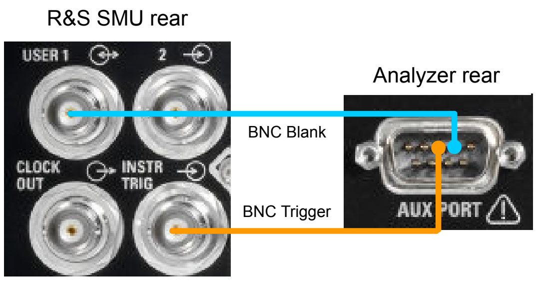


Figure 5-26: TTL connection for an R&S SMU generator

In Figure 5-27, the connection for an R&S SMW is shown.

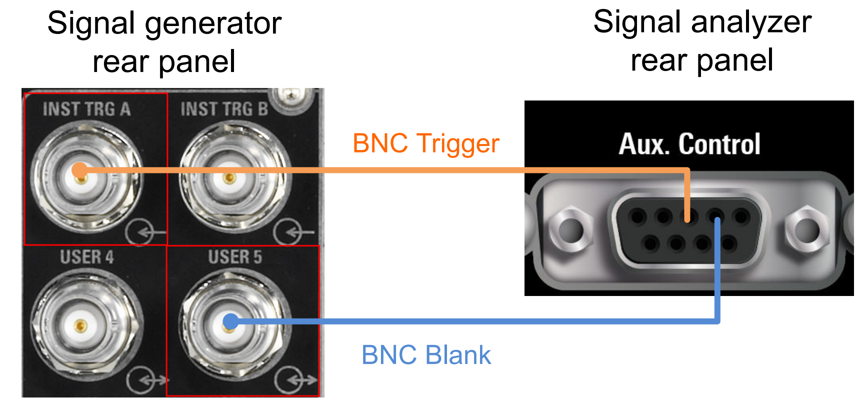


Figure 5-27: TTL connection for an R&S SMW generator

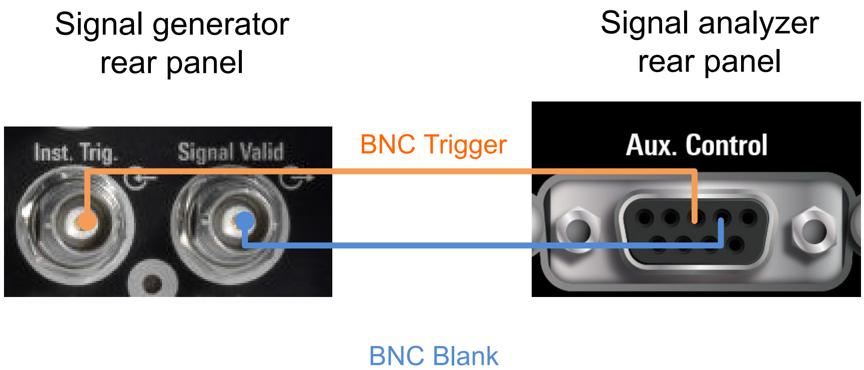


Figure 5-28: TTL connection for an R&S SMA100B generator

The external generator can be used to calibrate the data source by performing either transmission or reflection measurements.

Transmission Measurement

This measurement yields the transmission characteristics of a two-port network. The external generator is used as a signal source. It is connected to the input connector of the DUT. The input of the R&S FSW is fed from the output of the DUT. A calibration can be carried out to compensate for the effects of the test setup (e.g. frequency response of connecting cables).

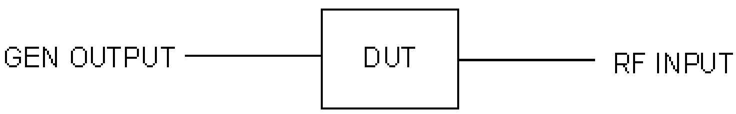


Figure 5-29: Test setup for transmission measurement

Reflection Measurement

Scalar reflection measurements can be carried out using a reflection-coefficient measurement bridge.

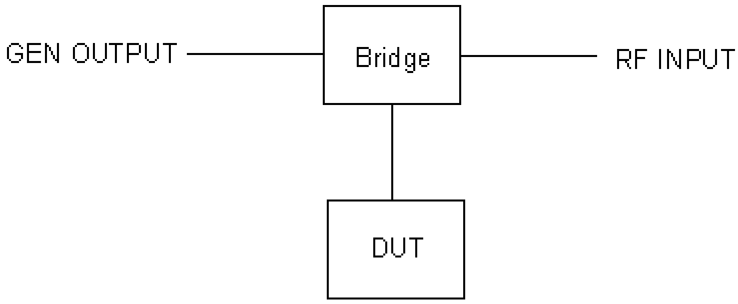


Figure 5-30: Test setup for reflection measurement

Generated signal input

In order to use the functions of the external generator, an appropriate generator must be connected and configured correctly. In particular, the generator output must be connected to the RF input of the R&S FSW.

External reference frequency

In order to enhance measurement accuracy, a common reference frequency should be used for both the R&S FSW and the generator. If no independent 10 MHz reference frequency is available, it is recommended that you connect the reference output of the generator with the reference input of the R&S FSW and that you enable usage of the external reference on the R&S FSW via "SETUP" > "Reference" > "External Reference".

For more information on external references see the "Instrument Setup" section in the R&S FSW User Manual.

Connection errors

If no external generator is connected, if the connection address is not correct, or the generator is not ready for operation, an error message is displayed (e.g."Ext. Generator TCPIP Handshake Error!", see Chapter 5.7.8, "Displayed Information and Errors", on page 83).

5.7.2 Overview of Supported Generators

Generator type	Model	Driver file	TTL support	Generator type	Model	Driver file	TTL support
SGS100A	6 GHz	SGS100A6	-	SMJ	3 GHz	SMJ03	X
	12 GHz	SGS100A12	-		6 GHz	SMJ06	X
SGT100A	3 GHz	SGT100A3	-	SML	1 GHz	SML01	-

1) Requires firmware version V2.10.x or later on the signal generator

2) Requires firmware version V1.10.x or later on the signal generator

3) Requires the option SMR-B11 on the signal generator

4) Requires firmware version V3.20.200 or later on the signal generator

Generator type	Model	Driver file	TTL support	Generator type	Model	Driver file	TTL support
	6 GHz	SGT100A6	-		2 GHz	SML02	-
SMA01A	3 GHz	SMA01A [1]	X		3 GHz	SML03	-
SMA100A	3 GHz	SMA100A3	X	SMP	2 GHz	SMP02	X
	6 GHz	SMA100A6	X		3 GHz	SMP03	X
SMA100B	3 GHz	SMA100B3	X		4 GHz	SMP04	X
	6 GHz	SMA100B6	X		22 GHz	SMP22	X
	12 GHz	SMA100B12	X	SMR	20 GHz	SMR20	-
	20 GHz	SMA100B20	X		20 GHz	SMR20B11 [3]	X
	32 GHz	SMA100B32	X		27 GHz	SMR27	X
	40 GHz	SMA100B40	X		27 GHz	SMR27B11 [3]	X
	50 GHz	SMA100B50	X		30 GHz	SMR30	X
	67 GHz	SMA100B67	X		30 GHz	SMR30B11 [3]	X
SMB100A	1 GHz	SMB100A1	X		40 GHz	SMR40	X
	12 GHz	SMB100A12	X		40 GHz	SMR40B11 [3]	X
	2 GHz	SMB100A2	X		50 GHz	SMR50	X
	20 GHz	SMB100A20	X		50 GHz	SMR50B11 [3]	X
	3 GHz	SMB100A3	X		60 GHz	SMR60	X
	40 GHz	SMB100A40	X		60 GHz	SMR60B11 [3]	X
SMB100B	1 GHz	SMB100B1	X	SMT	2 GHz	SMT02	-
	3 GHz	SMB100B3	X		3 GHz	SMT03	-
	6 GHz	SMB100B6	X		6 GHz	SMT06	-
SMBV100A	3 GHz	SMBV100A3	X	SMU	2 GHz	SMU02	X
	6 GHz	SMBV100A6	X		2 GHz	SMU02B31 [2]	X
SMBV100B	3 GHz	SMBV100B3	X		3 GHz	SMU03 [2]	X
	6 GHz	SMBV100B6	X		3 GHz	SMU03B31 [2]	X
SMC100A	1 GHz	SMC100A1	-		4 GHz	SMU04 [2]	X
	3 GHz	SMC100A3	-		4 GHz	SMU04B31 [2]	X
SMCV100B	3 GHz	SMCV100B3	-		6 GHz	SMU06 [2]	X
	6 GHz	SMCV100B6	-		6 GHz	SMU06B31 [2]	X

1) Requires firmware version V2.10.x or later on the signal generator
2) Requires firmware version V1.10.x or later on the signal generator
3) Requires the option SMR-B11 on the signal generator
4) Requires firmware version V3.20.200 or later on the signal generator

Generator type	Model	Driver file	TTL support		Generator type	Model	Driver file	TTL support
	7 GHz	SMCV100B7	-		SMV	3 GHz	SMV03	-
SME	2 GHz	SME02	X		SMW	3 GHz	SMW03	X 4)
	3 GHz	SME03	X			6 GHz	SMW06	X 4)
	6 GHz	SME06	X			12.75 GHz	SMW12	X 4)
SMF100A	43.5 GHz	SMF100A	X			20 GHz	SMW20	X 4)
SMF	22 GHz	SMF22	X			31.8 GHz	SMW31	X 4)
	22 GHz	SMF22B2	X			40 GHz	SMW40	X 4)
	43 GHz	SMF43	X			44 GHz	SMW44	X
	43 GHz	SMF43B2	X		SMX	all	SMX	-
SMG	all	SMG	-		SMY	1 GHz	SMY01	-
SMGL	all	SMGL	-			2 GHz	SMY02	-
SMGU	all	SMGU	-					
SMH	all	SMH	-					
SMHU		SMHU	-					
SMIQ	2 GHz	SMIQ02	X					
	2 GHz	SMIQ02B	X					
	2 GHz	SMIQ02E	-					
	3 GHz	SMIQ03	X					
	3 GHz	SMIQ03B	X					
	3 GHz	SMIQ03E	-					
	4 GHz	SMIQ04B	X					
	6 GHz	SMIQ06B	X					

1) Requires firmware version V2.10.x or later on the signal generator

2) Requires firmware version V1.10.x or later on the signal generator

3) Requires the option SMR-B11 on the signal generator

4) Requires firmware version V3.20.200 or later on the signal generator

5.7.3 Generator Setup Files

For each signal generator type to be controlled by the R&S FSW a generator setup file must be configured and stored on the R&S FSW. The setup file defines the frequency and power ranges supported by the generator, as well as information required for communication. For the signal generators listed in Chapter 5.7.2, "Overview of Supported Generators", on page 75, default setup files are provided. If necessary, these files can be edited or duplicated for varying measurement setups or other instruments.

The existing setup files can be displayed in an editor in read-only mode directly from the "External Generator" configuration dialog box. From there, they can be edited and stored under a different name, and are then available on the R&S FSW.

(For details see the R&S FSW User Manual).

5.7.4 Calibration Mechanism

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer. Therefore, it is useful to measure the attenuation or gain caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known level offsets can then be removed from the measurement results in order to obtain accurate information on the DUT.

Calculating the difference between the currently measured power and a reference trace is referred to as *calibration*. Thus, the measurement results from the controlled external generator - including the inherent distortions - can be used as a reference trace to calibrate the measurement setup.

The inherent frequency and power level distortions can be determined by connecting the R&S FSW to the signal generator. The R&S FSW sends a predefined list of frequencies to the signal generator (see also Chapter 5.7.7, "Coupling the Frequencies", on page 81). The signal generator then sends a signal with the specified level at each frequency in the predefined list. The R&S FSW measures the signal and determines the level offsets to the expected values.

Saving calibration results

A reference dataset for the calibration results is stored internally as a table of value pairs (frequency/level), one for each sweep point. The measured offsets can then be used as calibration factors for subsequent measurement results. The calibration data can also be stored permanently with the instrument settings using the "Save" function in the toolbar.

The calibration can be performed using either transmission or reflection measurements. The selected type of measurement used to determine the reference trace is included in the reference dataset.

5.7.5 Normalization

Once the measurement setup has been calibrated and the reference trace is available, subsequent measurement results can be corrected according to the calibration factors, if necessary. This is done by subtracting the reference trace from the measurement results. This process is referred to as *normalization* and can be activated or deactivated as required. If normalization is activated, "NOR" is displayed in the channel bar, next to the indication that an external generator is being used ("Ext.Gen").The normalized trace from the calibration sweep is a constant 0 dB line, as <calibration trace> - <reference trace> = 0.

As long as the same settings are used for measurement as for calibration, the normalized measurement results should not contain any inherent frequency or power distortions. Thus, the measured DUT values are very accurate.

Approximate normalization

As soon as any of the calibration measurement settings are changed, the stored reference trace will no longer be identical to the new measurement results. However, if the measurement settings do not deviate too much, the measurement results can still be normalized *approximately* using the stored reference trace. This is indicated by the "APX" label in the channel bar (instead of "NOR").

This is the case if one or more of the following values deviate from the calibration settings:

- Coupling (RBW, VBW, SWT)
- Reference level, RF attenuation
- Start or stop frequency
- Output level of external generator
- Detector (max. peak, min. peak, sample, etc.)
- Frequency deviation at a maximum of 1001 points within the set sweep limits (corresponds to a doubling of the span)

Differences in level settings between the reference trace and the current instrument settings are taken into account automatically. If the span is reduced, a linear interpolation of the intermediate values is applied. If the span increases, the values at the left or right border of the reference dataset are extrapolated to the current start or stop frequency, i.e. the reference dataset is extended by constant values.

Thus, the instrument settings can be changed in a wide area without giving up normalization. This reduces the necessity to carry out a new normalization to a minimum.

The normalized trace in the display

The normalized reference trace is also displayed in the spectrum diagram, by default at the top of the diagram (= 100% of the window height). It is indicated by a red line labeled "NOR", followed by the current reference value. However, it can be shifted vertically to reflect an attenuation or gain caused by the measured DUT (see also "Shifting the reference line (and normalized trace)" on page 80).

Restoring the calibration settings

If the measurement settings no longer match the instrument settings with which the calibration was performed (indicated by the "APX" or no label next to "Ext.TG" in the channel bar), you can restore the calibration settings, which are stored with the reference dataset on the R&S FSW.

Storing the normalized reference trace as a transducer factor

The (inverse) normalized reference trace can also be stored as a *transducer factor* for use in other R&S FSW applications that do not support external generator control. The normalized trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under `c:\r_s\instr\trd`. The frequency points are allocated in equidistant steps between the start and stop frequency.

This is useful, for example, to determine the effects of a particular device component and then remove these effects from a subsequent measurement which includes this component.

For an example see the "External Generator Control: Measurement Examples" section in the R&S FSW User Manual.

Note that the *normalized* measurement data is stored, not the original *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor will be 0 dB for the entire span (by definition of the normalized trace).

5.7.6 Reference Trace, Reference Line and Reference Level

Reference trace

The calibration results are stored internally on the R&S FSW as a *reference trace*. For each measured sweep point the offset to the expected values is determined. If normalization is activated, the offsets in the reference trace are removed from the current measurement results to compensate for the inherent distortions.

Reference line

The reference line is defined by the Reference Value and Reference Position in the "External Generator" > "Source Calibration" settings. It is similar to the Reference Level defined in the "Amplitude" settings. However, as opposed to the reference *level*, this reference *line* only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The reference line determines the range and the scaling of the y-axis, just as the reference level does.

The normalized reference trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. By default, the reference line is displayed at the top of the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Shifting the reference line (and normalized trace)

You can shift the reference line - and thus the normalized trace - in the result display by changing the Reference Position or the Reference Value .

If the DUT inserts a gain or an attenuation in the measurement, this effect can be reflected in the result display on the R&S FSW. To reflect a power offset in the measurement trace, change the Reference Value .

5.7.7 Coupling the Frequencies

As described in Chapter 5.7.5, "Normalization", on page 78, normalized measurement results are very accurate *as long as the same settings are used as for calibration*. Although approximate normalization is possible, it is important to consider the required frequencies for calibration in advance. The frequencies and levels supported by the connected signal generator are provided for reference with the interface configuration.

Two different methods are available to define the frequencies for calibration, that is to couple the frequencies of the R&S FSW with those of the signal generator:

- **Manual coupling**: a single frequency is defined
- **Automatic coupling**: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSW; the RF frequency range covers the currently defined span of the R&S FSW (unless limited by the range of the signal generator)

Automatic coupling

If automatic coupling is used, the output frequency of the generator (source frequency) is calculated as follows:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

Equation 5-1: Output frequency of the generator

Where:

$F_{Generator}$ = output frequency of the generator

$F_{Analyzer}$ = current frequency at the RF input of the R&S FSW

Numerator = multiplication factor for $F_{Analyzer}$

Denominator = division factor for $F_{Analyzer}$

F_{Offset} = frequency offset for $F_{Analyzer}$, for example for frequency-converting measurements or harmonics measurements

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets other than 0 Hz are indicated by the "FRQ" label in the channel bar (see also Chapter 5.7.8, "Displayed Information and Errors", on page 83).

Swept frequency range

The $F_{Analyzer}$ values for the calibration sweep start with the start frequency and end with the stop frequency defined in the "Frequency" settings of the R&S FSW. The resulting output frequencies (Result Frequency Start and Result Frequency Stop) are displayed in "External Generator" > "Measurement Configuration" for reference.

If the resulting frequency range exceeds the allowed ranges of the signal generator, an error message is displayed (see Chapter 5.7.8, "Displayed Information and Errors", on page 83) and the Result Frequency Start and Result Frequency Stop values are corrected to comply with the range limits.

The calibration sweep nevertheless covers the entire span defined by the R&S FSW; however, no input is received from the generator outside the generator's defined limits.

TTL synchronization

Some Rohde & Schwarz signal generators support TTL synchronization when connected via GPIB. The TTL interface is included in the AUX control connector of the External Generator Control option.

When pure GPIB connections are used between the R&S FSW and the signal generator, the R&S FSW sets the generator frequency for each frequency point individually via GPIB, and only when the setting procedure is finished, the R&S FSW can measure the next sweep point.

For generators with a TTL interface, the R&S FSW sends a list of the frequencies to be set to the generator before the beginning of the first sweep. Then the R&S FSW starts the sweep and the next frequency point is selected by both the R&S FSW and the generator using the TTL handshake line "TRIGGER". The R&S FSW can only measure a value when the generator signals the end of the setting procedure via the "BLANK" signal.

Using the TTL interface allows for considerably higher measurement rates, because the frequency stepping of the R&S FSW is directly coupled with the frequency stepping of the generator.

Reverse sweep

The frequency offset for automatic coupling can be used to sweep in the reverse direction. To do so, define a negative offset in the external generator measurement configuration. (Note that the frequency is defined as the unsigned value of the equation, thus a negative frequency is not possible.)

Example: Example for reverse sweep

$F_{AnalyzerStart}$= 100 MHz

$F_{AnalyzerStop}$ = 200 MHz

F_{Offset} = -300 MHz

Numerator = Denominator = 1

$\rightarrow F_{GeneratorStart}$ = 200 MHz

$\rightarrow F_{GeneratorStop}$ = 100 MHz

If the offset is adjusted so that the sweep of the generator crosses the minimum generator frequency, a message is displayed in the status bar ("Reverse Sweep via min. Ext. Generator Frequency!").

Example: Example for reverse sweep via minimum frequency

$F_{AnalyzerStart}$= 100 MHz

$F_{AnalyzerStop}$ = 200 MHz

F_{Offset} = -150 MHz

F_{min} = 20 MHz

Numerator = Denominator = 1

→$F_{GeneratorStart}$ = 50 MHz

→$F_{GeneratorStop}$ = 50 MHz via F_{min}

5.7.8 Displayed Information and Errors

Channel bar

If external generator control is active, some additional information is displayed in the channel bar.

Label	Description
EXT TG: <source power>	External generator active; signal sent with <source power> level
LVL	Power Offset (see " Source Offset " on page 146
FRQ	Frequency Offset (see "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 147
NOR	Normalization on; No difference between reference setting and measurement
APX (approximation)	Normalization on; Deviation from the reference setting occurs
-	Aborted normalization or no calibration performed yet

Error and status messages

The following status and error messages may occur during external generator control.

Message	Description
"Ext. Generator GPIB Handshake Error!" / "Ext. Generator TCPIP Handshake Error!" / "Ext. Generator TTL Handshake Error!"	Connection to the generator is not possible, e.g. due to a cable damage or loose connection or wrong address.
"Ext. Generator Limits Exceeded!"	The allowed frequency or power ranges for the generator were exceeded.
"Reverse Sweep via min. Ext. Generator Frequency!"	Reverse sweep is performed; frequencies are reduced to the minimum frequency, then increased again; see "Reverse sweep" on page 82
"Ext. Generator File Syntax Error!"	Syntax error in the generator setup file (see Chapter 5.7.3, "Generator Setup Files", on page 77

Message	Description
"Ext. Generator Command Error!"	Missing or wrong command in the generator setup file (see Chapter 5.7.3, "Generator Setup Files", on page 77
"Ext. Generator Visa Error!"	Error with Visa driver provided with installation (very unlikely)

NOTICE

Overloading

At a reference level of -10 dBm and at an external generator output level of the same value, the R&S FSW operates without overrange reserve. That means the R&S FSW is in danger of being overloaded if a signal is applied whose amplitude is higher than the reference line. In this case, either the message "RF OVLD" for overload or "OVLD" for exceeded display range (clipping of the trace at the upper diagram border = overrange) is displayed in the status line.

Overloading can be avoided as follows:

- Reducing the output level of the external generator (" Source Power " on page 146 in "External Generator > Measurement Configuration")
- Increasing the reference level (Reference Level in the "Amplitude" menu)

5.8 Basics on Input from I/Q Data Files

The I/Q data to be evaluated in a particular R&S FSW application can not only be captured by the application itself, it can also be loaded from a file, provided it has the correct format. The file is then used as the input source for the application.

For example, you can capture I/Q data using the I/Q Analyzer application, store it to a file, and then analyze the signal parameters for that data later using the Pulse application (if available).

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

(See Table D-1)

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

As opposed to importing data from an I/Q data file using the import functions provided by some R&S FSW applications, the data is not only stored temporarily in the capture buffer, where it overwrites the current measurement data and is in turn overwritten by a new measurement. Instead, the stored I/Q data remains available as input for any number of subsequent measurements. Furthermore, the (temporary) data import requires the current measurement settings in the current application to match the settings that were applied when the measurement results were stored (possibly in a different application). When the data is used as an input source, however, the data acquisition settings in the current application (attenuation, center frequency, measurement bandwidth, sample rate) can be ignored. As a result, these settings cannot be changed in the current application. Only the measurement time can be decreased, in order to perform measurements on an extract of the available data (from the beginning of the file) only.

For input files that contain multiple data streams from different channels, you can define which data stream to be used for the currently selected channel in the input settings.

You can define whether the data stream is used only once, or repeatedly, to create a larger amount of input data.

When using input from an I/Q data file, the [RUN SINGLE] function starts a single measurement (i.e. analysis) of the stored I/Q data, while the [RUN CONT] function repeatedly analyzes the same data from the file.

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.

Furthermore, you can create your own `iq.tar` files in the I/Q Analyzer, see Chapter 8.4, "How to Export and Import I/Q Data", on page 255.

Pre-trigger and post-trigger samples

In applications that use pre-triggers or post-triggers, if no pre-trigger or post-trigger samples are specified in the I/Q data file, or too few trigger samples are provided to satisfy the requirements of the application, the missing pre- or post-trigger values are filled up with zeros. Superfluous samples in the file are dropped, if necessary. For pre-trigger samples, values are filled up or omitted at the beginning of the capture buffer, for post-trigger samples, values are filled up or omitted at the end of the capture buffer.

5.9 Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)

Some background knowledge on basic terms and principles used by the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is provided here for a better understanding of the required configuration settings.

Additional information

An application note discussing wideband mm-wave signal analysis using the R&S FSW-B2000 option is available from the Rohde & Schwarz website:

1MA257: Wideband mm-Wave Signal Generation and Analysis

5.9.1 Basic Principle of the B2000

The optional 2 GHz bandwidth extension (R&S FSW-B2000) allows you to analyze signals with a bandwidth of up to 2 GHz. In order to process the data with this bandwidth, a Rohde & Schwarz oscilloscope (e.g. R&S RTO) is inserted in the measurement setup. The R&S FSW provides the signal to the oscilloscope at a fixed IF frequency of 2 GHz via the additional connector. The oscilloscope samples the signal at a configurable rate of 10 Gigasamples or 20 Gigasamples, using an external frequency reference. The A/D converted data is then sent to the R&S FSW, where it is equalized and resampled to the sample rate required by the R&S FSW measurement application. The entire measurement and both instruments are controlled by the R&S FSW.

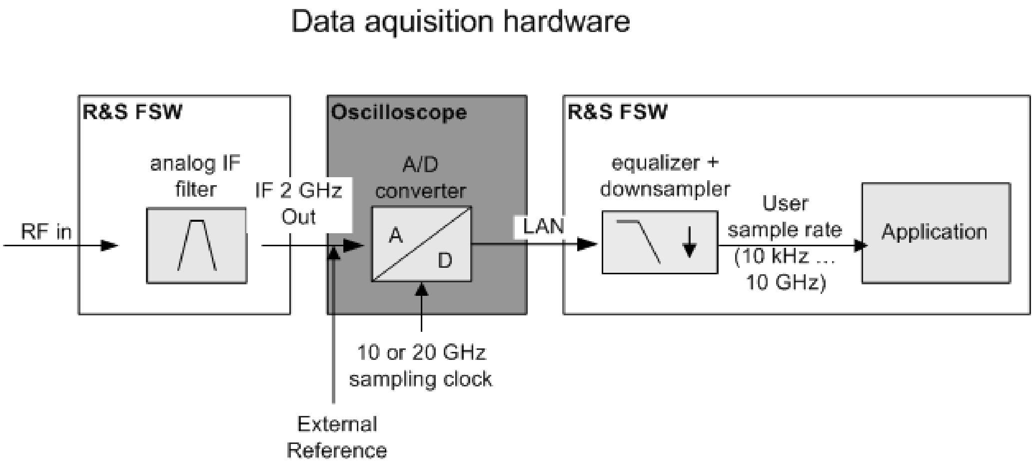


Figure 5-31: Signal processing using the optional 2 GHz bandwidth extension (R&S FSW-B2000)

The RF input signal to the R&S FSW may also be provided from an imported I/Q data file. The data evaluated by the R&S FSW with the 2 GHz / 5 GHz bandwidth extension can also be exported for further processing in another application.

For details see Chapter 5.13, "I/Q Data Import and Export", on page 100.

5.9.2 Basic Principle of the B5000

The optional 5 GHz bandwidth extension (R&S FSW-B5000) allows you to analyze signals with a bandwidth of up to 5 GHz. In order to process the data with this bandwidth, a Rohde & Schwarz oscilloscope (e.g. R&S RTO) is inserted in the measurement setup. The R&S FSW provides the signal to the oscilloscope at a fixed IF frequency via the additional IF OUT 5 GHz connector. Which IF frequency the data is output at depends on the analysis bandwidth.

Analysis bandwidth	**IF frequency**
≤4.4 GHz	2.8 GHz
>4.4 GHz	3.5 GHz

When using the "2ND IF" function to output IF data (see Data Output), the B5000 option outputs the measured IF value at a fixed frequency of 2 GHz.

The oscilloscope samples the signal at a rate of 20 Gigasamples, using an external frequency reference. The A/D converted data is then sent to the R&S FSW, where it is equalized and resampled to the sample rate required by the R&S FSW measurement application. The entire measurement and both instruments are controlled by the R&S FSW.

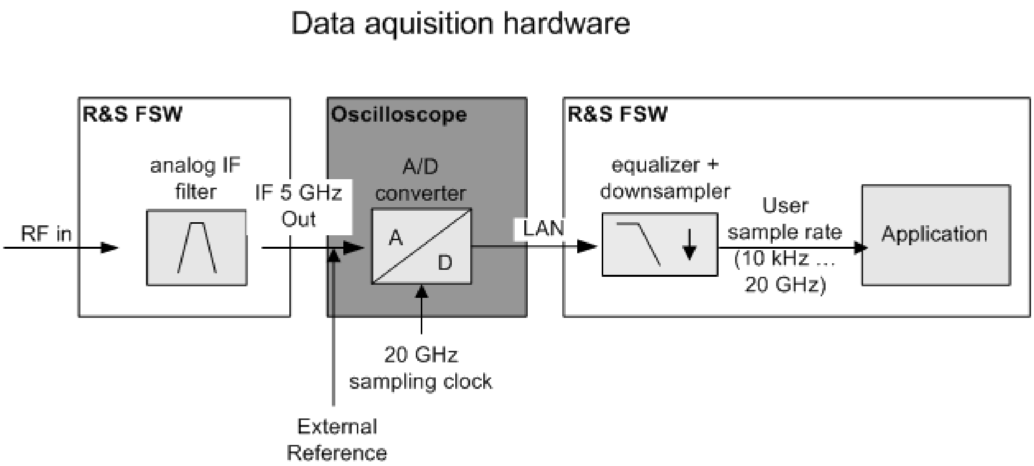


Figure 5-32: Signal processing using the optional 5 GHz bandwidth extension (R&S FSW-B5000)

5.9.3 Prerequisites and Measurement Setup

Use of the 2 GHz / 5 GHz bandwidth extension option is only available if the following prerequisites apply:

For R&S FSW-B2000:

- R&S FSW model with at least 26 GHz
- The R&S FSW-B2000 option and the IF OUT 2 GHz connector installed on the R&S FSW
- A supported Rohde & Schwarz oscilloscope (see data sheet) with:
  - Sampling rate: 10 GHz or higher
  - Bandwidth: 4 GHz or more
  - The external reference option (B4)
  - A firmware version 2.45.1.1 or higher
- The connector of the R&S FSW is connected to the CH1 input of the oscilloscope
- An external reference (for example the REF OUTPUT 10 MHz connector of the R&S FSW or a reference from a signal generator) is connected to the REF IN connector of the oscilloscope
- The oscilloscope is connected to the R&S FSW via LAN, and the oscilloscope's address is made known to the R&S FSW
- Optionally, a trigger signal (for example from the TRIG OUT connector of the R&S FSW) can be connected to the CH3 input connector of the oscilloscope

For R&S FSW-B5000:

- R&S FSW85
- The R&S FSW-B5000 option and the IF OUT 5 GHz connector installed on the R&S FSW
- A supported Rohde & Schwarz oscilloscope (see data sheet) with:
  - Sampling rate: 20 GHz or higher
  - Bandwidth: 6 GHz or more
  - The external reference option (B4)
  - A firmware version 3.50 or higher
- The connector of the R&S FSW is connected to the CH1 input of the oscilloscope
- An external reference (for example the REF OUTPUT 10 MHz connector of the R&S FSW or a reference from a signal generator) is connected to the REF IN connector of the oscilloscope
- The oscilloscope is connected to the R&S FSW via LAN, and the oscilloscope's address is made known to the R&S FSW
- Optionally, a trigger signal (for example from the TRIG OUT connector of the R&S FSW) can be connected to the CH3 input connector of the oscilloscope

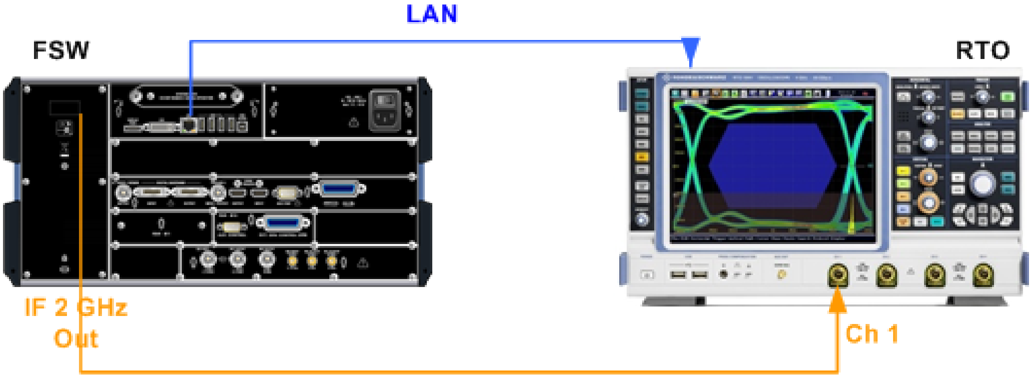


Figure 5-33: Measurement setup using the R&S FSW and an R&S RTO

Prerequisites for power splitter mode

When using the power splitter mode, other (additional) prerequisites and setup conditions apply, see Chapter 5.9.8, "Power Splitter Mode", on page 93.

5.9.4 Controlling the Oscilloscope

The entire measurement via the IF OUT 2 GHz/ IF OUT 5 GHz connector and an oscilloscope, as well as both instruments, are controlled by the R&S FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the R&S FSW.

For tips on how to determine the oscilloscope's computer name or IP address see Chapter 8.3, "How to Configure Data Acquisition via the Optional 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)", on page 249.

As soon as the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is activated (see "B2000/B5000 State" on page 151), the R&S FSW takes control of the oscilloscope. The display on the oscilloscope is turned off to improve performance during data export. As soon as the R&S FSW closes the connection to the oscilloscope, the display is reactivated and the oscilloscope can be operated as usual. However, if the LAN connection is lost for any reason, the display of the oscilloscope remains deactivated. Restart the oscilloscope to reactivate the display.

Alternatively, re-establish the connection and then close it properly, or use the remote command to re-activate the display (see `EXPort:WAVeform:DISPlayoff` on page 346).

5.9.5 Alignment

An initial alignment of the output to the oscilloscope and the oscilloscope itself is required once after setup. The alignment data is stored on the oscilloscope.

Thus, alignment need only be repeated if one of the following applies:

- A new oscilloscope is connected to the IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW
- A new cable is used between the IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW and the oscilloscope
- A power splitter is inserted between the IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW and the oscilloscope
- New firmware is installed on the oscilloscope or the R&S FSW

If the oscilloscope is detected to be uncalibrated, a self-alignment is performed on the oscilloscope before the actual B2000/B5000 alignment starts. In addition, it is useful to perform an alignment on the oscilloscope manually in the following cases:

- Major temperature changes occur (> 5 °C)
- The last alignment on the oscilloscope is significantly longer than 1 week ago

A self-alignment on the oscilloscope can be started directly from the R&S FSW, together with the B2000/B5000 alignment.

General alignment process

The alignment process between the R&S FSW and the oscilloscope is performed by selecting a button on the R&S FSW. Successful alignment of the oscilloscope and the oscilloscope ADC are indicated in a dialog box on the R&S FSW.

If alignment was performed successfully, the alignment data is stored on the oscilloscope, and the date it was performed is indicated in the dialog box on the R&S FSW.

If necessary, in particular after the firmware on the oscilloscope has been updated, a self-alignment is performed on the oscilloscope before the actual B2000/B5000 alignment starts. This may take a few minutes.

Alignment of the R&S FSW-B2000 option

Alignment of the R&S FSW-B2000 option consists of two steps. The first step requires a (temporary) connection from the REF OUTPUT 640 MHZ connector on the R&S FSW to the "CH1" input on the oscilloscope, in addition to the reference and trigger connections described above.

For the second alignment step, the connector must be disconnected from the REF OUTPUT 640 MHZ connector and instead connected to the FSW B2000 Alignment Signal Source input connector on the R&S FSW. Then the alignment process can be continued in the dialog box.

If both alignment steps were performed successfully, the alignment data is stored on the oscilloscope, and the date it was performed is indicated in the B2000 dialog box on the R&S FSW. For a description of possible errors see Table 9-5.

After alignment, the cable from the Alignment signal source input can be disconnected and instead connected to the IF OUT 2 GHz connector on the R&S FSW.

5.9.6 Data Acquisition

Once the B2000/B5000 option has been aligned and activated, the R&S FSW measurement applications can process I/Q data with a bandwidth of up to 2 GHz / 5 GHz, with a center frequency starting at 5.5 GHz, up to the maximum frequency supported by the instrument model (the useful range may be restricted, see data sheet). The record length may be restricted by the connected oscilloscope (see its data sheet).

The analysis bandwidth is defined in the data acquisition settings of the application as usual. Note that the maximum bandwidth cannot be restricted manually as for other bandwidth extension options.

Currently, the following applications support the **B2000** option:

- R&S FSW I/Q Analyzer
- R&S FSW VSA
- R&S FSW Analog Demodulation
- R&S FSW Pulse Measurements
- R&S FSW Amplifier Measurements
- R&S FSW Transient Measurements
- R&S FSW 802.11ad Measurements
- R&S®FS-K96 OFDM Vector Signal Analysis Software

Currently, the following applications support the **B5000** option:

- R&S FSW I/Q Analyzer
- R&S FSW Analog Demodulation

5.9.7 Triggering

Since the oscilloscope samples the data, triggering is also processed by the oscilloscope. The trigger source can be either the IF level or an external trigger, for example from the R&S FSW.

External trigger

The external trigger must be connected to the **Ch3** input on the oscilloscope.

In previous firmware versions, the external trigger was connected to the Ch2 input on the oscilloscope. As of firmware version R&S FSW 2.30, the **Ch3** input on the oscilloscope must be used!

All common trigger settings are available, except for a dropout time. In addition, the coupling to be used for external trigger input to the oscilloscope can be defined.

Data acquisition starts when the signal fed into the Ch3 input connector on the oscilloscope meets or exceeds the specified trigger level.

The length of the external trigger cable affects the trigger runtime. The R&S FSW assumes a cable the length of 1 m between the R&S FSW and the oscilloscope. Longer cables between the instruments must be compensated for by defining a Trigger Offset , if necessary.

Since the external trigger uses another channel on the oscilloscope, the maximum memory size, and thus record length, available for the input channel 1 may be reduced by half. For details see the oscilloscope's data sheet and documentation.

IF Power trigger

The IF power trigger is used to trigger on a current power level, which corresponds to the envelope of the voltage. However, Rohde & Schwarz oscilloscopes do not have power triggers or envelope triggers. Therefore, when using the B2000/B5000 option, the IF power trigger corresponds to a "width" trigger with a negative polarity and the range "longer" on the oscilloscope.

The width is specified by the Trigger Drop-out Time on the R&S FSW, with a default value of 1 µs.

Triggering on a falling edge for the IF Power trigger with the B2000/B5000 option is not allowed.

Thus, data acquisition starts when the power level at the signal fed into the Ch1 input connector on the oscilloscope rises above the specified trigger level after having been below this level for a duration longer than the drop-out time.

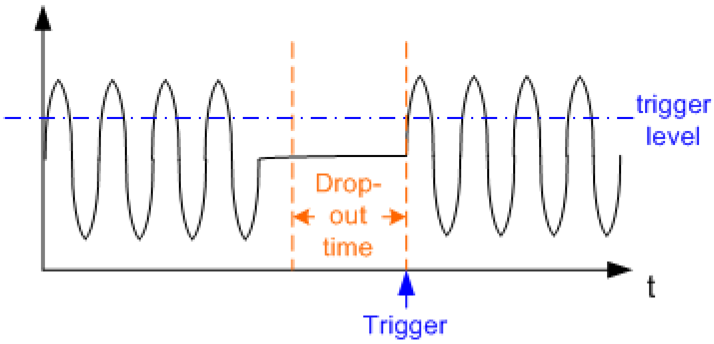


Figure 5-34: Trigger event for IF power trigger using B2000/B5000

A Hysteresis defined on the R&S FSW is used as the hysteresis for the width of the trigger on the oscilloscope. By default this value is 0. However, if a value other than 0 is defined, an undefined state of the trigger system might occur. Therefore, the "robust trigger" option is activated on the oscilloscope.

The "robust trigger" shifts the trigger thresholds for the falling edge and for the rising edge by the Hysteresis , resulting in different trigger levels. Thus, the trigger cannot "hang" inside the hysteresis, triggering is always ensured. The disadvantage of the robust trigger is a slight inaccuracy in the trigger measurements, because different trigger levels are used. For steep edges, the inaccuracy can be ignored.

For more details on the robust trigger functionality see the oscilloscope's documentation.

Trigger coupling

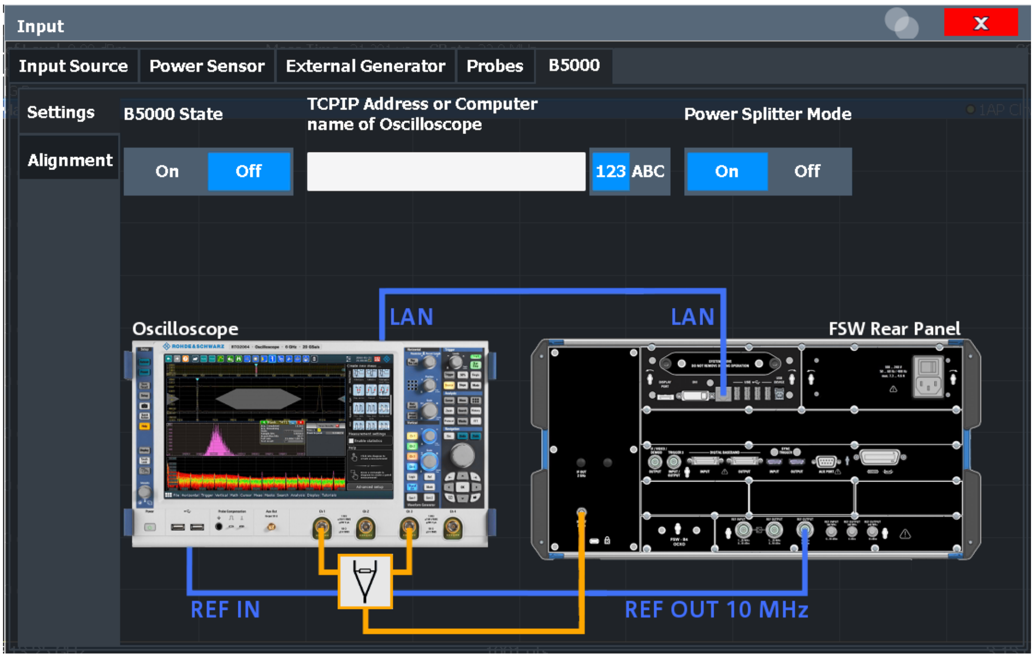
The coupling mode of the external trigger to the oscilloscope can be configured in the "Trigger" settings.

5.9.8 Power Splitter Mode

In the default measurement setup using the B2000/B5000 option, the IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW is connected to the Ch1 input of the oscilloscope (see Measurement setup using the R&S FSW and an R&S RTO). In some cases, splitting the output power of the R&S FSW and sending the input to two different channels of the oscilloscope simultaneously may improve the accuracy of EVM measurements. Thus, a new power splitter mode has been introduced.

A power splitter is provided with the B2000/B5000 option as of R&S FSW firmware version 2.60. For power splitter mode, it is inserted between the IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW and input channels **CH1** and **CH3** of the oscilloscope. In this case, both channels must be calibrated, which is done automatically during alignment. The alignment data is stored separately for common B2000/B5000 mode and power splitter mode. The indicated "Cal. Date" refers to the currently active mode. Thus, you need not re-align after you remove the power splitter again (unless that measurement setup was not yet aligned).

Power splitter mode is activated in the general B2000/B5000 settings (see Chapter 6.3.1.9, "Settings for 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/ B5000)", on page 151). For the user, the subsequent measurement process is identical to the common B2000/B5000 mode, except for the prerequisites and restrictions mentioned below. Internally, the two signals are processed to provide a single measurement result with an improved EVM.



External trigger

Since the **CH3** input of the oscilloscope is already in use in power splitter mode, an **external trigger** signal must be applied to the analog EXT TRIGGER INPUT connector on the rear panel of the oscilloscope. Use the "External Analog" trigger option in the trigger settings (see " Trigger Source " on page 175).

(Additional) Prerequisites and measurement setup for power splitter mode

In addition to the prerequisites and measurement setup described for the common B2000/B5000 mode (see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88), the following applies when using the power splitter mode:

- The IF OUT 2 GHz/ IF OUT 5 GHz connector of the R&S FSW is connected to the power splitter
- The power splitter is connected to the Ch1 and the Ch3 input of the oscilloscope
- Optionally, a trigger signal (for example from the TRIG OUT connector of the R&S FSW) can be connected to the EXT TRIGGER INPUT connector of the oscilloscope
- Since the power splitter mode uses two channels on the oscilloscope, the maximum memory size, and thus record length, available for a single input channel may be reduced by half. For details see the oscilloscope's data sheet and documentation.

5.9.9 Restrictions

If one of the 2 GHz / 5 GHz bandwidth extensions (R&S FSWB2000/B5000) is active, the following restrictions apply:

- Manual operation on the oscilloscope, or remote operation other than by the R&S FSW controlling the option, is not possible.
- MSRA mode is not available.
- The center frequency must lie between 5.5 GHz and the maximum frequency supported by the instrument model.
- The record length may be restricted by the number of samples provided by the oscilloscope (see its data sheet).
- Common IF, 2ND IF (via the IF OUT 2 GHz/ IF OUT 5 GHz connector), and video output are not available.
- IF power and external are the only supported trigger sources. For the external trigger, a drop-out time cannot be defined.
- When querying the trace data remotely, the I/Q data can only be transferred in interleaved format (I,Q,I,Q...), see `TRACe:IQ:DATA:FORMat` on page 471).
- The I/Q data cannot be stored using the `TRACe<n>[:DATA]:MEMory?` remote command.
- Y-axis scaling on the oscilloscope is limited to a minimum of 5mV per division.

- Special conversion loss tables for external mixers (in `.b2g` or `.b5g` files) cannot be edited within the R&S FSW firmware. (See also Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.)

5.10 Digital I/Q 40G Streaming Output

The Digital I/Q 40G Streaming Output option (R&S FSW-B517) provides raw, unprocessed I/Q data to the QSFP+ connector on the rear panel of the R&S FSW. Any supported device (see data sheet) can be connected to the R&S FSW to process the I/Q data further. Sample rates up to 600 MHz are available.

Currently, the following applications can provide Digital I/Q 40G streaming output:

- I/Q Analyzer (not MSRA mode)
- Analog Modulation Analysis (R&S FSW-K7)
- Vector Signal Analysis (R&S FSW-K70)
- Pulse measurements (R&S FSW-K6)
- Transient Analysis (R&S FSW-K60)

The QSFP+ connector is part of all bandwidth extension hardware options for 512 MHz or more. The connector can be covered by a metal plate.

See the description of connectors in the R&S FSW Getting Started manual.

The Digital Baseband Interface (R&S FSW-B17) is *NOT* required.

Providing digital output

The I/Q Analyzer application samples I/Q data and stores it in the I/Q memory. Simultaneously, it writes the data to the Digital I/Q 40G Streaming Output connector continuously. Output is enabled or disabled in the "Output" settings (see Chapter 6.3.4, "Digital I/Q 40G Output Settings", on page 161).

Digital I/Q output and transducer factors

Digital output provides raw I/Q data, without any transducer or user correction data applied.

Sample rate

The **sample rate** for the Digital I/Q 40G Streaming Output corresponds to the sample rate defined by the user. The valid sample rate range is from 100.1 MHz to 600 MHz. (Up to 100 MHz, the bandwidth extension hardware that provides the connector is not used.) The current sample rate is displayed in the "Digital I/Q 40G Output" dialog box (read-only) when the digital output is enabled (see "Output Settings Information" on page 162).

Reference level

The "Full Scale Level" defines the level that corresponds to an I/Q sample with the magnitude "1". For digital output, the full scale level corresponds to the defined reference level (without the reference level offset and transducer). Any values that exceed the magnitude "1" are cut off, causing a signal distortion. In this case, an error message is displayed in the status bar ("DIG IQ 40G OUT Overload"). Furthermore, the `IF Overload` bit (bit 2) in the `STATus:QUEStionable:POWer:CONDition` status register is set.

See the R&S FSW Base Software User Manual, Status Reporting System chapter.

Use the Setting the Reference Level Automatically (Auto Level) function to obtain the optimal reference level.

Trigger information

All input data is output regardless of any trigger event. Pretrigger settings (negative trigger offsets) are not available for I/Q output. However, trigger events from external and power triggers are indicated in the I/Q data output automatically and can be evaluated in other applications.

Note that in "Run Continuous" mode, during brief periods, some trigger events cannot be detected. To ensure that all eligible events are detected and marked as trigger events, use "Run Single" mode.

Also note that the recording device, such as the R&S IQW, can have a minimum allowed distance between individual trigger events. If trigger events occur in too rapid succession, individual events can be faulty or lost.

Marker information

You can insert marker information manually at any time. When you select a button, marker information is inserted in the running data stream. For example, if you identify a particular effect in a measurement result window, you can mark that position in the data stream. Then you can search for the marker information in the output data to analyze the effects at that time.

Interface Status Information

When an instrument is connected to the Digital I/Q 40G Streaming Output connector on the R&S FSW, the "Output" > "Digital I/Q 40G" dialog box provides information on the status of the connection (see " Connected Instrument " on page 162).

You can query the information in this dialog box using a remote command, see `OUTPut<up>:IQHS:CDEVice?` on page 355.

Status icons

If Digital I/Q 40G Streaming Output is enabled, the status of the connection is also indicated as icons in the status bar. The status icons have the following meaning:

Table 5-15: Status information for Digital I/Q 40G Streaming Output connections

Icon	Status
	Connection established
	• Connection error • No cable connected although "Digital I/Q 40G Streaming Out" state = "ON"
	"Digital I/Q 40G Streaming Out" state = "OFF"

5.11 IF and Video Signal Output

The measured IF signal or displayed video signal (i.e. the filtered and detected IF signal) can be provided at the IF/VIDEO/DEMOD or "IF OUT 2 GHz/ IF OUT 5 GHz " output connector.

The **IF output** is a signal of the measured level at a specified frequency.

The "2ND IF" output is a signal with a bandwidth of 2 GHz at the frequency 2 GHz. This output is only available if the "IF OUT 2 GHz/ IF OUT 5 GHz " output connector is installed. (The availability of this connector depends on the instrument model.)

If the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is active, the "IF OUT 2 GHz/ IF OUT 5 GHz " output connector is used to transfer the measured data from the R&S FSW to the connected oscilloscope. In this case, the "2ND IF" output is automatically deactivated. It is not reactivated when the B2000/B5000 option is switched off.

The frequency at which the active B5000 option transmits data to the oscilloscope via the "IF 5 GHz OUT" connector depends on the analysis bandwidth.

For details see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85.

Restrictions

Note the following restrictions for data output:

- IF and video output is only available in the time domain (zero span).
- For I/Q data, only IF output is available.
- IF output is not available if any of the following conditions apply:
  – The optional Digital Baseband Interface is active (for input or output)
  – MSRA operating mode is active
  – MSRT operating mode is active
  – A wideband extension is used (hardware options R&S FSWB160--B512; used automatically for bandwidths > 80 MHz; in this case select the "IF WIDE OUT"

output, which uses the "IF WIDE OUTPUT" connector; for bandwidths larger than 512 MHz, IF output is not available.)
A wideband extension is used (hardware options R&S FSWB160--B512; used automatically for bandwidths > 80 MHz; in this case select the "IF WIDE OUT" output, which uses the "IF WIDE OUTPUT" connector)

– The sample rate is larger than 200 MHz (upsampling)

IF WIDE OUTPUT

For bandwidths > 80 MHz, but less than 512 MHz, the IF output is provided at the **"IF WIDE OUTPUT"** connector.

For bandwidths larger than 512 MHz, IF output is not available.

In this case, the IF output frequency cannot be defined manually, but is determined automatically depending on the center frequency. The currently used output frequency is indicated in the "IF Wide Out Frequency" field of the "Output" dialog box. For details on the used frequencies see the data sheet.

2ND IF Output

For instrument models R&S FSW26/43/50/67/85, the IF output can also be provided at the optional "IF OUT 2 GHz" output connector at a frequency of 2 GHz and **with a bandwidth of 2 GHz**. The IF output can then be analyzed by a different instrument, for example an R&S®RTO oscilloscope.

For instrument model R&S FSW85, the IF output can also be provided at the optional "IF OUT 2 GHz" output connector at a frequency of 2 GHz and **with a bandwidth of 2 GHz**. The IF output can then be analyzed by a different instrument. However, consider the note on the 2 GHz / 5 GHz bandwidth extension option below.

If "2ND IF" output is activated, the measured values are no longer available on the display; thus, the trace data currently displayed on the R&S FSW becomes invalid. A message in the status bar indicates this situation. The message also indicates whether the sidebands of the IF spectrum output are in normal or inverted order compared to the RF signal, which depends on the used center frequency.

2 GHz / 5 GHz bandwidth extension option (R&S FSW-B2000/B5000)

To analyze IF data with a bandwidth of 2 GHz / 5 GHz using an R&S®RTO oscilloscope, it is recommended that you use the fully integrated solution including alignment with the **2 GHz / 5 GHz bandwidth extension option (R&S FSW-B2000/B5000)**, rather than the "2ND IF" output solution.

If the B2000/B5000 option is activated, the "2ND IF" output is automatically deactivated. It is not reactivated when the B2000/B5000 option is switched off.

For details see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85

Prerequisites

Note the following prerequisites for output to the **"IF OUT 2 GHz"** connector ("2ND IF"):

- Instrument model R&S FSW26/43/50/67/85; external mixers can be used
- Zero span mode, I/Q Analyzer, or optional application supporting B2000
(See Chapter 5.9.6, "Data Acquisition", on page 91)
- Center frequency ≥ 5.5 GHz
- Optional 2 GHz bandwidth extension (R&S FSW-B2000) is not active

Prerequisites for output to the **"IF OUT 2 GHz"** connector ("2ND IF"):

- Instrument model R&S FSW85; external mixers **cannot** be used
- Zero span mode, I/Q Analyzer, or Analog Demodulation (R&S FSW-K7) application
- Center frequency ≥ 5.5 GHz
- Optional 5 GHz bandwidth extension (R&S FSW-B5000) is not active

5.12 Receiving and Providing Trigger Signals

Using one of the "TRIGGER INPUT / OUTPUT" connectors of the R&S FSW, the R&S FSW can use a signal from an external device as a trigger to capture data. Alternatively, the internal trigger signal used by the R&S FSW can be output for use by other connected devices. Using the same trigger on several devices is useful to synchronize the transmitted and received signals within a measurement.

For details on the connectors see the R&S FSW "Getting Started" manual.

External trigger as input

If the trigger signal for the R&S FSW is provided by an external device, the trigger signal source must be connected to the R&S FSW and the trigger source must be defined as "External" in the R&S FSW.

External triggers with R&S FSW-B2000/B5000

When the input is provided from an R&S FSW with the B2000/B5000 option, the connected oscilloscope samples the data. Thus, triggering is also processed by the oscilloscope. The trigger source can be either the IF level or an external trigger, for example from the R&S FSW.

In this case, the trigger source must be defined as "External CH3" (or "External Analog" for power splitting mode) on the R&S FSW.

For details, see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85.

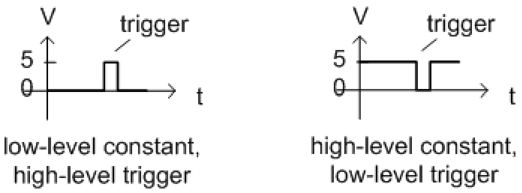
Trigger output

The R&S FSW can provide output to another device either to pass on the internal trigger signal, or to indicate that the R&S FSW itself is ready to trigger.

The trigger signal can be output by the R&S FSW automatically, or manually by the user. If it is provided automatically, a high signal is output when the R&S FSW has triggered due to a sweep start ("Device Triggered"), or when the R&S FSW is ready to receive a trigger signal after a sweep start ("Trigger Armed").

Manual triggering

If the trigger output signal is initiated manually, the length and level (high/low) of the trigger pulse is also user-definable. Note, however, that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level" = "High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is provided.



5.13 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.
  The I/Q analyzer supports various data formats for import, see Chapter D, "Reference: Supported I/Q File Formats", on page 504.
- Capturing and saving I/Q signals with the R&S FSW to analyze them with the R&S FSW or an external software tool later
  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. Multi-channel data is not supported.
  The data is stored as complex values in 32-bit floating-point format. The I/Q data is stored in a format with the file extension `.iq.tar`.

For example, you can capture I/Q data using the I/Q Analyzer application and then perform analog demodulation on that data using the R&S FSW AnalogDemodulation application, if available.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

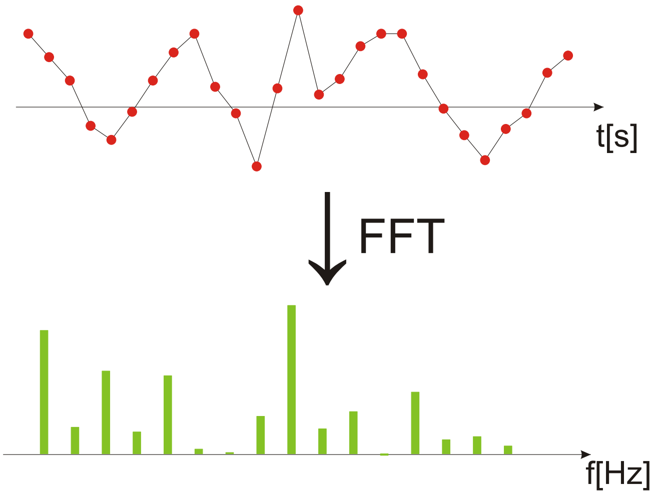
The import and export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar (see Chapter 6.2, "Import/Export Functions", on page 112).

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.

5.14 Basics on FFT

The I/Q Analyzer measures the power of the signal input over time. To convert the time domain signal to a frequency spectrum, an FFT (Fast Fourier Transformation) is performed which converts a vector of input values into a discrete spectrum of frequencies.



5.14.1 Window Functions

The Fourier transformation is not performed on the entire captured data in one step. Only a limited number of samples is used to calculate an individual result. This process is called windowing.

After sampling in the time domain, each window is multiplied with a specific window function. Windowing helps minimize the discontinuities at the end of the measured signal interval and thus reduces the effect of spectral leakage, increasing the frequency resolution.

Various different window functions are provided in the R&S FSW to suit different input signals. Each of the window functions has specific characteristics, including some advantages and some trade-offs. Consider these characteristics to find the optimum solution for the measurement task.

Ignoring the window function - rectangular window

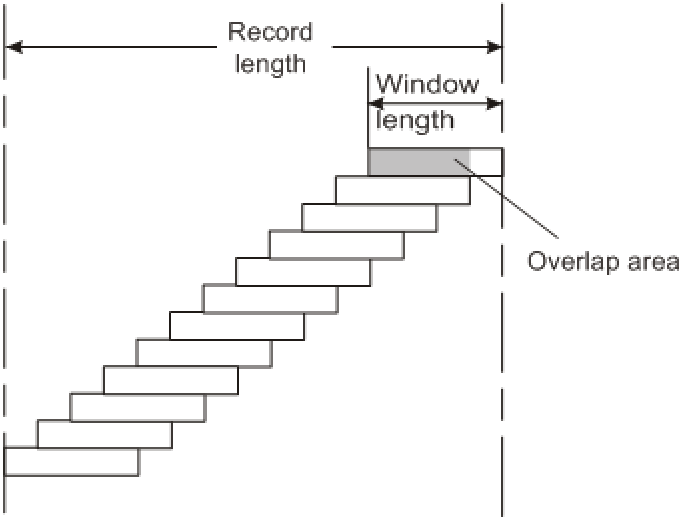
The rectangular window function is in effect not a function at all, it maintains the original sampled data. This may be useful to minimize the required bandwidth. However, be aware that if the window does not contain exactly one period of your signal, heavy sidelobes may occur, which do not exist in the original signal.

Table 5-16: Characteristics of typical FFT window functions

Window type	Frequency resolution	Magnitude resolution	Sidelobe suppression	Measurement recommendation
Rectangular	Best	Worst	Worst	No function applied. Separation of two tones with almost equal amplitudes and a small frequency distance
Blackman-Harris (default)	Good	Good	Good	Harmonic detection and spurious emission detection
Gauss (Alpha = 0.4)	Good	Good	Good	Weak signals and short duration
Flattop	Worst	Best	Good	Accurate single tone measurements
5-Term	Good	Good	Best	Measurements with very high dynamic range

5.14.2 Overlapping

The I/Q Analyzer calculates multiple FFTs per measurement by dividing one captured record into several windows. Furthermore, the I/Q Analyzer allows consecutive windows to overlap. Overlapping "reuses" samples that were already used to calculate the preceding FFT result.



In advanced FFT mode with averaging, the overlapping factor can be set freely. The higher the overlap factor, the more windows are used. This leads to more individual results and improves detection of transient signal effects. However, it also extends the duration of the calculation. The size of the window can be defined manually according to the record length, the overlap factor, and the FFT length.

An FFT overlap of 67%, for example, means the second FFT calculation uses the last 67% of the data of the first FFT. It uses only 33% new data. The third FFT still covers 33% of the first FFT and 67% of the second FFT, and so on.

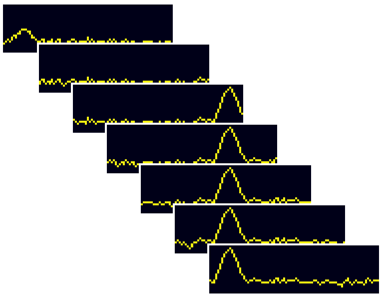


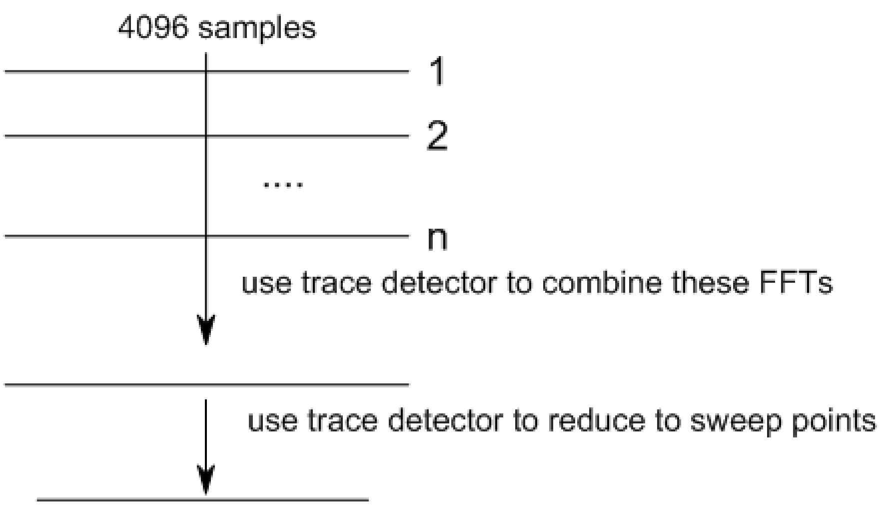
Figure 5-35: Overlapping FFTs

In "Manual" or "Auto" FFT mode, an FFT length of 4096 and a window length of 4096 (or the record length, if shorter) is used to calculate the spectrum.

Combining results - trace detector

If the record length permits, multiple overlapping windows are calculated and combined to create the final spectrum using the selected trace detector. If necessary, the trace detector is also used to reduce the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the Autopeak trace detector is used.

Since the frequency points are reduced to the number of sweep points, using a detector other than "Auto Peak" and fewer than 4096 sweep points can lead to false level results.



5.14.3 Dependencies Between FFT Parameters

FFT analysis in the R&S FSW is highly configurable. Several parameters, including the resolution bandwidth, record length, and FFT length, are user-definable. Note, however, that several parameters are correlated and not all can be configured independently of the others.

Record Length

Defines the number of I/Q samples to capture. By default, the number of sweep points is used. The record length is calculated as the measurement time multiplied by the sample rate.

If you change the record length, the Meas Time is automatically changed, as well.

For FFTs using only a single window ("Single" mode), the record length (which is then identical to the FFT length) must not exceed 512k.

FFT Length

Defines 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.

In "Auto" or "Manual" mode, an FFT length of 4096 is used.

In advanced FFT mode, the FFT length is user-definable. If you use the arrow keys or the rotary knob to change the FFT length, the value is incremented or decremented by powers of 2. If you enter the value manually, any integer value from 3 to 524288 is available.

If the FFT length is longer than the Window Length the sample data is filled up with zeros up to the FFT length. The FFT is then performed using interpolated frequency points.

For an FFT length that is not a power of 2, a DFT (discrete Fourier transform) is performed, which requires more time for calculation, but avoids the effects of interpolation.

To display all calculated frequency points (defined by the FFT length), the number of sweep points is set to the FFT length automatically in advanced FFT mode.

Window Length

Defines the number of samples to be included in a single window in averaging mode. (In single mode, the window length corresponds to the " Record Length " on page 187.)

Values from 3 to 4096 are available in "Manual" mode; in "Advanced" FFT mode, values from 3 to 524288 are available. However, the window length must not be longer than the FFT Length .

If the window length is shorter than the FFT Length , the sample data is filled up with zeros up to the FFT length.

If the window length is longer than the Record Length (that is, not enough samples are available), a window length the size of the Record Length is used for calculation.

The window length and the Window Overlap determine how many FFT calculations must be performed for each record in averaging mode (see " Transformation Algorithm " on page 189).

5.14.4 Frequency Resolution of FFT Results - RBW

The **resolution bandwidth** defines the minimum frequency separation at which the individual components of a spectrum can be distinguished. Small values result in high precision, as the distance between two distinguishable frequencies is small. Higher values decrease the precision, but increase measurement speed.

The RBW is determined by the following equation:

$$RBW = Normalized\,Bandwidth * \frac{Sample\ Rate}{Window\ Length}$$

Equation 5-2: Definition of RBW

(Note: The normalized bandwidth is a fixed value that takes the noise bandwidth of the window function into consideration.)

The maximum RBW is restricted by the Analysis Bandwidth , or by the following equation, whichever is higher:

$$RBW_{max} = \frac{Normalized\,Bandwidth * Sample\ Rate}{3}$$

If a higher spectral resolution is required, the number of samples must be increased by using a higher sample rate or longer record length.

The minimum achievable RBW depends on the sample rate and record length, according to the following equation:

$$RBW_{min} = \frac{Normalized\,Bandwidth * Sample\ Rate}{min(4096, Record\ Length)}$$

To simplify operation, some parameters are coupled and automatically calculated, such as record length and RBW.

RBW mode

Depending on the selected RBW mode, the resolution bandwidth is either determined automatically or can be defined manually.

Auto mode:

This is the default mode in the I/Q Analyzer. The RBW is determined automatically depending on the Sample Rate and Window Length , where the window length corresponds to the Record Length , or a maximum of 4096.

If the record length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

Manual mode:

The RBW is user-definable.

The Window Length is adapted to comply with Equation 5-2. Since only window lengths with integer values can be employed, the Sample Rate is adapted, if necessary, to obtain an integer window length value.

If the record length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

Advanced FFT mode

The RBW is determined by the advanced FFT parameters, depending on the selected FFT Calculation Methods method.

5.14.5 FFT Calculation Methods

FFT calculation can be performed using different methods.

Single

In single mode, one FFT is calculated for the entire record length, that means the window length is identical to the record length.

If the defined FFT Length is larger than the record length, zeros are appended to the captured data to reach the FFT length.

Figure 5-36: FFT parameters for single FFT calculation

Averaging

In averaging mode, several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record.

The number of FFTs to be combined is determined by the Window Overlap and the Window Length .

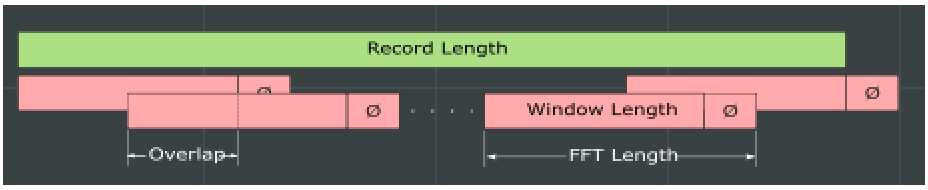


Figure 5-37: FFT parameters for averaged FFT calculation

5.15 I/Q Analyzer in MSRA/MSRT Operating Mode

The I/Q Analyzer can also be used in MSRA and MSRT operating mode. The MSRA Master channel is implemented as an I/Q Analyzer application. Only this channel captures data in MSRA mode. Thus, the functions and settings described for data acquisition in the I/Q Analyzer application also apply to the MSRA Master. Furthermore, the I/Q Analyzer can be used to analyze data in MSRA mode. Thus, the result displays and analysis functions provided by the I/Q Analyzer can also be used in MSRA mode.

In MSRT mode, the MSRT Master performs a real-time measurement to capture data.

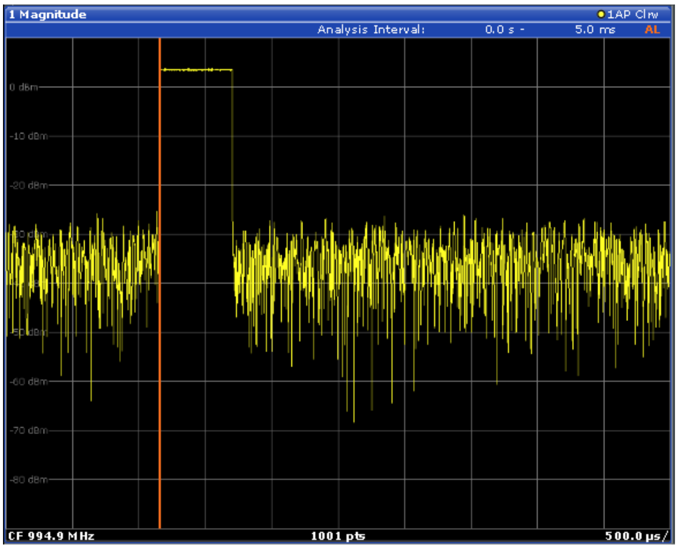
Note that the available functions and settings for the I/Q Analyzer in MSRA mode vary depending on whether the MSRA Master channel or an I/Q Analyzer application channel is selected. For example, data acquisition settings for an I/Q Analyzer **application** channel in MSRA mode configure the analysis interval, not an actual data capture from the input signal. And measurements in the time and frequency domain are only available in an I/Q Analyzer **application** channel in MSRA mode.

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 client applications. It can be positioned in any MSRA client application or the MSRA Master and is then adjusted in all other client applications. Thus, you can easily analyze the results at a specific time in the measurement in all client applications and determine correlations.

If the marked point in time is contained in the analysis interval of the client 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



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.

5.16 Measurements in the Time and Frequency Domain

The I/Q Analyzer client application (*not Master*) **in multistandard mode** can also perform measurements on the captured I/Q data in the time and frequency domain. In order to do so, the I/Q Analyzer performs an FFT sweep on the captured I/Q data, providing power vs frequency results, or uses the RBW filter to obtain power vs time (zero span) results. This data is then used for the common frequency or time domain measurements provided by the R&S FSW Spectrum application, such as ACLR, SEM or CCDF.

Configuration

Apart from the data capturing process, the measurements are identical in the Spectrum and I/Q Analyzer client applications. They are configured using the same settings and provide the same results. The "Magnitude" result display in the I/Q Analyzer, for instance, will principally show the same results as the zero span measurement for the same data. However, while the "Magnitude" evaluation is configured by the I/Q analysis bandwidth and the measurement time, the zero span measurement is configured by the center frequency, RBW and sweep time settings. Internally, these "time domain" settings are converted to the required I/Q settings by the I/Q Analyzer.

The time and frequency domain measurements and the required settings are described in detail in the R&S FSW User Manual.

Limitations

However, since the data in the I/Q Analyzer client application is captured by the Master, independently of the specific time or frequency measurement requirements concerning the RBW, filter type and number of sweep points in the client application, some restrictions may apply to these measurements in the I/Q Analyzer. If not enough samples are available in the captured and converted I/Q data, for example, an error message is displayed in the client application.

The **maximum span** for a frequency sweep on I/Q-based data corresponds to the maximum I/Q bandwidth (see Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24 and Chapter 5.2.3, "Sample Rates and Bandwidths for Digital I/Q Data", on page 45).

The **maximum resolution bandwidth (RBW)** is 1 MHz.

Furthermore, the following **functions** are not available for time and frequency domain measurements in multistandard mode:

- Marker demodulation
- Frequency counter marker
- Gated measurement
- Video trigger

6 Configuration

Access: [MODE] > "I/Q Analyzer"

The I/Q Analyzer is a special application on the R&S FSW.

When you switch to an I/Q Analyzer channel the first time, a set of parameters is passed on from the currently active application. After initial setup, the parameters for the 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 channel for the I/Q Analyzer application, data acquisition from the input signal is started automatically with the default configuration. The "I/Q Analyzer" menu is displayed and provides access to the most important configuration functions.

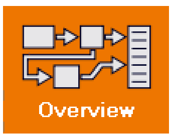
The remote commands required to perform these tasks are described in Chapter 10, "Remote Commands to Perform Measurements with I/Q Data", on page 261.

Importing and Exporting I/Q Data

The I/Q data to be evaluated in the I/Q Analyzer application can not only be captured by the I/Q Analyzer itself, it can also be imported to the R&S FSW, provided it has the correct format. Furthermore, the captured I/Q data from the I/Q Analyzer can be exported for further analysis in external applications.

For details see Chapter 5.13, "I/Q Data Import and Export", on page 100.

6.1 Configuration Overview



Access: all menus

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

Multiple access paths to functionality

The easiest way to configure a channel is via the "Overview" dialog box, which is available from all menus.

Alternatively, you can access the individual dialog boxes from the corresponding menu items, or via tools in the toolbars, if available.

In this documentation, only the most convenient method of accessing the dialog boxes is indicated - usually via the "Overview" .

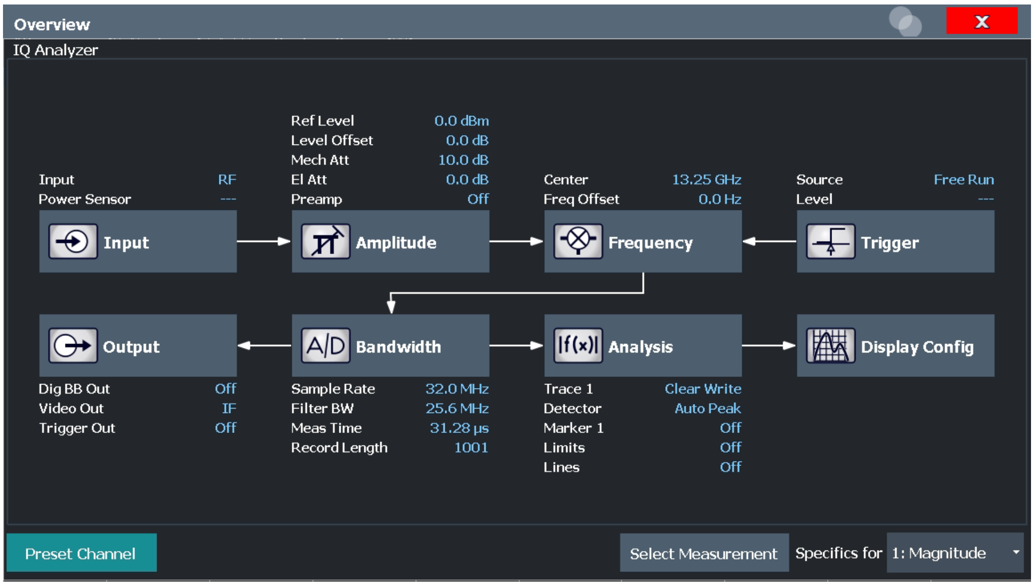


Figure 6-1: Configuration Overview for I/Q Analyzer Master

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 channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview" .

The "Overview" for the I/Q Analyzer provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Input settings
   See Chapter 6.3.1, "Input Source Settings", on page 116
2. Amplitude settings
   See Chapter 6.4, "Amplitude", on page 162
3. Frequency settings
   See Chapter 6.5, "Frequency Settings", on page 172
4. Optionally, Trigger/Gate settings
   See Chapter 6.6, "Trigger Settings", on page 174
5. Bandwidth settings

See Chapter 6.7, "Data Acquisition and Bandwidth Settings", on page 183

6. Optionally, output settings
See Chapter 6.3.2, "Output Settings", on page 157
7. Analysis settings and functions
See Chapter 7, "Analysis", on page 199
8. Display configuration
See Chapter 6.8, "Display Configuration", on page 194

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the channel tab) to change a specific setting.

For step-by-step instructions on configuring I/Q Analyzer measurements, see Chapter 8.1, "How to Perform Measurements in the I/Q Analyzer Application", on page 241.

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

Do not confuse the "Preset Channel" button with the [Preset] *key*, which restores the entire instrument to its default values and thus closes **all channels** on the R&S FSW (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 272

Specific Settings for
The 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 "Specific Settings 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.

6.2 Import/Export Functions

Access: "Save" / "Open" icon in the toolbar > "Import" / "Export"

The R&S FSW provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with further, external applications. In this case, you can export the measurement data to a standard format file (ASCII or XML). Some of the data stored in these formats can also be re-imported to the R&S FSW for further evaluation later, for example in other applications.

The following data types can be exported (depending on the application):

- Trace data
- Table results, such as result summaries, marker peak lists etc.
- I/Q data

I/Q data can only be imported and exported in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

See the corresponding user manuals for those applications for details.

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.

Import

Access: "Save/Recall" > Import

Provides functions to import data.

Importing I/Q data is not possible in MSRA operating mode.

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.

Input from I/Q data files is imported as it was stored, including any correction factors, for example from transducers or SnP files. Any currently configured correction factors at the time of import, however, are not applied.

Remote command:
`MMEMory:LOAD:IQ:STATe` on page 482

File Explorer ← I/Q Import ← Import

Opens the Microsoft Windows File Explorer.

Remote command:
not supported

Export

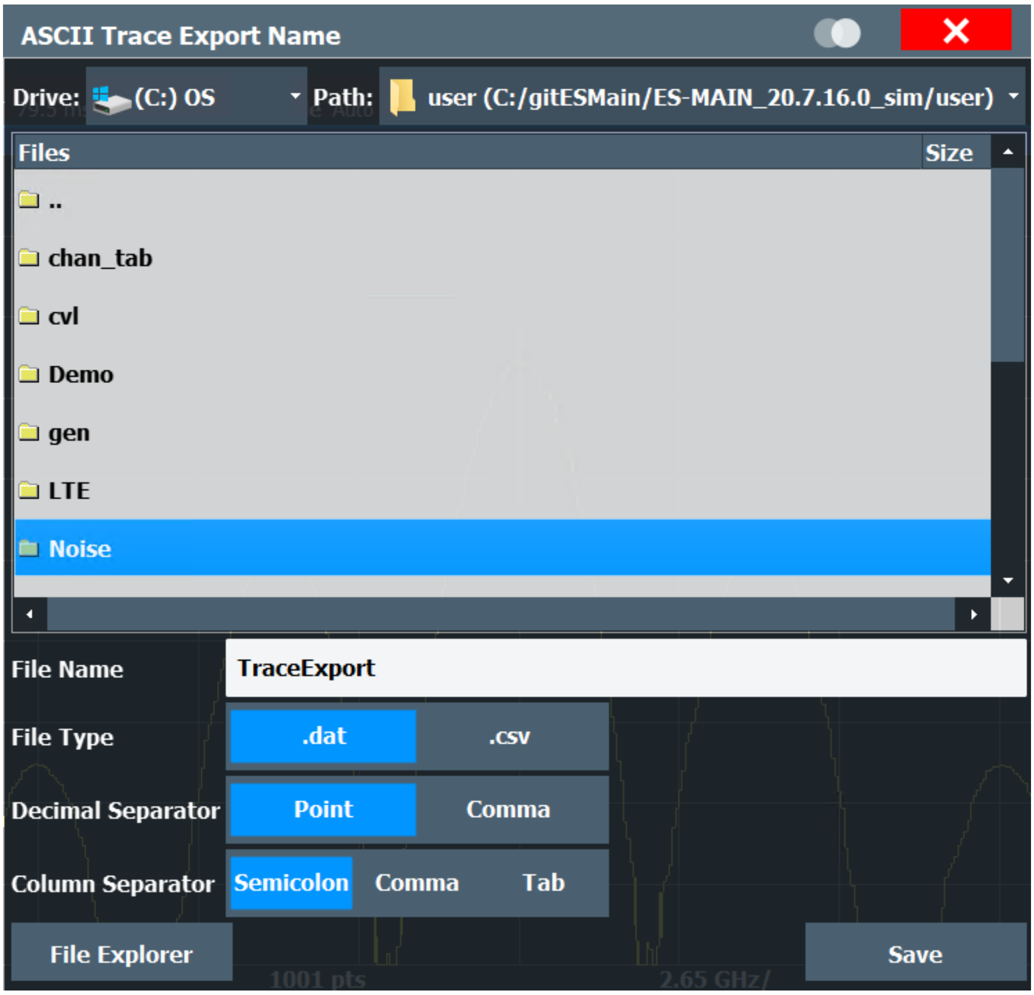
Access: "Save/Recall" > Export

Opens a submenu to configure data export.

Export Trace to ASCII File ← Export

Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

"File Explorer": Instead of using the file manager of the R&S FSW firmware, you can also use the Microsoft Windows File Explorer to manage files.



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 limit reached" 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 base unit user manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 479

File Type ← Export Trace to ASCII File ← Export
Determines the format of the ASCII file to be imported or exported.

Depending on the external program in which the data file was created or is evaluated, a comma-separated list (`CSV`) or a plain data format (`DAT`) file is required.

Remote command:
`FORMat:DEXPort:FORMat` on page 478

Decimal Separator ← Export Trace to ASCII File ← Export
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 478

Column Separator ← Export Trace to ASCII File ← Export
Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;FSW13;Version;1.80;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSW13,
Version,1.80,
Date,01.Jan 3000,
```

Example for tabulator (tab after the last column is not visible):

```
Type	FSW13
Version	1.80
Date	01.Jan 3000
```

The selected column separator settings remains the same, even after a preset.

Remote command:
`FORMat:DEXPort:CSEParator` on page 477

File Explorer ← Export Trace to ASCII File ← Export
Opens the Microsoft Windows File Explorer.

Remote command:
not supported

Trace Export Configuration ← Export
Opens the "Traces" dialog box to configure the trace and data export settings.

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.

It is not available in the Spectrum application, only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

For details, see the description in the R&S FSW I/Q Analyzer User Manual ("Importing and Exporting I/Q Data").

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 limit reached" 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 base unit user manual.

Remote command:
`MMEMory:STORe<n>:IQ:STATe` on page 483
`MMEMory:STORe<n>:IQ:COMMent` on page 482

File Explorer ← I/Q Export ← Export
Opens the Microsoft Windows File Explorer.

Remote command:
not supported

6.3 Data Input and Output Settings

Access: "Overview" > "Input" / "Output"

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

For background information on providing input and output or working with power sensors, see the R&S FSW User Manual.

6.3.1 Input Source Settings

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

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

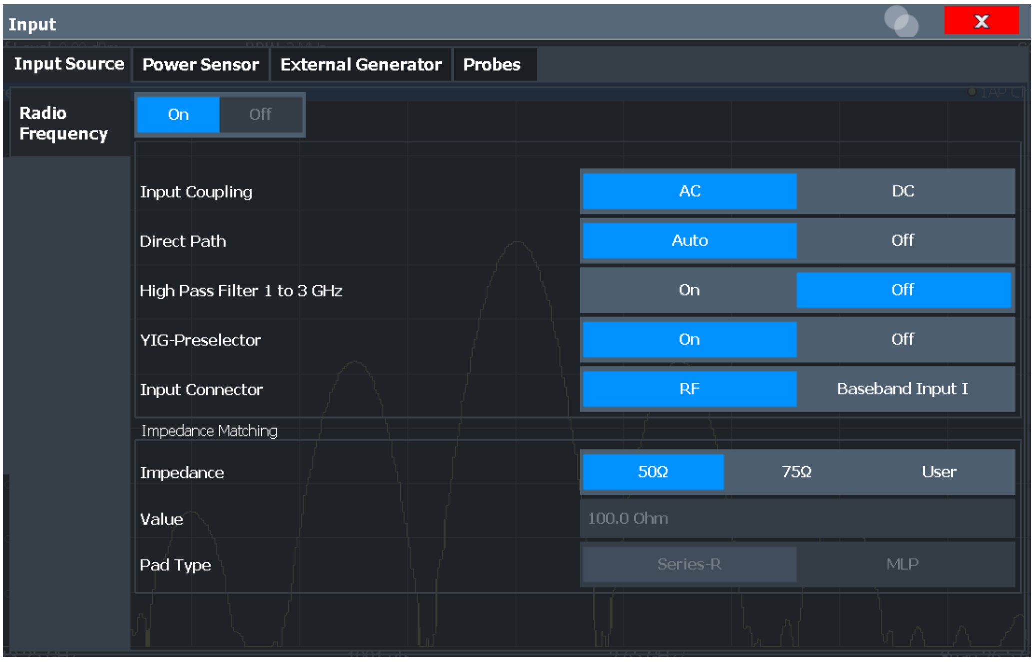
The default input source for the R&S FSW is "Radio Frequency" , i.e. the signal at the "RF Input" connector of the R&S FSW. If no additional options are installed, this is the only available input source.

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.

External mixers are not supported in MSRA/MSRT mode.

6.3.1.1 Radio Frequency Input

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



RF Input Protection

The RF input connector of the R&S FSW must be protected against signal levels that exceed the ranges specified in the data sheet. Therefore, the R&S FSW is equipped with an overload protection mechanism for DC and signal frequencies up to 30 MHz. This mechanism becomes active as soon as the power at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF Input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case you must decrease the level at the RF input connector and then close the message box. Then measurement is possible again. Reactivating the RF input is also possible via the remote command `INPut<ip>:ATTenuation:PROTection:RESet`.

Radio Frequency State

Activates input from the "RF Input" connector.

For R&S FSW85 models with two input connectors, you must define which input source is used for each measurement channel.

"Input 1"	1.00 mm RF input connector for frequencies up to 85 GHz (90 GHz with option R&S FSW-B90G)
"Input2"	1.85 mm RF input connector for frequencies up to 67 GHz

Remote command:
`INPut<ip>:SELect` on page 278
`INPut<ip>:TYPE` on page 279

Input Coupling

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

This function is not available for input from the optional Digital Baseband Interface or from the optional Analog Baseband Interface.

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<ip>:COUPling` on page 275

Impedance
The R&S FSW has an internal impedance of 50 Ω. However, some applications use other impedance values. In order to match the impedance of an external application to the impedance of the R&S FSW, an *impedance matching pad* can be inserted at the input. If the type and impedance value of the used matching pad is known to the R&S FSW, it can convert the measured units accordingly so that the results are calculated correctly.

This function is not available for input from the optional Digital Baseband Interface. Not all settings are supported by all R&S FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output)

"50Ω"	(Default:) no conversion takes place
"75Ω"	The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)
"User"	The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

Remote command:
`INPut<ip>:IMPedance` on page 277
`INPut<ip>:IMPedance:PTYPe` on page 278
For Analog Baseband input:
`INPut<ip>:IQ:IMPedance` on page 291
`INPut<ip>:IQ:IMPedance:PTYPe` on page 291
For Oscilloscope Baseband Input:
`INPut<ip>:IQ:OSC:IMPedance` on page 298
`INPut<ip>:IQ:OSC:IMPedance:PTYPe` on page 298

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 disabled. 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<ip>:DPATh` on page 276

High Pass Filter 1 to 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<ip>:FILTer:HPASs[:STATe]` on page 276

YIG-Preselector
Enables or disables 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 disable 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.

In order to make use of the optional 90 GHz frequency extension (R&S FSW-B90G), the YIG-preselector must be disabled.

Note:
For the following measurements, the YIG-Preselector is off by default (if available).
- I/Q Analyzer
- All client applications in MSRA operating mode
- Real-Time (and thus in all client applications in MSRT operating mode)
- Multi-Carrier Group Delay
- GSM
- VSA

Remote command:
`INPut<ip>:FILTer:YIG[:STATe]` on page 277

Input Connector
Determines which connector the input data for the measurement is taken from.

For more information, see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48.

"RF"	(Default:) the RF INPUT connector

"RF Probe" The RF INPUT connector with an adapter for a modular probe
This setting is only available if a probe is connected to the RF INPUT connector.

"Baseband Input I" The optional Baseband Input I connector
This setting is only available if the optional Analog Baseband Interface is installed and active for input. It is not available for the R&S FSW67.
For R&S FSW85 models with two input connectors, this setting is only available for "Input 1".

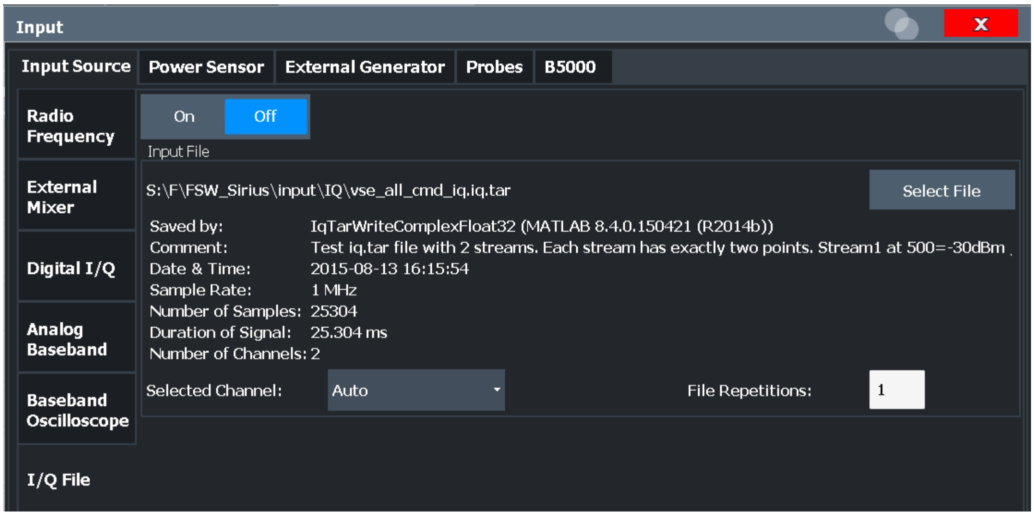
Remote command:
`INPut<ip>:CONNector` on page 274

6.3.1.2 Settings for Input from I/Q Data Files

Access: "Overview" > "Input/Frontend" > "Input Source" > "I/Q File"

Or: [INPUT/OUTPUT] > "Input Source Config" > "Input Source" > "I/Q File"

This input source is **not available in all applications**, and **not in MSRA/MSRT** operating mode.



For details, see Chapter 5.8, "Basics on Input from I/Q Data Files", on page 84.

I/Q Input File State
Enables input from the selected I/Q input file.

If enabled, the application performs measurements on the data from this file. Thus, most measurement settings related to data acquisition (attenuation, center frequency, measurement bandwidth, sample rate) cannot be changed. The measurement time can only be decreased, to perform measurements on an extract of the available data only.

Note: Even when the file input is disabled, the input file remains selected and can be enabled again quickly by changing the state.

Remote command:
`INPut<ip>:SELect` on page 278

Select I/Q data file
Opens a file selection dialog box to select an input file that contains I/Q data.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

For details on formats, see Chapter D, "Reference: Supported I/Q File Formats", on page 504.

Note: Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

Note: For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

The default storage location for I/Q data files is `C:\R_S\INSTR\USER`.

Remote command:
`INPut<ip>:FILE:PATH` on page 281

Selected Channel
Only available for files that contain more than one data stream from multiple channels: selects the data stream to be used as input for the currently selected channel.

In "Auto" mode (default), the first data stream in the file is used as input for the channel. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc.

Remote command:
`MMEMory:LOAD:IQ:STReam` on page 282
`MMEMory:LOAD:IQ:STReam:AUTO` on page 283
`MMEMory:LOAD:IQ:STReam:LIST?` on page 283

File Repetitions
Determines how often the data stream is repeatedly copied in the I/Q data memory to create a longer record. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Remote command:

`TRACe:IQ:FILE:REPetition:COUNt` on page 283

6.3.1.3 External Mixer Settings

Access: [INPUT/OUTPUT] > "External Mixer Config"

If installed, the optional external mixer can be configured from the I/Q Analyzer application.

Note that external mixers are not supported in MSRA/MSRT mode.

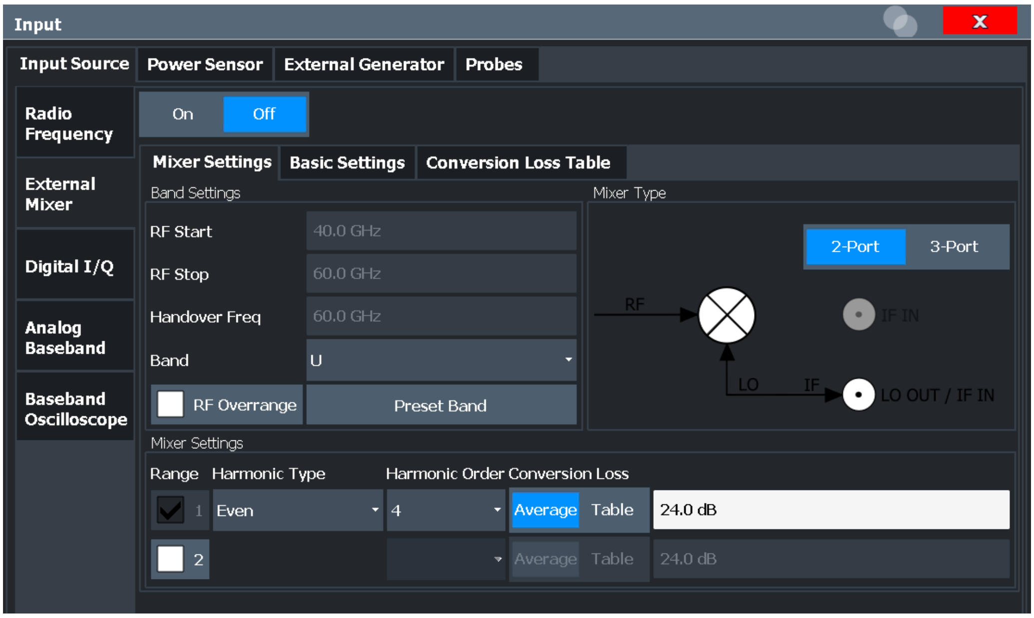
Special conversion loss tables (in `.b2g` or `.b5g` files) cannot be edited within the R&S FSW firmware; they can only be imported and deleted.

See Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70

For details on using external mixers, see the R&S FSW User Manual.

Mixer Settings

Access: [INPUT/OUTPUT] > "External Mixer Config" > "Mixer Settings"



External Mixer (State)

Activates or deactivates the external mixer for input. If activated, "ExtMix" is indicated in the channel bar of the application, together with the used band (see " Band " on page 124).

Remote command:
`[SENSe:]MIXer<x>[:STATe]` on page 304

RF Start / RF Stop

Displays the start and stop frequency of the selected band (read-only).

The frequency range for the user-defined band is defined via the harmonics configuration (see " Range 1 / Range 2 " on page 125).

For details on available frequency ranges, see table 10-3 on page 307.

Remote command:
`[SENSe:]MIXer<x>:FREQuency:STARt` on page 306
`[SENSe:]MIXer<x>:FREQuency:STOP` on page 306

Handover Freq

If due to the LO frequency the conversion of the input signal is not possible using one harmonic, the band must be split. An adjacent, partially overlapping frequency range can be defined using different harmonics. In this case, the sweep begins using the harmonic defined for the first range. At the specified "handover frequency" in the overlapping range, it switches to the harmonic for the second range.

The handover frequency can be selected freely within the overlapping frequency range.

Remote command:
`[SENSe:]MIXer<x>:FREQuency:HANDover` on page 306

Band

Defines the waveguide frequency band or user-defined frequency band to be used by the mixer.

The start and stop frequencies of the selected band are displayed in the "RF Start" and "RF Stop" fields.

For a definition of the frequency range for the pre-defined bands, see table 10-3 on page 307.

The mixer settings for the user-defined band can be selected freely. The frequency range for the user-defined band is defined via the harmonics configuration (see " Range 1 / Range 2 " on page 125).

Remote command:
`[SENSe:]MIXer<x>:HARMonic:BAND` on page 307

RF Overrange

In some cases, the harmonics defined for a specific band allow for an even larger frequency range than the band requires. By default, the pre-defined range is used. However, you can take advantage of the extended frequency range by overriding the defined "RF Start" and "RF Stop" frequencies by the maximum values.

If "RF Overrange" is enabled, the frequency range is not restricted by the band limits ("RF Start" and "RF Stop"). In this case, the full frequency range that can be reached using the selected harmonics is used.

Remote command:
`[SENSe:]MIXer<x>:RFOVerrange[:STATe]` on page 311

Preset Band

Restores the presettings for the selected band.

Note: changes to the band and mixer settings are maintained even after using the [PRESET] function. This function allows you to restore the original band settings.

Remote command:
`[SENSe:]MIXer<x>:HARMonic:BAND:PRESet` on page 307

Mixer Type

The External Mixer option supports the following external mixer types:

Note: For measurements with a bandwidth larger than 2 GHz and an external mixer, only 3-port mixers are supported.
For more information see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

"2 Port"	LO and IF data use the same port
"3 Port"	LO and IF data use separate ports

Remote command:
`[SENSe:]MIXer<x>:PORTs` on page 311

Mixer Settings (Harmonics Configuration)

The harmonics configuration determines the frequency range for user-defined bands (see " Band " on page 124).

Range 1 / Range 2 ← Mixer Settings (Harmonics Configuration)

Enables the use of one or two frequency ranges, where the second range is based on another harmonic frequency of the mixer to cover the band's frequency range.

For each range, you can define which harmonic to use and how the conversion loss is handled.

Remote command:
`[SENSe:]MIXer<x>:HARMonic:HIGH:STATe` on page 308

Harmonic Type ← Mixer Settings (Harmonics Configuration)
Defines if only even, only odd, or even and odd harmonics can be used for conversion. Depending on this selection, the order of harmonic to be used for conversion changes (see " Harmonic Order " on page 126). Which harmonics are supported depends on the mixer type.

Remote command:
`[SENSe:]MIXer<x>:HARMonic:TYPE` on page 308

Harmonic Order ← Mixer Settings (Harmonics Configuration)
Defines which order of the harmonic of the LO frequencies is used to cover the frequency range.

By default, the lowest order of the specified harmonic type is selected that allows conversion of input signals in the whole band. If due to the LO frequency the conversion is not possible using one harmonic, the band is split.

For the "USER" band, you define the order of harmonic yourself. The order of harmonic can be between 2 and 128, the lowest usable frequency being 16.88 GHz.

Remote command:
`[SENSe:]MIXer<x>:HARMonic[:LOW]` on page 309
`[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue]` on page 308

Conversion Loss ← Mixer Settings (Harmonics Configuration)
Defines how the conversion loss is handled. The following methods are available:

"Average" Defines the average conversion loss for the entire frequency range in dB.

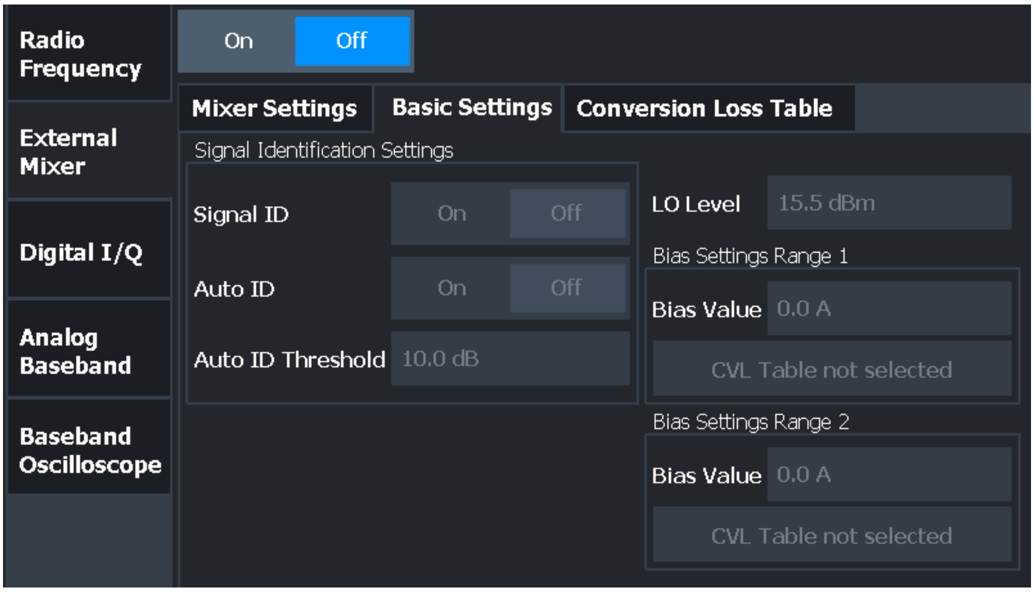
"Table" Defines the conversion loss via the table selected from the list. Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S FSW. Alternatively, you can define your own conversion loss tables. Imported tables are checked for compatibility with the current settings before being assigned.
For details on conversion loss tables, see the External Mixer description in the R&S FSW User Manual.
For details on importing tables, see " Import Table " on page 129.

Remote command:
Average for range 1:
`[SENSe:]MIXer<x>:LOSS[:LOW]` on page 311
Table for range 1:
`[SENSe:]MIXer<x>:LOSS:TABLe[:LOW]` on page 310
Average for range 2:
`[SENSe:]MIXer<x>:LOSS:HIGH` on page 309
Table for range 2:
`[SENSe:]MIXer<x>:LOSS:TABLe:HIGH` on page 309

Basic Settings

Access: [INPUT/OUTPUT] > "External Mixer Config" > "Basic Settings"

The basic settings concern general use of an external mixer. They are only available if the External Mixer (State) is "On" .



LO Level

Defines the LO level of the external mixer's LO port. Possible values are from 13.0 dBm to 17.0 dBm in 0.1 dB steps. Default value is 15.5 dB.

Remote command:
`[SENSe:]MIXer<x>:LOPower` on page 305

Signal ID / Auto ID / Auto ID Threshold

Not available for the I/Q Analyzer application.

Bias Value

Define the bias current for each range, which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

Tip: The trace in the currently active result display (if applicable) is adapted to the settings immediately so you can check the results.

To store the bias setting in the currently selected conversion loss table, select the Write to CVL table button.

Remote command:
`[SENSe:]MIXer<x>:BIAS[:LOW]` on page 305
`[SENSe:]MIXer<x>:BIAS:HIGH` on page 304

Write to CVL table ← Bias Value
Stores the bias setting in the currently selected "Conversion Loss Table" for the range. If no conversion loss table is selected yet, this function is not available ("CVL Table not selected").

(See " Conversion Loss " on page 126).

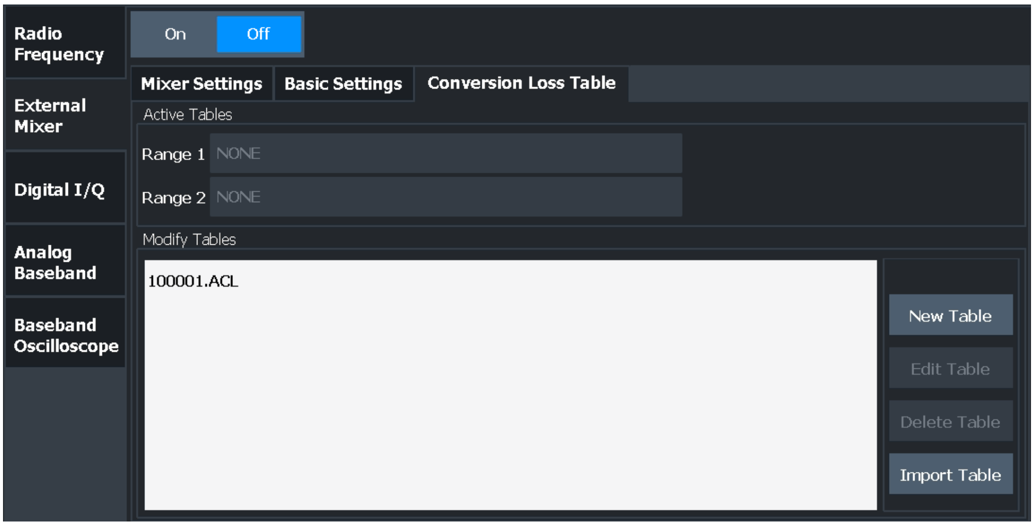
Remote command:
[SENSe:]CORRection:CVL:BIAS on page 312

Managing Conversion Loss Tables

Access: [INPUT/OUTPUT] > "External Mixer Config" > "Conversion Loss Table"

In this tab, you configure and manage conversion loss tables. Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. The correction values for frequencies between the reference points are obtained via interpolation.

The currently selected table for each range is displayed at the top of the dialog box. All conversion loss tables found in the instrument's `C:\R_S\INSTR\USER\cvl\` directory are listed in the "Modify Tables" list.



New Table
Opens the "Edit conversion loss table" dialog box to configure a new conversion loss table.

Remote command:
[SENSe:]CORRection:CVL:SELect on page 315

Edit Table
Opens the "Edit conversion loss table" dialog box to edit the selected conversion loss table.

Note: Note that only common conversion loss tables (in `.acl` files) can be edited. Special conversion loss tables (in `.b2g` or `.b5g` files) can only be imported and deleted.
For more details, see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

Remote command:
`[SENSe:]CORRection:CVL:SELect` on page 315

Delete Table
Deletes the currently selected conversion loss table after you confirm the action.

Remote command:
`[SENSe:]CORRection:CVL:CLEar` on page 313

Import Table
Imports one or more stored conversion loss tables from any directory and copies them to the instrument's `C:\R_S\INSTR\USER\cvl\` directory. They can then be assigned for use for a specific frequency range (see " Conversion Loss " on page 126).

Note:
Before copying any files to the `C:\R_S\INSTR\USER\cvl\` directory, the R&S FSW firmware moves any existing user-defined cvl tables to a `backup` subdirectory. To use a user-defined cvl table later, select the file in the `C:\R_S\INSTR\USER\cvl\backup` directory.

Note: If the bandwidth extension options R&S FSW-B6001/-B8001 are active, external mixers are supported for an analysis bandwidth up to 4 GHz.
Measurements using bandwidth extension options over 512 MHz require special conversion loss tables, see Table 5-14.

Supported tables have the file extension `.b2g` or `.b5g`, as opposed to `.acl` for common tables. While `.acl` files can be used, data acquisition with larger bandwidths using such conversion loss tables leads to substantial inaccuracy. Using no conversion loss tables at all during data acquisition with the larger bandwidth options causes even more inaccuracy.

Note that only common conversion loss tables (in `.acl` files) can be edited. Special conversion loss tables (in `.b2g` or `.b5g` files) can only be imported and deleted.

For more details, see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

Remote command:
`MMEM:COPY '<conversionlosstable>',C:\R_S\INSTR\USER\cvl\`
See R&S FSW base unit user manual.

Creating and Editing Conversion Loss Tables

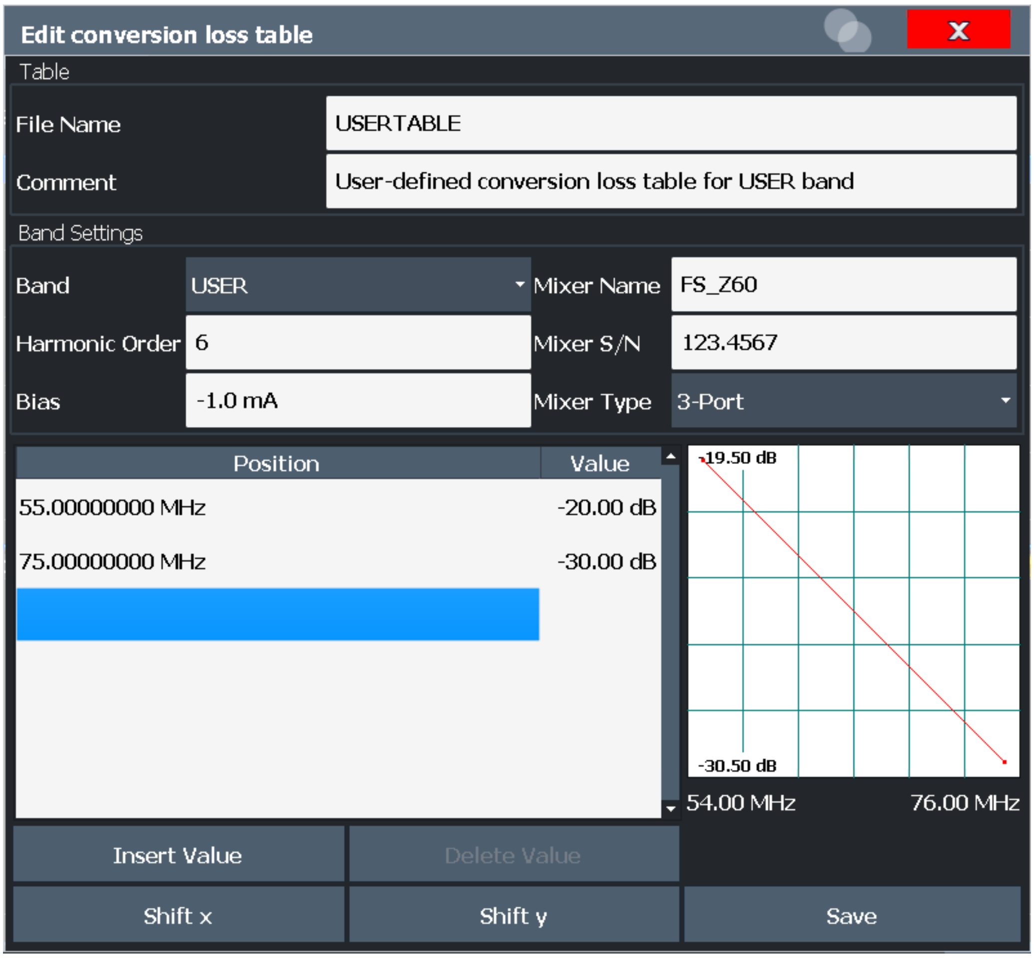
Access: [INPUT/OUTPUT] > "External Mixer Config" > "Conversion Loss Table" > "New Table" / "Edit Table"

Conversion loss tables can be newly defined and edited.

Note that only common conversion loss tables (in `.acl` files) can be edited. Special conversion loss tables (in `.b2g` or `.b5g` files) can only be imported and deleted.

For details see Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70.

A preview pane displays the current configuration of the conversion loss function as described by the position/value entries.



File Name

Defines the name under which the table is stored in the `C:\R_S\INSTR\USER\cvl\` directory on the instrument. The name of the table is identical with the name of the file (without extension) in which the table is stored. This setting is mandatory. The `.ACL` extension is automatically appended during storage.

Note: When using the the bandwidth extension options R&S FSW-B2000/-B5000, special conversion loss tables are required. These tables are stored with the file extension `.b2g` or `.b5g`.

Remote command:
`[SENSe:]CORRection:CVL:SELect` on page 315

Comment

An optional comment that describes the conversion loss table. The comment is user-definable.

Remote command:
`[SENSe:]CORRection:CVL:COMMent` on page 313

Band

The waveguide or user-defined band to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

For a definition of the frequency range for the pre-defined bands, see table 10-3 on page 307.

Remote command:
`[SENSe:]CORRection:CVL:BAND` on page 312

Harmonic Order

The harmonic order of the range to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:
`[SENSe:]CORRection:CVL:HARMonic` on page 314

Bias

The bias current which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

Tip: You can also define the bias interactively while a preview of the trace with the changed setting is displayed, see " Bias Value " on page 127.

Remote command:
`[SENSe:]CORRection:CVL:BIAS` on page 312

Mixer Name

Specifies the name of the external mixer to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:MIXer on page 314

Mixer S/N

Specifies the serial number of the external mixer to which the table applies.

The specified number is checked against the currently connected mixer number before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:SNUMber on page 315

Mixer Type

Specifies whether the external mixer to which the table applies is a two-port or three-port type. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:PORTs on page 315

Position / Value

Each position/value pair defines the conversion loss value in dB for a specific frequency. The reference values must be entered in order of increasing frequencies. A maximum of 50 reference values can be entered. To enter a new value pair, select an empty space in the "Position" / "Value" table, or select the Insert Value button.

Correction values for frequencies between the reference values are interpolated. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table, the conversion loss is assumed to be the same as that for the first and last reference value.

The current configuration of the conversion loss function as described by the position/value entries is displayed in the preview pane to the right of the table.

Remote command:
[SENSe:]CORRection:CVL:DATA on page 314

Insert Value

Inserts a new position/value entry in the table.

If the table is empty, a new entry at 0 Hz is inserted.

If entries already exist, a new entry is inserted above the selected entry. The position of the new entry is selected such that it divides the span to the previous entry in half.

Delete Value

Deletes the currently selected position/value entry.

Shift x
Shifts all positions in the table by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the x-axis.

Shift y
Shifts all conversion loss values by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the y-axis.

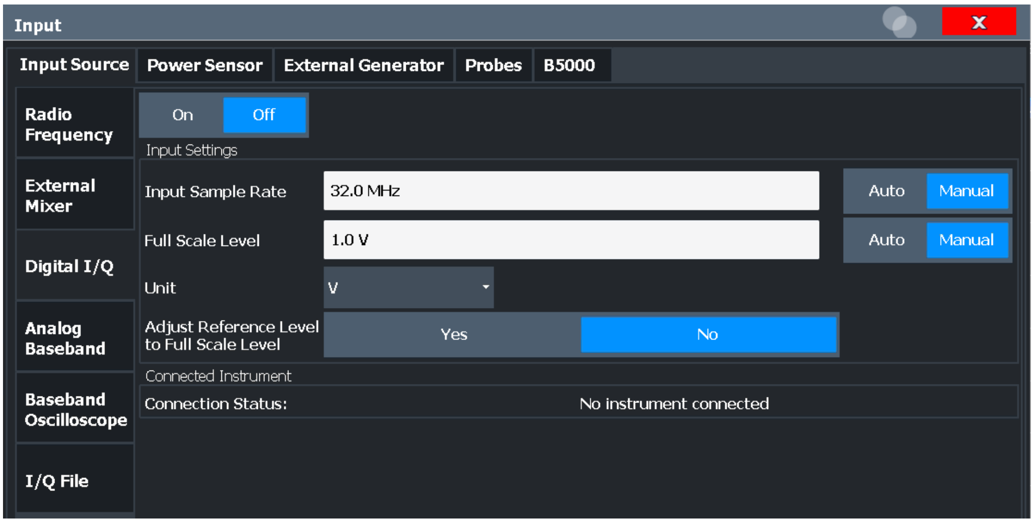
Save
The conversion loss table is stored under the specified file name in the `C:\R_S\INSTR\USER\cvl\` directory of the instrument.

6.3.1.4 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.



Digital I/Q Input State
Enables or disable the use of the "Digital I/Q" input source for measurements.

"Digital I/Q" is only available if the optional Digital Baseband Interface is installed.

Remote command:
`INPut<ip>:SELect` on page 278

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 20 GHz.

Remote command:

`INPut<ip>:DIQ:SRATe` on page 286

`INPut<ip>:DIQ:SRATe:AUTO` on page 286

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<ip>:DIQ:RANGe[:UPPer]` on page 285

`INPut<ip>:DIQ:RANGe[:UPPer]:UNIT` on page 286

`INPut<ip>:DIQ:RANGe[:UPPer]:AUTO` on page 285

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<ip>:DIQ:RANGe:COUPling` on page 284

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

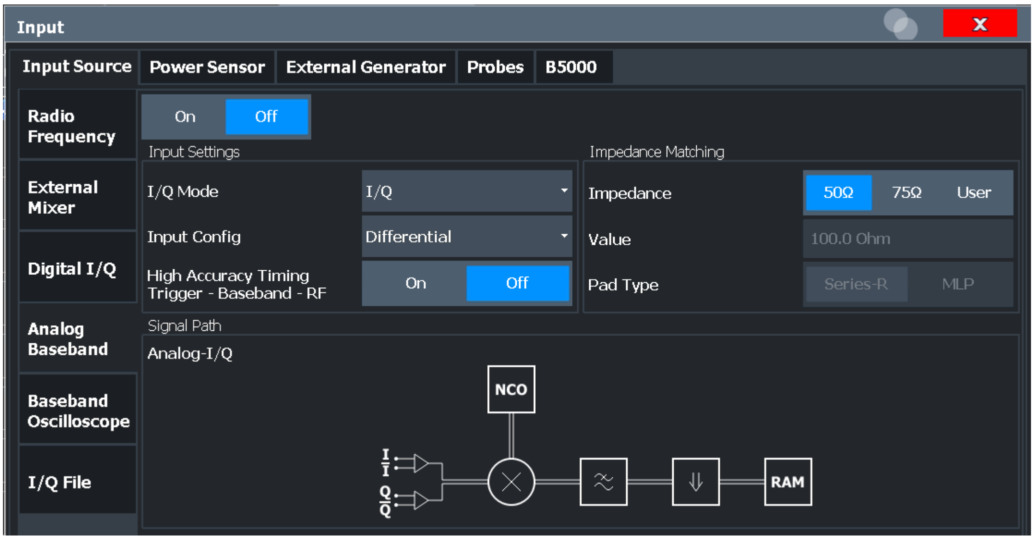
Remote command:

`INPut<ip>:DIQ:CDEVice` on page 284

6.3.1.5 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.



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<ip>:SELect` on page 278

I/Q Mode

Defines the format of the input signal.

For more information, see Chapter 5.3.3, "I/Q Processing Modes", on page 51.

"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<ip>:IQ:TYPE` on page 292

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<ip>:IQ:BALanced[:STATe]` on page 289

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 "High-accuracy timing" on page 51.

Remote command:
`CALibration:AIQ:HATiming[:STATe]` on page 293

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.
For details on frequency ranges and the analysis bandwidth, see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 367

Impedance

The R&S FSW has an internal impedance of 50 Ω. However, some applications use other impedance values. In order to match the impedance of an external application to the impedance of the R&S FSW, an *impedance matching pad* can be inserted at the input. If the type and impedance value of the used matching pad is known to the R&S FSW, it can convert the measured units accordingly so that the results are calculated correctly.

This function is not available for input from the optional Digital Baseband Interface. Not all settings are supported by all R&S FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output)

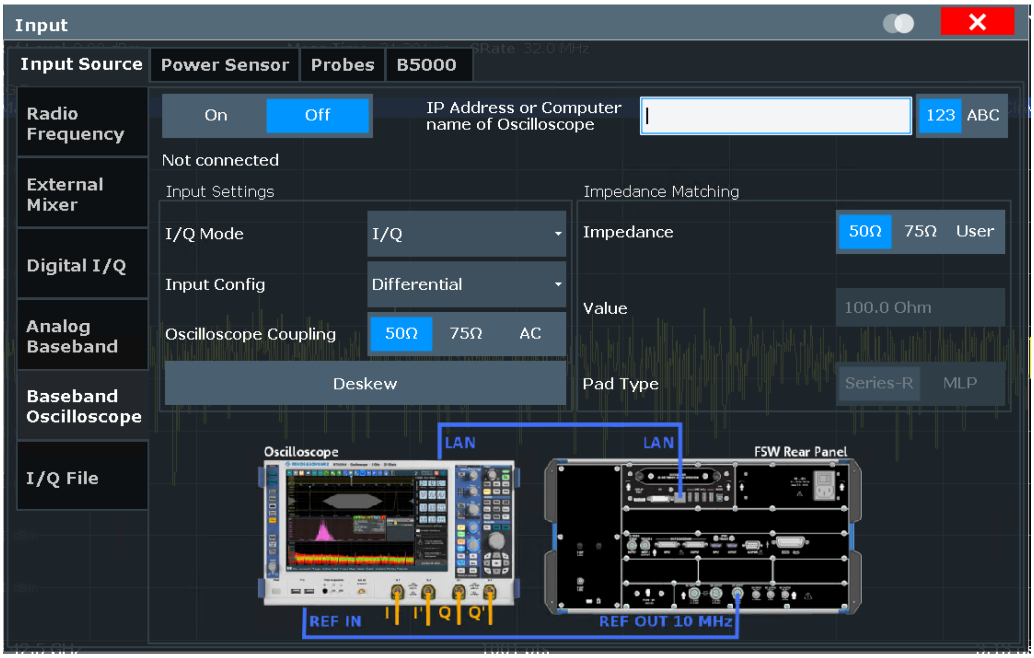
"50Ω"	(Default:) no conversion takes place
"75Ω"	The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)
"User"	The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

Remote command:
`INPut<ip>:IMPedance` on page 277
`INPut<ip>:IMPedance:PTYPe` on page 278
For Analog Baseband input:
`INPut<ip>:IQ:IMPedance` on page 291
`INPut<ip>:IQ:IMPedance:PTYPe` on page 291
For Oscilloscope Baseband Input:
`INPut<ip>:IQ:OSC:IMPedance` on page 298
`INPut<ip>:IQ:OSC:IMPedance:PTYPe` on page 298

6.3.1.6 Oscilloscope Baseband Input

Access: "Overview" > "Input" > "Input Source" > "Oscilloscope Baseband"

The following settings are available for the optional Oscilloscope Baseband Input.



The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.

For details on prerequisites and restrictions, see Chapter 5.4, "Processing Oscilloscope Baseband Input", on page 55.

Oscilloscope Baseband Input State
Activates the optional Oscilloscope Baseband Input.

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S FSW, is not possible while the Oscilloscope Baseband Input is active.

Remote command:
`INPut<ip>:IQ:OSC[:STATe]` on page 301

TCPIP Address / Computer Name
When using the optional Oscilloscope Baseband Input, the entire measurement, as well as both instruments, are controlled by the R&S FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the R&S FSW.

For tips on how to determine the computer name or TCPIP address, see "To determine the oscilloscope's computer name" on page 247, "To determine the oscilloscope's TCPIP address" on page 247, or the oscilloscope's user documentation.

By default, the TCPIP address is expected. To enter the computer name, toggle the "123"/"ABC" button to "ABC".

As soon as a name or address is entered, the R&S FSW attempts to establish a connection to the oscilloscope. If it is detected, the oscilloscope's identity string is queried and displayed in the dialog box.

Note: The IP address / computer name is maintained after a [PRESET], and is transferred between applications.

Remote command:
`INPut<ip>:IQ:OSC:TCPip` on page 302
`INPut<ip>:IQ:OSC:IDN?` on page 297
To check whether the connected oscilloscope is supported for Oscilloscope Baseband Input:
`INPut<ip>:IQ:OSC:VDEVice?` on page 303
`INPut<ip>:IQ:OSC:VFIRmware?` on page 303

I/Q Mode
Defines the format of the input signal.

For more information, see Chapter 5.4, "Processing Oscilloscope Baseband Input", on page 55.

"I/Q" Both components of the complex input signal (in-phase component, quadrature component) are filtered and resampled to the sample rate of the application. The input signal is down-converted with the center frequency (**Low IF I**).

"I Only / Low IF I"
The input signal at the channel providing I data is filtered and resampled to the sample rate of the application.
The input signal is down-converted with the center frequency (**Low IF I**).

Remote command:
`INPut<ip>:IQ:OSC:TYPE` on page 302

Input Configuration
Defines whether the input is provided as a differential signal via all four input channel connectors on the oscilloscope, or as a plain I/Q signal via two simple-ended lines.

"Single-ended" I, Q data only

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

Remote command:
`INPut<ip>:IQ:OSC:BALanced[:STATe]` on page 295

Oscilloscope Coupling
The input coupling influences the signal path between input connector and the following internal signal stage.

"50 Ω" DC coupling shows all parts of an input signal. DC 50 Ω coupling is the default for 50 Ω input impedance to connect, for example, active probes.

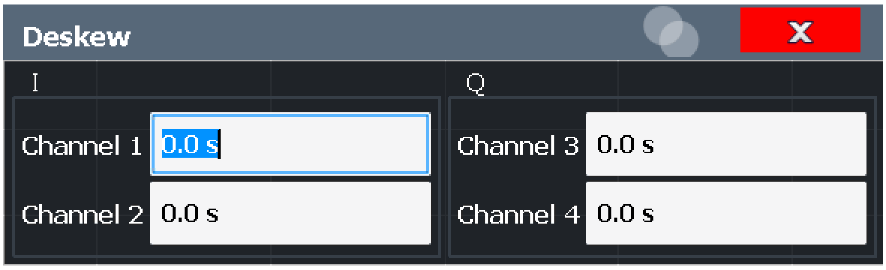
"1 MΩ" DC coupling with 1 MΩ input impedance to connect standard passive probes.

"AC" AC coupling is useful if the DC component of a signal is of no interest. AC coupling blocks the DC component of the signal so that the waveform is centered on zero volts.

Remote command:
`INPut<ip>:IQ:OSC:COUPling` on page 296

I/Q Skew

Compensates for skewed I/Q values, e.g. due to different input cables



Define the delay values individually for the I and Q channels. For differential input, changing the positive skew automatically also changes the negative skew (but not vice versa).

Depending on the connected oscilloscope, values between ±100 ns are allowed.

Remote command:
`INPut<ip>:IQ:OSC:SKEW:I` on page 299
`INPut<ip>:IQ:OSC:SKEW:I:INVerted` on page 299
`INPut<ip>:IQ:OSC:SKEW:Q` on page 300
`INPut<ip>:IQ:OSC:SKEW:Q:INVerted` on page 300

Impedance

The R&S FSW has an internal impedance of 50 Ω. However, some applications use other impedance values. In order to match the impedance of an external application to the impedance of the R&S FSW, an *impedance matching pad* can be inserted at the input. If the type and impedance value of the used matching pad is known to the R&S FSW, it can convert the measured units accordingly so that the results are calculated correctly.

This function is not available for input from the optional Digital Baseband Interface. Not all settings are supported by all R&S FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output)

"50Ω" (Default:) no conversion takes place

"75Ω" The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

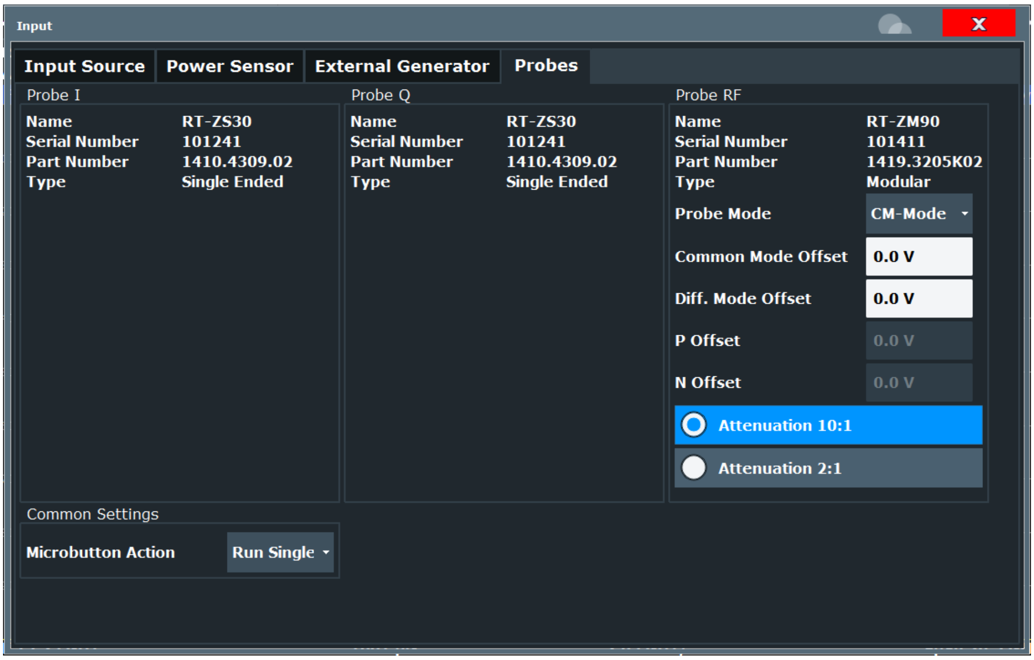
"User" The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

Remote command:
`INPut<ip>:IMPedance` on page 277
`INPut<ip>:IMPedance:PTYPe` on page 278
For Analog Baseband input:
`INPut<ip>:IQ:IMPedance` on page 291
`INPut<ip>:IQ:IMPedance:PTYPe` on page 291
For Oscilloscope Baseband Input:
`INPut<ip>:IQ:OSC:IMPedance` on page 298
`INPut<ip>:IQ:OSC:IMPedance:PTYPe` on page 298

6.3.1.7 Probe Settings

Access: [INPUT / OUTPUT] > "Input Source Config" > "Probes"

Data input for the measurement can be provided by probes if the optional Analog Baseband Interface (R&S FSW-B71) is available or the R&S RT-ZA9 adapter is used.



For each possible probe connector (Baseband Input I, Baseband Input Q, RF), the detected type of probe, if any, is displayed.

For more information on using probes with an R&S FSW, see Chapter 5.5, "Using Probes", on page 60.

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

Name
Probe name

Remote command:
`[SENSe:]PROBe<pb>:SETup:NAME?` on page 321

Serial Number
Serial number of the probe

Remote command:
`[SENSe:]PROBe<pb>:ID:SRNumber?` on page 319

Part Number
Rohde & Schwarz part number

Remote command:
`[SENSe:]PROBe<pb>:ID:PARTnumber?` on page 318

Type
Type of probe:

- Single-ended
- Differential
- Active Modular

Remote command:
`[SENSe:]PROBe<pb>:SETup:TYPE?` on page 324

Mode
Mode for multi-mode modular probes. Determines which voltage is measured.

"DM-mode"	Voltage between the positive and negative input terminal
"CM-mode"	Mean voltage between the positive and negative input terminal vs. ground
"P-mode"	Voltage between the positive input terminal and ground
"N-mode"	Voltage between the negative input terminal and ground

Remote command:
`[SENSe:]PROBe<pb>:SETup:PMODe` on page 322

Common Mode Offset / Diff. Mode Offset / P Offset / N Offset /
Sets the offset for the probe, depending on the used mode (CM and DM mode both use the "Common Mode Offset"). The setting is only available if a differential (R&S RT-ZD) or modular (R&S RT-ZM) probe is connected to the R&S FSW.

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

Note: If the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

Remote command:
[SENSe:]PROBe<pb>:SETup:CMOFfset on page 320
[SENSe:]PROBe<pb>:SETup:DMOFfset on page 320
[SENSe:]PROBe<pb>:SETup:NMOFfset on page 321
[SENSe:]PROBe<pb>:SETup:PMOFfset on page 323

Attenuation

Defines the attenuation applied to the input at the probe. This setting is only available for modular probes.

"10:1" Attenuation by 20 dB

"2:1" Attenuation by 6 dB

Remote command:
[SENSe:]PROBe<pb>:SETup:ATTRatio on page 319

Microbutton Action

Active Rohde & Schwarz probes (except for R&S 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<pb>:SETup:MODE on page 321

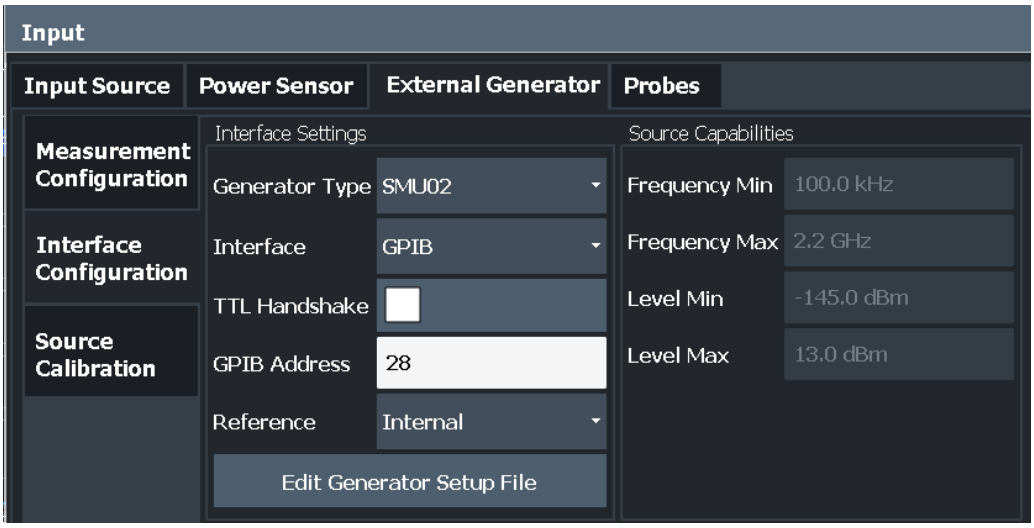
6.3.1.8 External Generator Control Settings

Access: [INPUT/OUPUT] > "External Generator Config"

The "External Generator" settings are available if the R&S FSW External Generator Control option is installed. For each measurement channel, you can configure one external generator. To switch between different configurations, define multiple measurement channels.

For more information on external generator control, see Chapter 5.7, "Basics on External Generator Control", on page 72.

Interface Configuration Settings



For more information on configuring interfaces, see the "Remote Control Interfaces and Protocols" section in the R&S FSW User Manual.

Generator Type

Selects the generator type and thus defines the generator setup file to use.

For an overview of supported generators, see Chapter 5.7.2, "Overview of Supported Generators", on page 75. For information on generator setup files, see Chapter 5.7.3, "Generator Setup Files", on page 77.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator<gen>:TYPE` on page 330

Interface

Type of interface connection used.

For details on which signal generators support which interfaces, see the documentation of the corresponding signal generator.

- GPIB
- TCP/IP

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator<gen>:INTerface` on page 329

TTL Handshake

If available for the specified generator type, this option activates TTL synchronization via handshake.

Using the TTL interface allows for considerably higher measurement rates, because the frequency stepping of the R&S FSW is directly coupled with the frequency stepping of the generator.

For more information on TTL synchronization, see "TTL synchronization" on page 82.

For an overview of which generators support TTL synchronization see Chapter 5.7.2, "Overview of Supported Generators", on page 75.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator<gen>:LINK` on page 329

GPIB Address / TCPIP Address / Computer Name

For LAN connections: TCP/IP address of the signal generator

For GPIB connections: GPIB address of the signal generator.

Remote command:
`SYSTem:COMMunicate:GPIB:RDEVice:GENerator<gen>:ADDRess` on page 329
`SYSTem:COMMunicate:TCPip:RDEVice:GENerator<gen>:ADDRess` on page 330

Reference

Selects the internal R&S FSW or an external frequency reference to synchronize the R&S FSW with the generator (default: internal).

Remote command:
`SOURce<si>:EXTernal<gen>:ROSCillator[:SOURce]` on page 328

Edit Generator Setup File

Displays the setup file for the currently selected Generator Type in read-only mode in an editor.

Although the existing setup files are displayed in read-only mode in the editor, they can be saved under a different name (using "File > SaveAs").

Be careful, however, to adhere to the required syntax and commands. Errors are only detected and displayed when you try to use the new generator (see also Chapter 5.7.8, "Displayed Information and Errors", on page 83).

For details, see Chapter 5.7.3, "Generator Setup Files", on page 77.

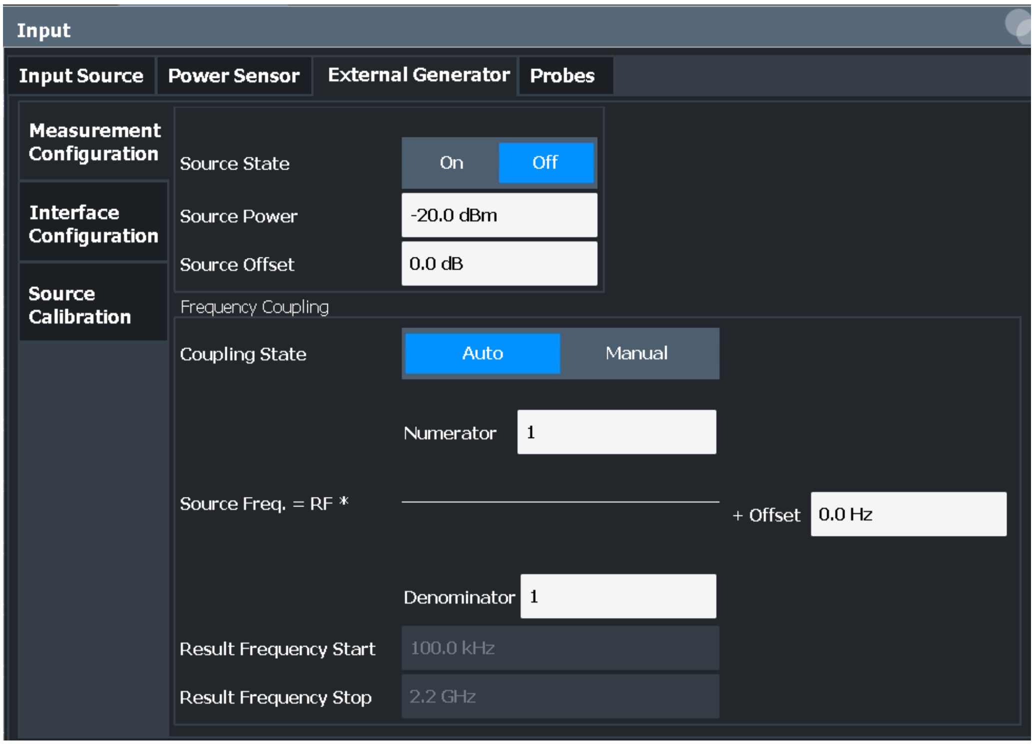
Frequency Min / Frequency Max

For reference only: Lower and upper frequency limit for the generator.

Level Min / Level Max

For reference only: Lower and upper power limit for the generator.

Measurement Settings



Source State

Activates or deactivates control of an external generator.

Remote command:
`SOURce<si>:EXTernal<gen>[:STATe]` on page 327

Source Power

The output power of the external generator. The default output power is -20 dBm. The range is specified in the data sheet.

Remote command:
`SOURce<si>:EXTernal<gen>:POWer[:LEVel]` on page 327

Source Offset

Constant level offset for the external generator. Values from -200 dB to +200 dB in 1 dB steps are allowed. The default setting is 0 dB. Offsets are indicated by the "LVL" label in the channel bar (see also Chapter 5.7.8, "Displayed Information and Errors", on page 83).

Using this offset, attenuators or amplifiers at the output connector of the external generator can be taken into account. This is useful, for example, for the displayed output power values on screen or during data entry. Positive offsets apply to an amplifier, while negative offsets apply to an attenuator after the external generator.

Remote command:
`SOURce<si>:POWer[:LEVel][:IMMediate]:OFFSet` on page 328

Source Frequency Coupling
Defines the frequency coupling mode between the R&S FSW and the generator.

For more information on coupling frequencies, see Chapter 5.7.7, "Coupling the Frequencies", on page 81.

"Auto" — Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSW (see "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 147). The RF frequency range covers the currently defined span of the R&S FSW (unless limited by the range of the signal generator).

"Manual" — The generator uses a single fixed frequency, defined by (Manual) Source Frequency which is displayed when you select "Manual" coupling.

Remote command:
`SOURce<si>:EXTernal<gen>:FREQuency:COUPling[:STATe]` on page 325

(Manual) Source Frequency
Defines the fixed frequency to be used by the generator.

Remote command:
`SOURce<si>:EXTernal<gen>:FREQuency` on page 325

(Automatic) Source Frequency (Numerator/Denominator/Offset)
With automatic frequency coupling, a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSW.

However, the frequency used by the generator may differ from the input from the R&S FSW. The RF frequency can be multiplied by a specified factor, or a frequency offset can be added, or both.

Note: The input for the generator frequency is not validated, i.e. you can enter any values. However, if the allowed frequency ranges of the generator are exceeded, an error message is displayed on the R&S FSW. The values for Result Frequency Start and Result Frequency Stop are corrected to comply with the range limits.

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets <> 0 Hz are indicated by the "FRQ" label in the channel bar. Negative offsets can be used to define reverse sweeps.

For more information on coupling frequencies and reverse sweeps, see Chapter 5.7.7, "Coupling the Frequencies", on page 81. For more information on error messages and the channel bar, see Chapter 5.7.8, "Displayed Information and Errors", on page 83.

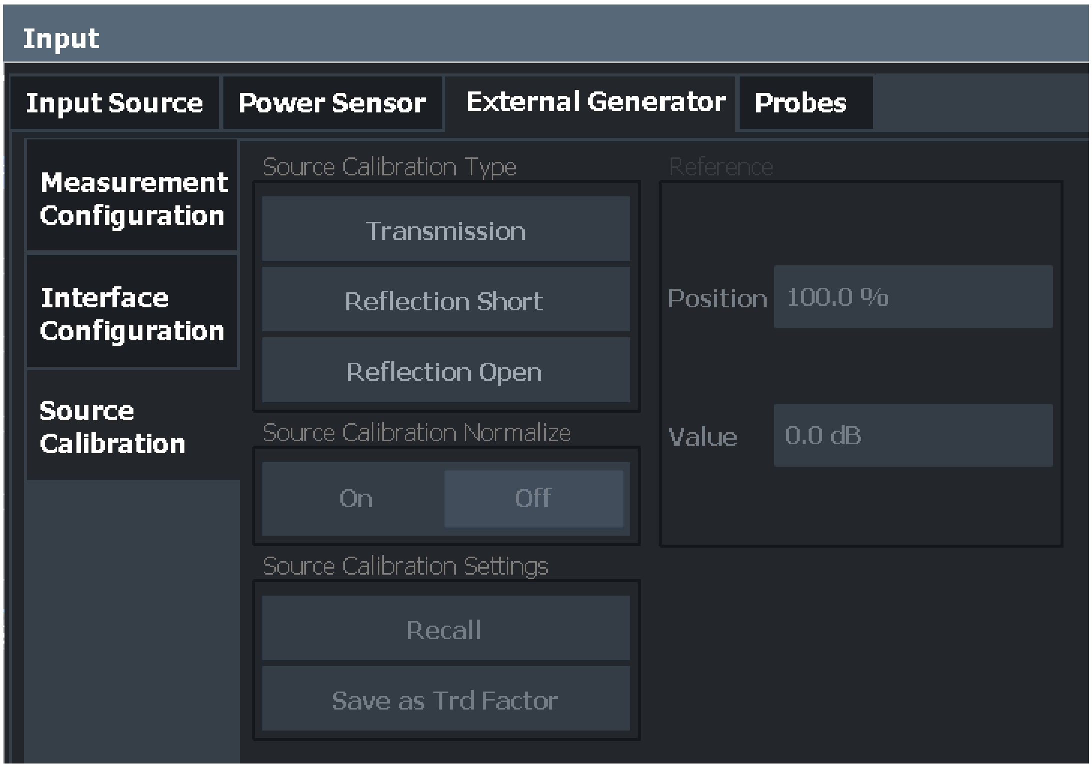
Remote command:
`SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:DENominator`
on page 325
`SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:NUMerator` on page 326
`SOURce<si>:EXTernal<gen>:FREQuency:OFFSet` on page 327

Result Frequency Start
For reference only: The start frequency for the generator, calculated from the configured generator frequency and the start value defined for the R&S FSW.

Result Frequency Stop
For reference only: The stop frequency for the generator, calculated from the configured generator frequency and the stop value defined for the R&S FSW.

Source Calibration Functions

The calibration functions of the external generator are available *only if external generator control is active* (see " Source State " on page 146).



Calibrate Transmission
Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

Remote command:
[SENSe:]CORRection:METHod on page 332

Calibrate Reflection Short
Starts a short-circuit reflection type measurement to determine a reference trace for calibration.

If both calibrations (open circuit, short circuit) are carried out, the calibration trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:
[SENSe:]CORRection:METHod on page 332
Selects the reflection method.
[SENSe:]CORRection:COLLect[:ACQuire] on page 332
Starts the sweep for short-circuit calibration.

Calibrate Reflection Open
Starts an open-circuit reflection type measurement to determine a reference trace for calibration.

If both reflection-type calibrations (open circuit, short circuit) are carried out, the reference trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:
[SENSe:]CORRection:METHod on page 332
Selects the reflection method.
[SENSe:]CORRection:COLLect[:ACQuire] on page 332
Starts the sweep for open-circuit calibration.

Normalization state
Switches the normalization of measurement results on or off. This function is only available if the memory contains a reference trace, that is, after a calibration has been performed.

For details on normalization, see Chapter 5.7.5, "Normalization", on page 78.

Remote command:
[SENSe:]CORRection[:STATe] on page 333

Recall Cal. Settings
Restores the settings that were used during source calibration. This can be useful if instrument settings were changed after calibration (e.g. center frequency, frequency deviation, reference level, etc.).

Remote command:
[SENSe:]CORRection:RECall on page 333

Save as Trd Factor

Uses the normalized measurement data to generate a transducer factor. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under `C:\Program Files (x86)\Rohde-Schwarz\FSW\<version>\trd`. The frequency points are allocated in equidistant steps between start and stop frequency.

The generated transducer factor can be further adapted using the "Transducer" function in the [Setup] menu.

For more information on transducers, see the "General Instrument Setup > Transducers" section in the R&S FSW User Manual.

Note: Note that the *normalized* measurement data is used, not the *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor will be 0 dB for the entire span (by definition of the normalized trace).

Remote command:
`[SENSe:]CORRection:TRANsducer:GENerate` on page 333

Reference Position

Defines the position of the reference line in percent of the total y-axis range.

The top of the diagram is 100%, the bottom is 0%. By default, the 0 dB line is displayed at the top of the diagram (100%).

This setting is only available if normalization is on (see " Normalization state" on page 149).

The reference line defined by the reference value and reference position is similar to the Reference Level defined in the "Amplitude" settings. However, this reference line only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The normalized trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 365

Reference Value

Defines an offset for the position of the reference line.

This setting can be used to shift the reference line and thus the normalized trace, similar to the Shifting the Display (Offset) defined in the "Amplitude" settings shifts the reference level *in the display*.

Shifting the normalized trace is useful, for example, to reflect an attenuation or gain caused by the measured DUT. If you then zoom into the diagram around the normalized trace, the measured trace still remains fully visible.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue` on page 331

6.3.1.9 Settings for 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)

Access: [Input/Output] > "B2000/B5000 Config"

The I/Q Analyzer application supports the optional 2 GHz / 5 GHz bandwidth extensions (R&S FSW-B2000/B5000), if installed.

For details on prerequisites and restrictions, see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85.

The following settings are available for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

General Settings

Access: [Input/Output] > "B2000/B5000 Config" > "Settings"

The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.

For details, see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.

B2000/B5000 State

Activates the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S FSW, is not possible while the B2000/B5000 option is active.
When the B2000/B5000 option is activated, the basic "IF OUT 2 GHz/ IF OUT 5 GHz " output is automatically deactivated. It is not reactivated when the B2000/B5000 option is switched off.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe]` on page 346

TCPIP Address / Computer Name
When using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/ B5000), the entire measurement via the "IF OUT 2 GHz/ IF OUT 5 GHz " connector and an oscilloscope, as well as both instruments, are controlled by the R&S FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the R&S FSW.

For tips on how to determine the computer name or TCPIP address, see Chapter 8.3, "How to Configure Data Acquisition via the Optional 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)", on page 249, or the oscilloscope's user documentation.

By default, the TCPIP address is expected. To enter the computer name, toggle the "123"/"ABC" button to "ABC".

As soon as a name or address is entered, the R&S FSW attempts to establish a connection to the oscilloscope. If it is detected, the oscilloscope's identity string is queried and displayed in the dialog box. The alignment status is also displayed.

(See "Alignment" on page 152).

Note: The IP address / computer name is maintained after a [PRESET], and is transferred between applications.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip` on page 350
`SYSTem:COMMunicate:RDEVice:OSCilloscope:IDN` on page 348

Oscilloscope Sample Rate
Determines whether the R&S FSW-B2000 option uses the 10 GHz mode (default) or 20 GHz mode of the connected oscilloscope. The 20 GHZ mode achieves a higher decimation gain, but reduces the record length by half.

The R&S FSW-B5000 option always uses the 20 GHZ mode.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe` on page 349

Power Splitter Mode
Activates the use of the power splitter inserted between the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW and the "Ch1" and "Ch3" input connectors of the oscilloscope. Note that this mode requires an additional alignment with the power splitter.

For details see Chapter 5.9.8, "Power Splitter Mode", on page 93.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:PSMode[:STATe]` on page 349

Alignment

Access: [Input/Output] > "B2000/B5000 Config"> "Alignment"

An initial alignment of the output to the oscilloscope is required once after setup. It need only be repeated if one of the following applies:

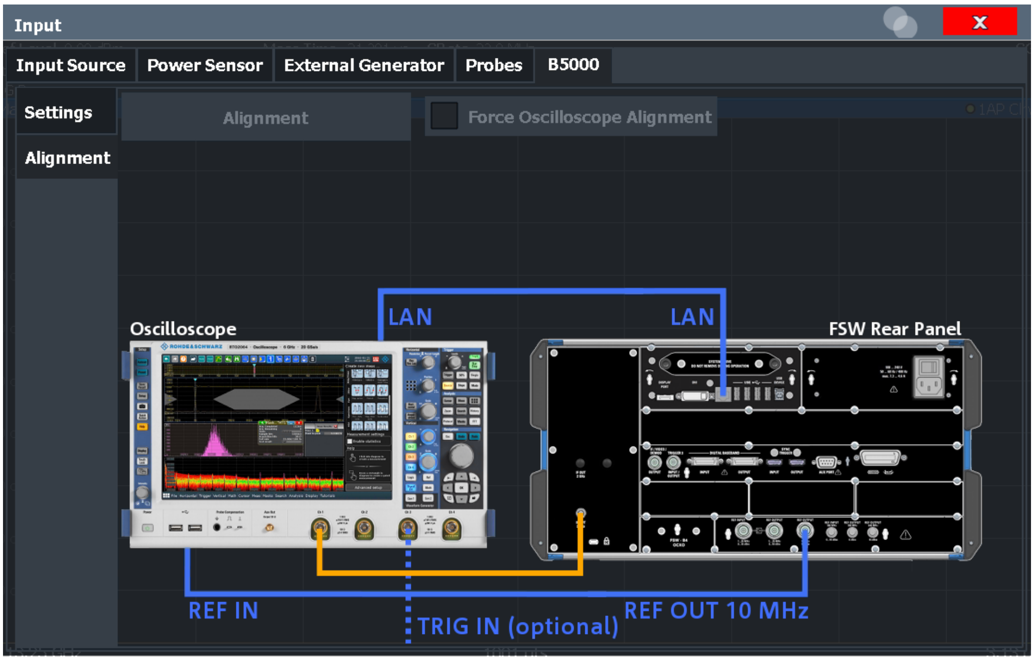
- A new oscilloscope is connected to the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW
- A new cable is used between the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW and the oscilloscope
- A power splitter is inserted between the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW and the oscilloscope
- New firmware is installed on the oscilloscope or the R&S FSW

In some cases, it is useful to force a self-alignment on the oscilloscope before the actual B5000 alignment, see "Force Oscilloscope Alignment" on page 154.

Alignment of the R&S FSW-B5000 Option

Access: "Input / Output" > "B5000 Config"

The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.



For details, see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.

Alignment requires a connection from the "IF OUT 2 GHz" connector on the R&S FSW to the "Ch1" input on the oscilloscope.

(In power splitter mode: connection from the "IF OUT 2 GHz" connector on the R&S FSW to the power splitter, which is connected to the "Ch1" and "Ch3" inputs on the oscilloscope.)

Alignment
Performs an alignment of the B2000/B5000 connection on the R&S FSW.

After alignment was performed successfully, the date of alignment is indicated.

If "UNCAL" is displayed, alignment was not yet performed (successfully).

Note: If the oscilloscope is detected to be uncalibrated, a self-alignment is performed on the oscilloscope before the actual B5000 alignment starts. This may take a few minutes.
In some cases, it is useful to force a self-alignment on the oscilloscope manually, see "Force Oscilloscope Alignment" on page 154.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP<st>[:STATe]` on page 347
`SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE` on page 348

Force Oscilloscope Alignment
If the oscilloscope is detected to be uncalibrated, a self-alignment is performed on the oscilloscope before the actual B2000/B5000 alignment starts. In addition, it is useful to perform an alignment on the oscilloscope manually in the following cases:

- Major temperature changes occur (> 5 °C)
- The last alignment on the oscilloscope is significantly longer than 1 week ago

To perform a self-alignment on the oscilloscope before the B2000/B5000 alignment on the R&S FSW, select this option before selecting Alignment.

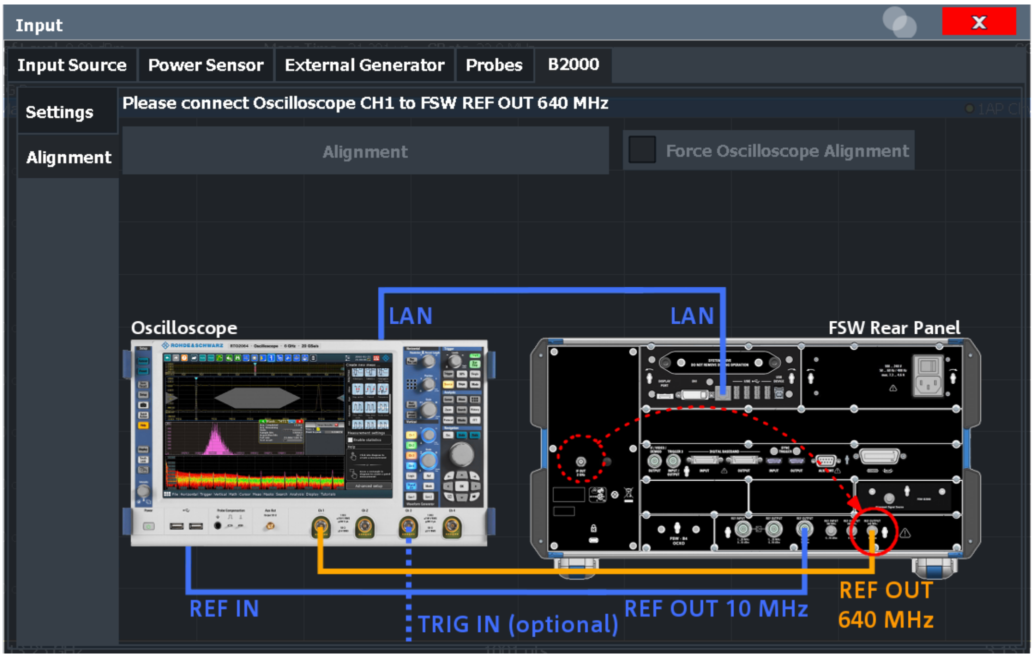
Note, however, that the self-alignment on the oscilloscope can take a few minutes.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:FALignment`
on page 348

Alignment of the R&S FSW-B2000 Option

Access: "Input / Output" > "B2000 Config"

The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.



The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.

For details, see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.

Alignment consists of two steps. The first step requires a (temporary) connection from the "REF OUTPUT 640 MHz" connector on the R&S FSW to the "Ch1" input on the oscilloscope.

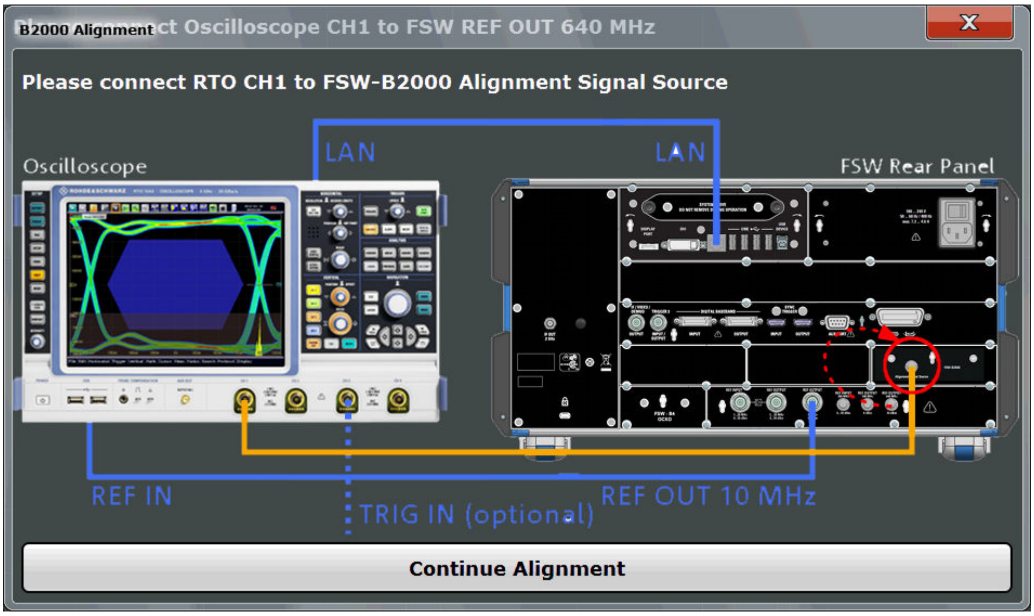
(In power splitter mode: connection from the "REF OUTPUT 640 MHz" connector on the R&S FSW to the power splitter, which is connected to the "Ch1" and "Ch3" inputs on the oscilloscope.)

To perform the alignment, select the "Alignment" button.

If the oscilloscope is detected to be uncalibrated, a self-alignment is performed on the oscilloscope before the actual B2000 alignment on the R&S FSW starts. This may take a few minutes.

In some cases, it is useful to force a self-alignment on the oscilloscope manually, see "Force Oscilloscope Alignment" on page 154.

If the oscilloscope and the oscilloscope ADC are aligned successfully, a new dialog box is displayed.

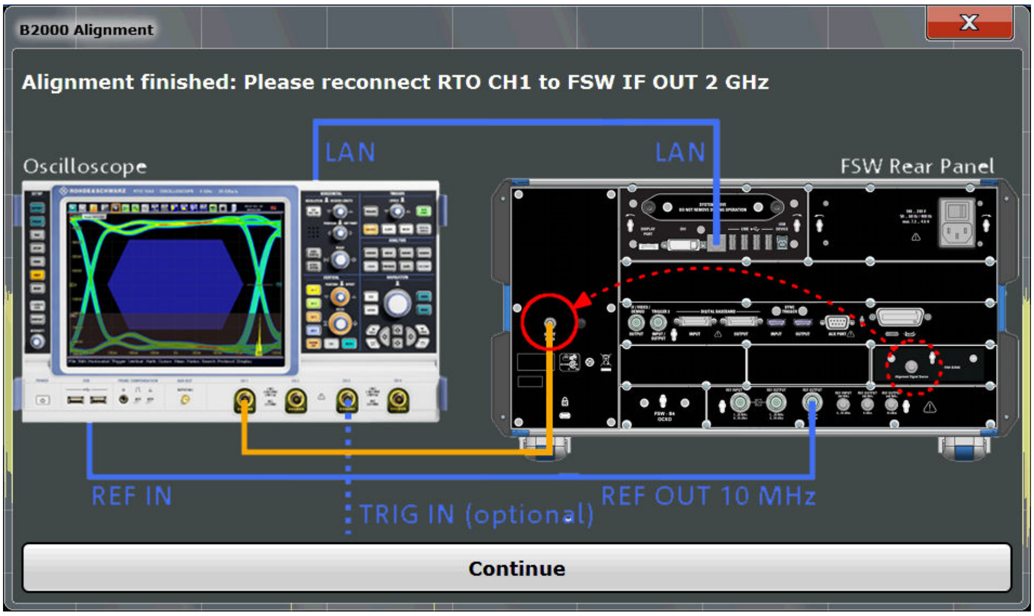


For the second alignment step, the connector must be disconnected from the "REF OUTPUT 640 MHz" connector and instead connected to the "FSW B2000 Alignment Signal Source" connector on the R&S FSW.

(In power splitter mode: connection from the "FSW B2000 Alignment Signal Source" connector on the R&S FSW to the power splitter.)

To continue the alignment, select the "Continue Alignment" button.

After the second alignment step has been completed successfully, a new dialog box is displayed.



In order to switch from alignment mode to measurement mode, move the cable from the "FSW B2000 Alignment Signal Source" back to the "IF OUT 2 GHz" connector, so that it is then connected to the "Ch1" input on the oscilloscope.

(In power splitter mode: connection from the "IF OUT 2 GHz" connector on the R&S FSW to the power splitter, which is connected to the "Ch1" and "Ch3" inputs on the oscilloscope.)

If "UNCAL" is displayed, alignment was not yet performed (successfully).

If both alignment steps were performed successfully, the date of alignment is indicated.

For a description of possible errors, see Errors using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) and possible solutions.

Remote commands:

`SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP<st>[:STATe]` on page 347

`SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE` on page 348

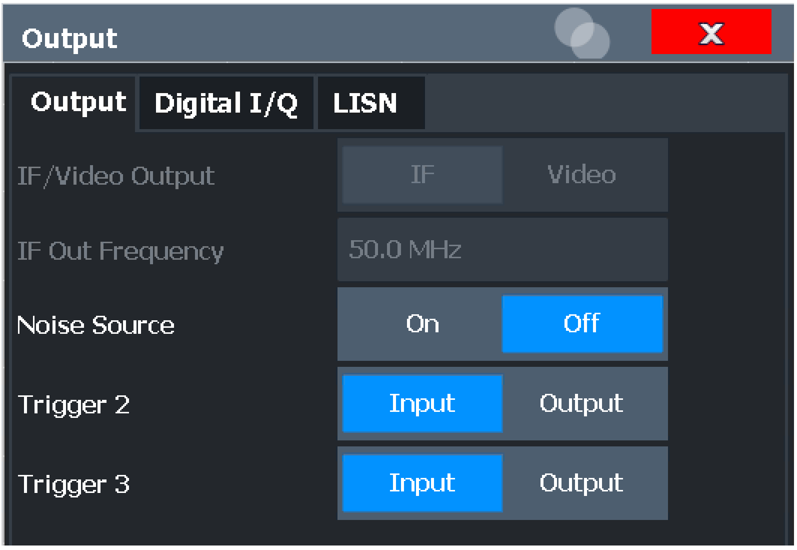
6.3.2 Output Settings

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.



Data Output

Defines the type of signal available at one of the output connectors of the R&S FSW.

For restrictions and additional information, see Chapter 5.11, "IF and Video Signal Output", on page 97.

"IF" The measured IF value is provided at the IF/VIDEO/DEMOD output connector.
For bandwidths up to 80 MHZ, the IF output is provided at the specified "IF Out Frequency" .
If an optional bandwidth extension R&S FSW-B160/-B320/-B512 is used, the measured IF value is available at the "IF WIDE OUTPUT" connector. The frequency at which this value is output is determined automatically. It is displayed as the "IF Wide Out Frequency" . For details on the used frequencies, see the data sheet.
This setting is not available for bandwidths larger than 512 MHz.

"2ND IF" The measured IF value is provided at the "IF OUT 2 GHz/ IF OUT 5 GHz " output connector, if available, at a frequency of 2 GHz and with a bandwidth of 2 GHz. The availability of this connector depends on the instrument model.
This setting is not available if the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is active.

"Video" The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output. It is not available for frequency sweeps or I/Q measurements.
The **video output** is a signal of 1 V. It can be used, for example, to control demodulated audio frequencies.

Remote command:
`OUTPut<up>:IF[:SOURce]` on page 352
`OUTPut<up>:IF:IFFRequency` on page 353

Noise Source Control

The R&S FSW provides a connector ("NOISE SOURCE CONTROL") with a 28 V voltage supply for an external noise source. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

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 an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S FSW and measure the total noise power. From this value you can determine the noise power of the R&S FSW. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 352

6.3.3 Digital I/Q Output Settings

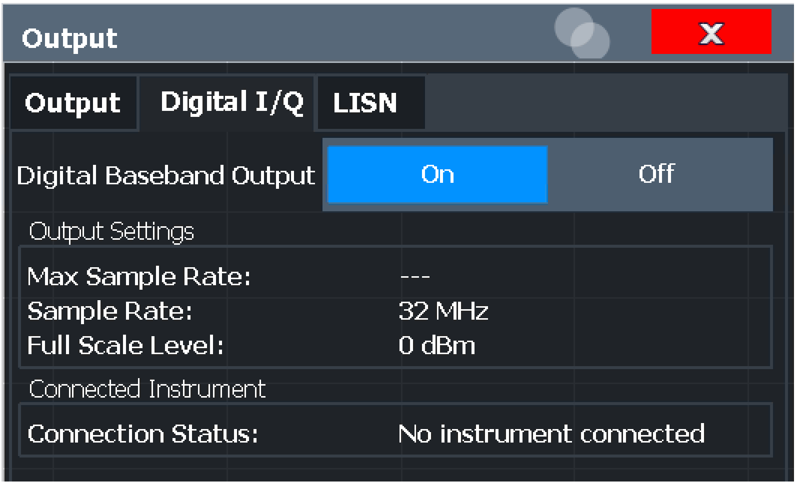
Access: "Overview" > "Output" > "Digital I/Q" tab

The optional Digital Baseband Interface allows you to output I/Q data from any R&S FSW application that processes I/Q data to an external device.

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

Digital I/Q output is available with bandwidth extension option R&S FSW-B512, but not with R&S FSW-B512R (Real-Time).

However, see the note regarding "Digital I/Q output and R&S FSW-B512/-B1200/-B2001 options" on page 45.



For details on digital I/Q output, see Chapter 5.2.2, "Digital Output", on page 44.

Digital Baseband Output

Enables or disables a digital output stream to the optional Digital Baseband Interface, if available.

Note: If digital baseband output is active, the sample rate is restricted to 200 MHz (max. 160 MHz bandwidth).
See also "Digital I/Q enhanced mode" on page 46.

The only data source that can be used for digital baseband output is RF input.

For details on digital I/Q output, see Chapter 5.2.2, "Digital Output", on page 44.

Remote command:
`OUTPut<up>:DIQ[:STATe]` on page 287

Output Settings Information

Displays information on the settings for output via the optional Digital Baseband Interface.

The following information is displayed:

- Maximum sample rate that can be used to transfer data via the Digital Baseband Interface (i.e. the maximum input sample rate that can be processed by the connected instrument)
- Sample rate currently used to transfer data via the Digital Baseband Interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1"

Remote command:
`OUTPut<up>:DIQ:CDEVice?` on page 287

Connected Instrument

Displays information on the instrument connected to the optional Digital Baseband Interface, if available.

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

Remote command:
OUTPut<up>:DIQ:CDEVice? on page 287

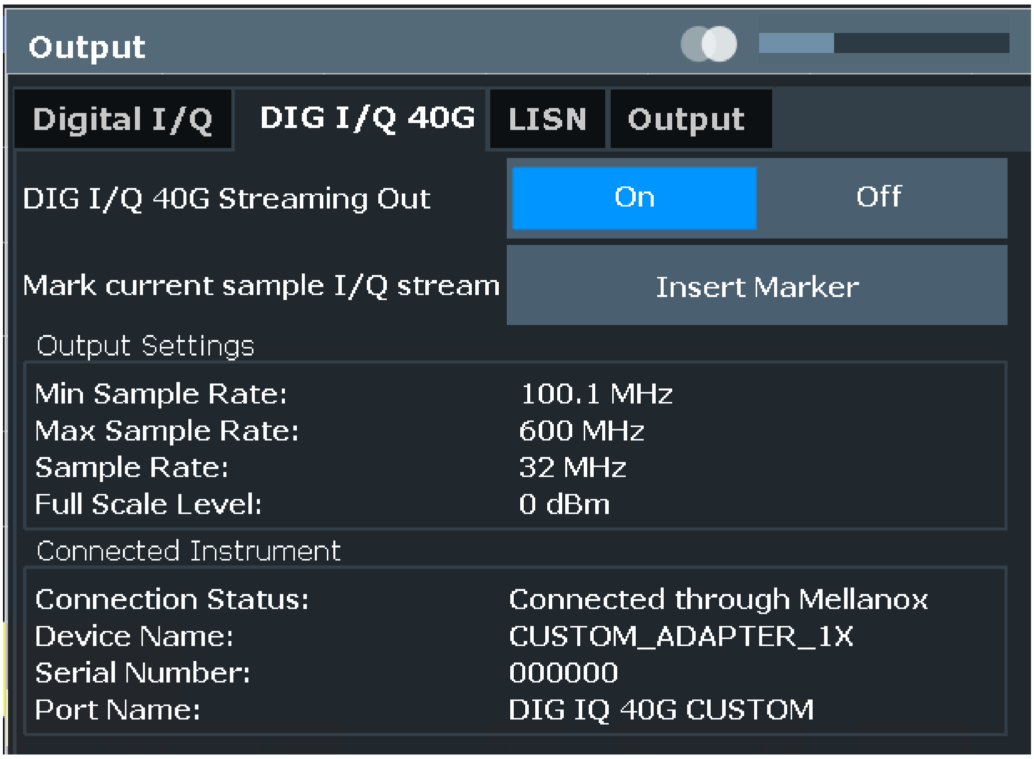
6.3.4 Digital I/Q 40G Output Settings

Access: "Overview" > "Output" > "Digital I/Q 40G" tab

The optional Digital I/Q 40G Streaming Output interface (R&S FSW-B517) allows you to output I/Q data to an external device at very high sample rates.

These settings are only available if the Digital I/Q 40G Streaming Output option is installed on the R&S FSW.

For details see Chapter 5.10, "Digital I/Q 40G Streaming Output", on page 95.



Digital I/Q 40G Streaming Out
Enables or disables a digital output stream to the optional Digital I/Q 40G Streaming Output connector, if available.

Remote command:
`OUTPut<up>:IQHS[:STATe]` on page 356

Insert Marker
Inserts marker information to the data stream during a running I/Q data output recording. Useful to mark a specific event during the measurement that you detect in the result window, for example. Then you can search for the marker information in the output data to analyze the effects at that time.

Tip: The "I/Q 40G Recording" window also provides an "Insert Marker" button that remains visible throughout the measurement, without having to open a dialog box. Thus, you can insert a marker at any time during the measurement.

For more information, see Chapter 5.10, "Digital I/Q 40G Streaming Output", on page 95.

Output Settings Information
Displays information on the settings for output via the Digital I/Q 40G Streaming Output option (R&S FSW-B517).

The following information is displayed:

- Minimum sample rate that can be used to transfer data via the Digital I/Q 40G Streaming Output interface
- Maximum sample rate that can be used to transfer data via the Digital I/Q 40G Streaming Output interface (i.e. the maximum input sample rate that can be processed by the connected instrument)
- Sample rate currently used to transfer data via the Digital I/Q 40G Streaming Output interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1" (Full scale level)

Remote command:
`OUTPut<up>:IQHS:SRATe?` on page 355

Connected Instrument
Displays information on the instrument connected to the Digital I/Q 40G Streaming Output connector, if available.

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

- Name and serial number of the instrument connected to the QSFP+ connector
- Used port

Remote command:
`OUTPut<up>:IQHS:CDEVice?` on page 355

6.4 Amplitude

Access: "Overview" > "Amplitude"

Amplitude settings are identical to the Spectrum application, except for a new scaling function for I/Q Vector and Real/Imag results (see " Y-Axis Max " on page 172).

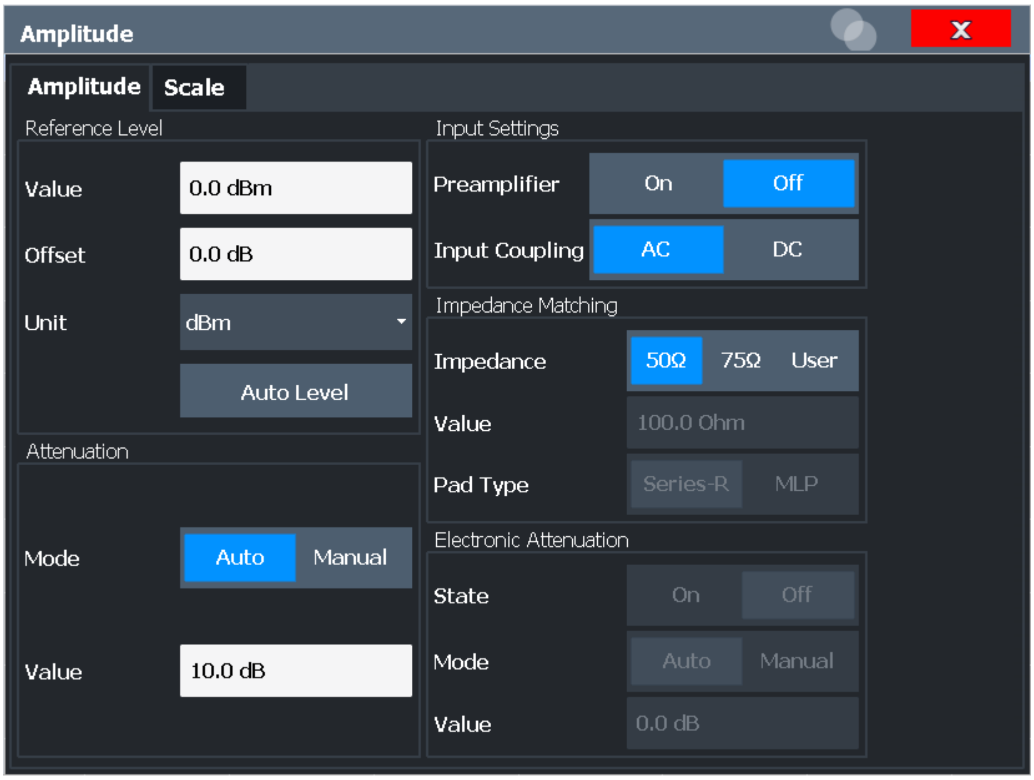
For background information on amplitude settings see the R&S FSW User Manual.

6.4.1 Amplitude Settings

Access: "Overview" > "Amplitude"

Amplitude settings determine how the R&S FSW must process or display the expected input power levels.

Amplitude settings for input from the optional Analog Baseband interface are described in the R&S FSW I/Q Analyzer and I/Q Input User Manual.



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 Overload" status display ("OVLD" for analog baseband or digital baseband input).

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).

Note that for input from the External Mixer (R&S FSW-B21) the maximum reference level also depends on the conversion loss; see the R&S FSW base unit user manual for details.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 357

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 358

Unit ← Reference Level

The R&S FSW measures the signal voltage at the RF input.

In the default state, the level is displayed at a power level of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see " Impedance " on page 119), conversion to other units is possible.

The following units are available and directly convertible:

- dBm
- dBmV
- dBμV
- dBμA
- dBpW
- Volt
- Ampere
- Watt

Remote command:
INPut<ip>:IMPedance on page 277
CALCulate<n>:UNIT:POWer on page 357

Setting the Reference Level Automatically (Auto Level) ← Reference Level
Automatically determines a reference level which ensures that no overload occurs at the R&S FSW for the current input data. At the same time, the internal attenuators and the preamplifier (for analog baseband input: the full scale level) are adjusted so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

Note: For Oscilloscope Baseband Input, the "Auto Level" function is not available.

To determine the required reference level, a level measurement is performed on the R&S FSW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

When using the optional 2 GHz / 5 GHz bandwidth extension (B2000/B5000) or the optional Oscilloscope Baseband Input, the level measurement is performed on the connected oscilloscope. For B2000/B5000, y-axis scaling on the oscilloscope is limited to a minimum of 5 mV per division.

You can change the measurement time for the level measurement if necessary (see " Changing the Automatic Measurement Time (Meastime Manual)" on page 196).

Remote command:
[SENSe:]ADJust:LEVel on page 392

RF Attenuation
Defines the attenuation applied to the RF input of the R&S FSW.

This function is not available for input from the optional Digital Baseband Interface.

Attenuation Mode / Value ← RF 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.

This function is not available for input from the optional **Digital Baseband Interface**.

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<ip>:ATTenuation on page 358
INPut<ip>:ATTenuation:AUTO on page 359

Optimization

Selects the priority for signal processing *after* the RF attenuation has been applied.

This function is only available under the following conditions:

- Bandwidth extension R&S FSW-B160/-B320 Extension Board 1, Revision 2 or higher, R&S FSW-B512, or the real-time option R&S FSW-B160R is installed (these options provide a separate wideband processing path in the R&S FSW)
- An I/Q bandwidth higher than 80 MHz is used (only in this case the wideband path is used)
- The optional Digital Baseband Interface is not active

"Low distortion" (Default:) Optimized for low distortion by avoiding intermodulation

"Low noise" Optimized for high sensitivity and low noise levels
If this setting is selected, "Low noise" is indicated in the channel information bar.

Remote command:
`INPut<ip>:ATTenuation:AUTO:MODE` on page 359

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.

This function is not available for input from the optional Digital Baseband Interface.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) above 15 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.

The electronic attenuation can be varied in 1 dB steps. If the electronic attenuation is on, the mechanical attenuation can be varied in 5 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<ip>:EATT:STATe` on page 361
`INPut<ip>:EATT:AUTO` on page 360
`INPut<ip>:EATT` on page 360

Input Settings

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

The parameters "Input Coupling" and "Impedance" are identical to those in the "Input" settings.

See Chapter 6.3.1, "Input Source Settings", on page 116.

Preamplifier ← Input Settings
If the (optional) internal 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.

Note that if an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

This function is not available for input from the (optional) Digital Baseband Interface.

For R&S FSW8, 13, and 26 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.

For R&S FSW43 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

Remote command:
`INPut<ip>:GAIN:STATe` on page 362
`INPut<ip>:GAIN[:VALue]` on page 363

Ext. PA Correction ← Input Settings
This function is only available if an external preamplifier is connected to the R&S FSW, and only for frequencies above 1 GHz. For details on connection, see the preamplifier's documentation.

Using an external preamplifier, you can measure signals from devices under test with low output power, using measurement devices which feature a low sensitivity and do not have a built-in RF preamplifier.

When you connect the external preamplifier, the R&S FSW reads out the touchdown (`.S2P`) file from the EEPROM of the preamplifier. This file contains the s-parameters of the preamplifier. As soon as you connect the preamplifier to the R&S FSW, the preamplifier is permanently on and ready to use. However, you must enable data correction based on the stored data explicitly on the R&S FSW using this setting.

When enabled, the R&S FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results. Any internal preamplifier, if available, is disabled.

For R&S FSW85 models with two RF inputs, you can enable correction from the external preamplifier for each input individually, but not for both at the same time.

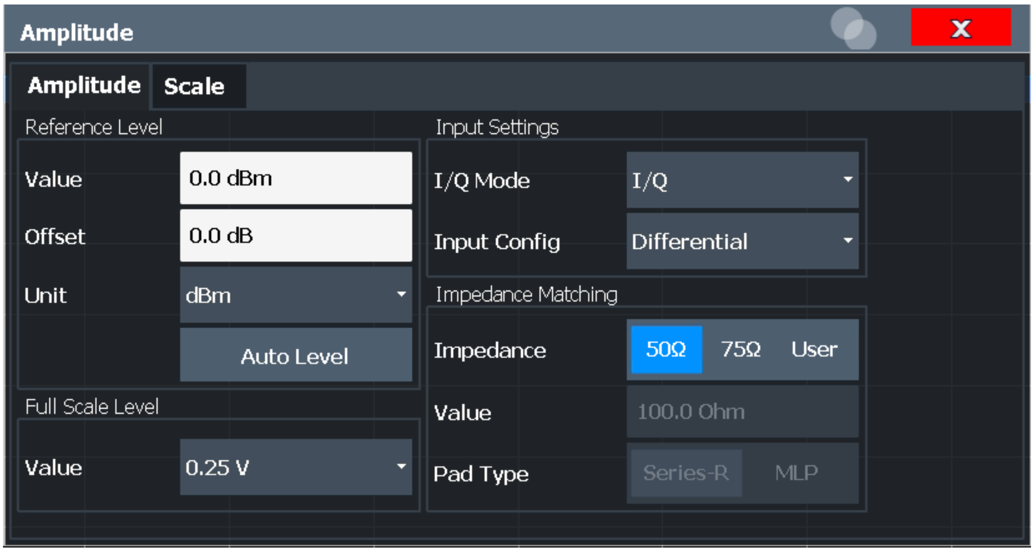
When disabled, no compensation is performed even if an external preamplifier remains connected.

Remote command:
`INPut<ip>:EGAin[:STATe]` on page 361

6.4.2 Amplitude Settings for Analog Baseband and Oscilloscope Baseband Input

Access: "Overview" > "Amplitude"

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



The input and impedance settings provided here are identical to those in the "Input Source" > "Analog Baseband" tab, see Chapter 6.3.1.5, "Analog Baseband Input Settings", on page 134.

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 Overload" status display ("OVLD" for analog baseband or digital baseband input).

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).

Note that for input from the External Mixer (R&S FSW-B21) the maximum reference level also depends on the conversion loss; see the R&S FSW base unit user manual for details.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel on page 357

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 358

Unit ← Reference Level

The R&S FSW measures the signal voltage at the RF input.

In the default state, the level is displayed at a power level of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see " Impedance " on page 119), conversion to other units is possible.

The following units are available and directly convertible:

- dBm
- dBmV
- dBμV
- dBμA
- dBpW
- Volt
- Ampere
- Watt

Remote command:
INPut<ip>:IMPedance on page 277
CALCulate<n>:UNIT:POWer on page 357

Setting the Reference Level Automatically (Auto Level) ← Reference Level

Automatically determines a reference level which ensures that no overload occurs at the R&S FSW for the current input data. At the same time, the internal attenuators and the preamplifier (for analog baseband input: the full scale level) are adjusted so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

Note: For Oscilloscope Baseband Input, the "Auto Level" function is not available.

To determine the required reference level, a level measurement is performed on the R&S FSW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

When using the optional 2 GHz / 5 GHz bandwidth extension (B2000/B5000) or the optional Oscilloscope Baseband Input, the level measurement is performed on the connected oscilloscope. For B2000/B5000, y-axis scaling on the oscilloscope is limited to a minimum of 5 mV per division.

You can change the measurement time for the level measurement if necessary (see " Changing the Automatic Measurement Time (Meastime Manual)" on page 196).

Remote command:
`[SENSe:]ADJust:LEVel` on page 392

Full Scale Level Mode / Value
The full scale level defines the maximum power you can input at the Baseband Input connector without clipping the signal.

The full scale level can be defined automatically according to the reference level, or manually.

For manual input, the following values can be selected:

- 0.25 V
- 0.5 V
- 1 V
- 2 V

If probes are connected, the possible full scale values are adapted according to the probe's attenuation and maximum allowed power.

For details on probes, see Chapter 5.5, "Using Probes", on page 60.

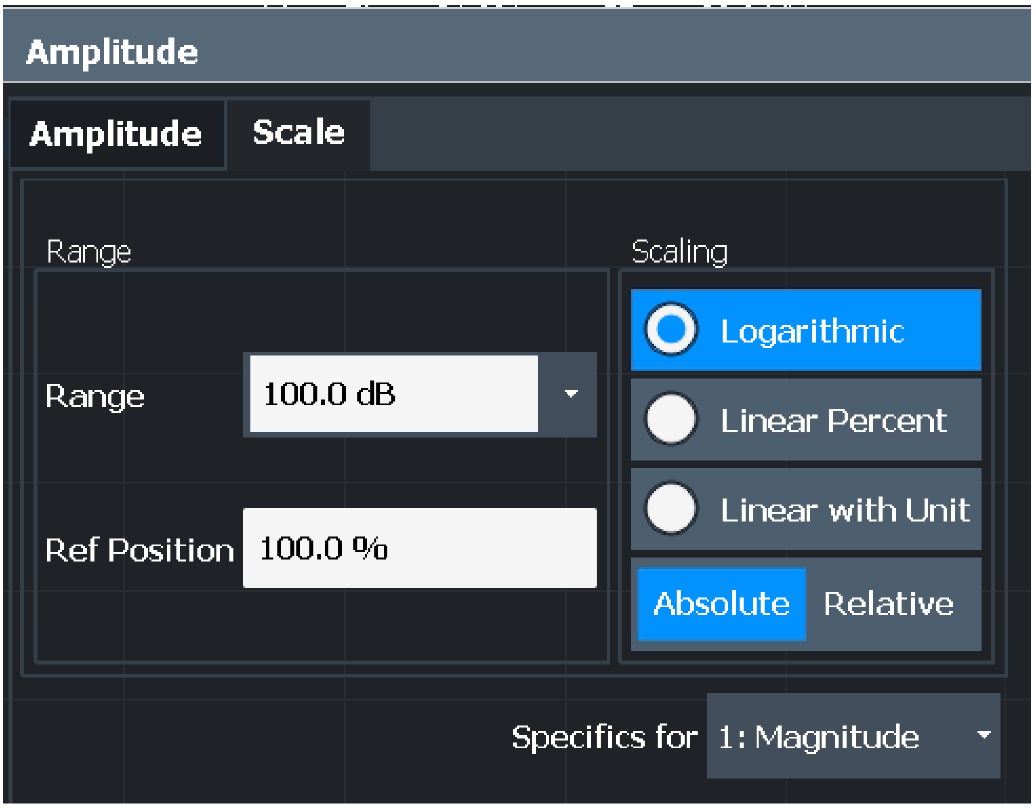
Remote command:
For Analog Baseband input:
`INPut<ip>:IQ:FULLscale:AUTO` on page 290
`INPut<ip>:IQ:FULLscale[:LEVel]` on page 290
For Oscilloscope Baseband Input:
`INPut<ip>:IQ:OSC:FULLscale[:LEVel]` on page 297

6.4.3 Scaling the Y-Axis

The individual scaling settings that affect the vertical axis are described here.

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [AMPT] > "Scale Config"



Range

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 364

Ref Level Position

Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %.

0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Values from -120 % to +600 % are available. Larger values are useful for small scales, such as a power range of 10 dB or 20 dB, and low signal levels, for example 60 dB below the reference level. In this case, large reference level position values allow you to see the trace again.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 365

Scaling

Defines the scaling method for the y-axis.

"Logarithmic"	Logarithmic scaling (only available for logarithmic units - dB..., and A, V, Watt)
"Linear with Unit"	Linear scaling in the unit of the measured signal
"Linear Percent"	Linear scaling in percentages from 0 to 100
"Absolute"	The labeling of the level lines refers to the absolute value of the reference level (not available for "Linear Percent")
"Relative"	The scaling is in dB, relative to the reference level (only available for logarithmic units - dB...). The upper line of the grid (reference level) is always at 0 dB.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 366
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE` on page 364

Y-Axis Max

Defines the maximum value of the y-axis in the currently selected diagram in either direction (in Volts). Thus, the y-axis scale starts at -<Y-Axis Max> and ends at +<Y-Axis Max>.

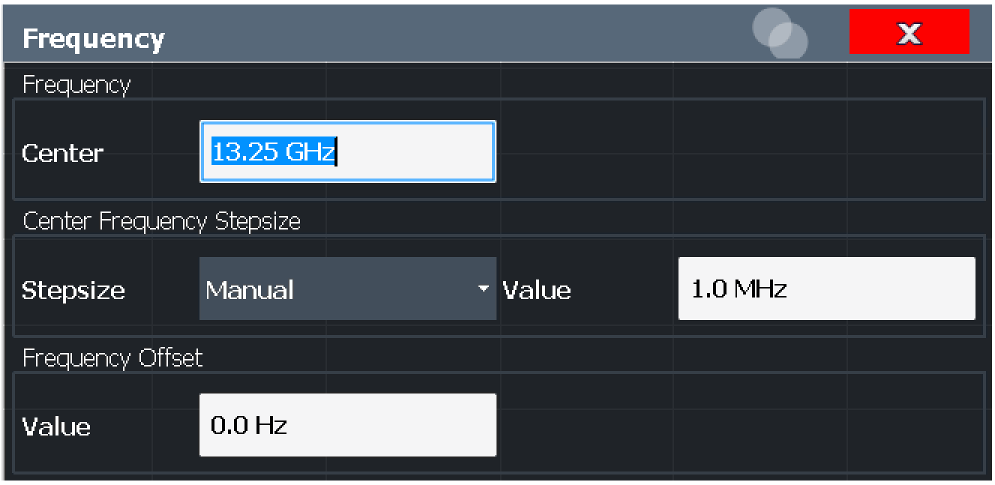
The maximum y-axis value depends on the current reference level. If the reference level is changed, the "Y-Axis Max" value is automatically set to the new reference level (in V).

This command is only available if the evaluation mode for the I/Q Analyzer is set to "I/Q-Vector" or "Real/Imag (I/Q)" .

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 364

6.5 Frequency Settings

Access: "Overview" > "Frequency"



Center Frequency

Defines the center frequency of the signal in Hertz.

The allowed range of values for the center frequency depends on the frequency span.

span > 0: $span_{min}/2 \leq f_{center} \leq f_{max} - span_{min}/2$

f_{max} and $span_{min}$ depend on the instrument and are specified in the data sheet.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 367

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.

"= 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 367

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. However, if it shows frequencies relative to the signal's center frequency, it is not shifted.

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 -1 THz to 1 THz. The default setting is 0 Hz.

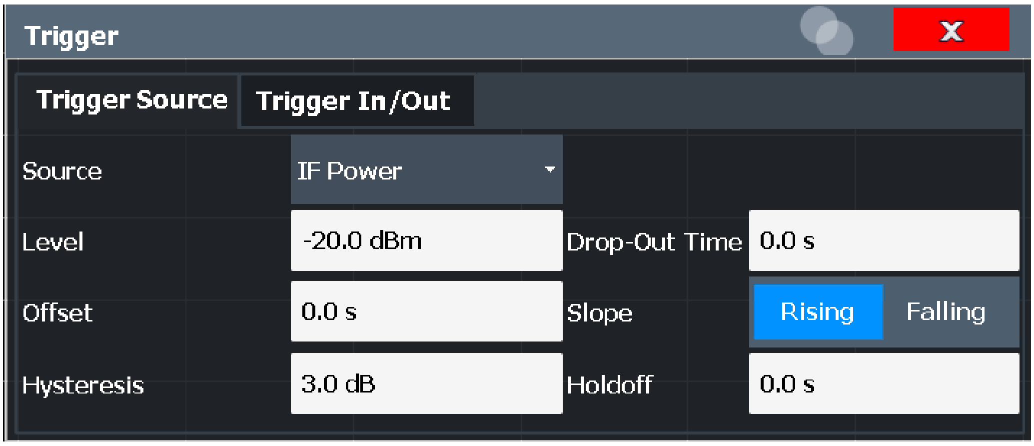
Note: In MSRA/MSRT mode, this function is only available for the MSRA/MSRT Master.

Remote command:
[SENSe:]FREQuency:OFFSet on page 368

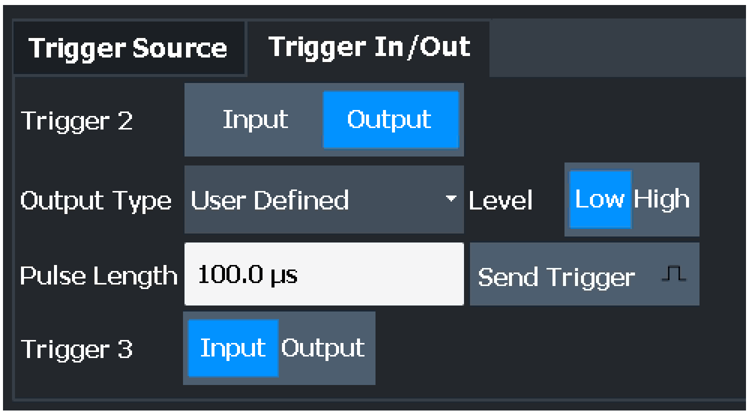
6.6 Trigger Settings

Access: "Overview" > "Trigger" (> "Trigger In/Out")

Trigger settings determine when the input signal is measured.



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.



Conventional gating as in the Spectrum application is not available for the I/Q Analyzer; however, a special gating mode is available in remote control, see Chapter 10.4.4.3, "Configuring I/Q Gating", on page 378.

For step-by-step instructions on configuring triggered measurements, see the R&S FSW User Manual.

Trigger Source

The trigger settings define the beginning of a measurement.

Trigger Source ← 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.

Note: If the 1.2 GHz bandwidth extension option (B1200) or the internal 2 GHz option (B2001) is active, only an external trigger, IF power trigger, or no trigger is available.
If a B4001/B6001/B8001 bandwidth extension option is active, only an external trigger, power trigger, or no trigger is available for bandwidths ≥80 MHz. If any trigger other than an external trigger or power trigger is active and the analysis bandwidth is increased above 80 MHz (thus activating the B4001/B6001/B8001 option), the trigger is automatically deactivated.

Remote command:

`TRIGger[:SEQuence]:SOURce` on page 373

Free Run ← Trigger Source ← 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 373

External Trigger 1/2/3 ← Trigger Source ← 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 179).

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT connector on the front panel.
In the I/Q Analyzer application, only "External Trigger 1" is supported.

If the optional 2 GHz / 5 GHz bandwidth extension (B2000/B5000) is active, only External Channel 3 is supported.

If the optional 2 GHz / 5 GHz bandwidth extension (B2000/B5000) *and the power splitter mode* is active, only "External Analog" on page 177 is supported.

If the optional Oscilloscope Baseband Input is active, only "External Analog" on page 177 is supported.

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 "Output" configuration
For R&S FSW85 models, Trigger 2 is not available due to the second RF input connector on the front panel.
(See the R&S FSW User Manual).

"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 "Output" configuration.

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
`TRIG:SOUR EXT3`
See `TRIGger[:SEQuence]:SOURce` on page 373

External Channel 3 ← Trigger Source ← Trigger Source
Data acquisition starts when the signal fed into the **Ch3** input connector on the oscilloscope meets or exceeds the specified trigger level.

Note: In previous firmware versions, the external trigger was connected to the Ch2 input on the oscilloscope. As of firmware version R&S FSW 2.30, the **Ch3** input on the oscilloscope must be used!

This trigger source is only available if the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is active (see R&S FSW I/Q Analyzer and I/Q Input User Manual).

If power splitter mode is active, use the "External Analog" on page 177 option.

For details, see Chapter 5.9.7, "Triggering", on page 91.

Note: Since the external trigger uses a second channel on the oscilloscope, the maximum memory size, and thus record length, available for the input channel 1 may be reduced by half. For details, see the oscilloscope's data sheet and documentation.

Remote command:
`TRIG:SOUR EXT`, see `TRIGger[:SEQuence]:SOURce` on page 373

External Analog ← Trigger Source ← Trigger Source
Data acquisition starts when the signal fed into the EXT TRIGGER INPUT connector on the oscilloscope meets or exceeds the specified trigger level.

For details, see Chapter 5, "Basics on I/Q Data Acquisition and Processing", on page 21.

Remote command:
`TRIG:SOUR EXT`, see `TRIGger[:SEQuence]:SOURce` on page 373

IF Power ← Trigger Source ← Trigger Source
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.

It is not available for input from the optional Digital Baseband Interface or the optional Analog Baseband Interface.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

When using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) with an IF power trigger, the IF power trigger corresponds to a "width" trigger on the oscilloscope, with a negative polarity and the range "longer". Thus, data acquisition starts when both of the following conditions apply to the signal fed into the CH1 input connector on the oscilloscope:
- The power level has remained below the specified trigger level for a duration longer than the drop-out time.
- The power level then rises above the specified trigger level.

For details, see "IF Power trigger" on page 92.

For details on available trigger levels and trigger bandwidths, see the data sheet.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 373

Baseband Power ← Trigger Source ← Trigger Source

Defines triggering on the baseband power (for baseband input via the optional Digital Baseband Interface or the optional Analog Baseband interface).

For more information on the Digital Baseband Interface, see Chapter 5.2, "Processing Data from the Digital Baseband Interface ", on page 42.

For more information on the Analog Baseband Interface, see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48.

Remote command:
`TRIG:SOUR BBP`, see `TRIGger[:SEQuence]:SOURce` on page 373

I/Q Power ← Trigger Source ← Trigger Source

This trigger source is only available in the I/Q Analyzer application and in applications that process I/Q data.

This trigger source is not available if the optional Digital Baseband Interface or optional Analog Baseband Interface is used for input.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the bandwidth setting for I/Q data acquisition.

(See " Analysis Bandwidth " on page 185).

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 373

Digital I/Q ← Trigger Source ← Trigger Source

For applications that process I/Q data, such as the I/Q Analyzer or optional applications, and only if the optional Digital Baseband Interface is available:

Defines triggering of the measurement directly via the LVDS connector. In the selection list, specify which general purpose bit (GP0 to GP5) provides the trigger data.

Note:
If the Digital I/Q enhanced mode is used, i.e. the connected device supports transfer rates up to 200 Msps, only the general purpose bits GP0 and GP1 are available as a Digital I/Q trigger source.

(See also "Digital I/Q enhanced mode" on page 46.)

A Trigger Offset , and " Slope " on page 181 can be defined for the Digital I/Q trigger to improve the trigger stability, but no hysteresis or holdoff value.

The following table describes the assignment of the general purpose bits to the LVDS connector pins.

(For details on the LVDS connector, see Chapter A, "Description of the LVDS Connector", on page 499)

Table 6-1: Assignment of general purpose bits to LVDS connector pins

Bit	LVDS pin
GP0	SDATA4_P - Trigger1
GP1	SDATA4_P - Trigger2
*): not available for Digital I/Q enhanced mode	

Bit	LVDS pin
GP2 *)	SDATA0_P - Reserve1
GP3 *)	SDATA4_P - Reserve2
GP4 *)	SDATA0_P - Marker1
GP5 *)	SDATA4_P - Marker2
*): not available for Digital I/Q enhanced mode	

Remote command:
`TRIG:SOUR GP0`, see `TRIGger[:SEQuence]:SOURce` on page 373

RF Power ← Trigger Source ← 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 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 sweep 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" .

This trigger source is not available for input from the optional Digital Baseband Interface or the optional Analog Baseband Interface. If the trigger source "RF Power" is selected and digital I/Q or analog baseband input is activated, the trigger source is automatically switched to "Free Run" .

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 373

Time ← Trigger Source ← Trigger Source
Triggers in a specified repetition interval.

See " Repetition Interval " on page 180.

If a B4001/B6001/B8001 bandwidth extension option is active, this trigger is not available for bandwidths ≥80 MHz.

Remote command:
`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 373

Trigger Level ← Trigger Source
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 372
`TRIGger[:SEQuence]:LEVel:IQPower` on page 372

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] on page 371
TRIGger[:SEQuence]:LEVel:RFPower on page 372
For analog baseband or digital baseband input only:
TRIGger[:SEQuence]:LEVel:BBPower on page 371

Repetition Interval ← Trigger Source
Defines the repetition interval for a time trigger. The shortest interval is 2 ns.

The repetition interval should be set to the exact pulse period, burst length, frame length or other repetitive signal characteristic.

Remote command:
TRIGger[:SEQuence]:TIME:RINTerval on page 375

Drop-Out Time ← Trigger Source
Defines the time the input signal must stay below the trigger level before triggering again.

Note: For input from the optional Analog Baseband Interface using the baseband power trigger (BBP), the default drop out time is set to 100 ns. This avoids unintentional trigger events (as no hysteresis can be configured in this case).

When using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) with an IF power trigger, the drop-out time defines the width of the robust width trigger. By default it is set to 1 µs. For external triggers, no drop-out time is available when using the B2000/B5000 option.

(For details, see "IF Power trigger" on page 92)

Remote command:
TRIGger[:SEQuence]:DTIMe on page 369

Trigger Offset ← Trigger Source
Defines the time offset between the trigger event and the start of the sweep.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off Maximum allowed range limited by the sweep time: $Pretrigger_{max}$ = sweep $time_{max}$ When using the optional Digital Baseband Interface, the maximum range is limited by the number of pretrigger samples. (See Table 5-11)

Tip: To determine the trigger point in the sample (for "External" or "IF Power" trigger source), use the TRACe:IQ:TPISample? command.

For the "Time" trigger source, this function is not available.

Remote command:
TRIGger[:SEQuence]:HOLDoff[:TIME] on page 370

Coupling ← Trigger Source
If the selected trigger source is "IF Power" or External Channel 3 , you can configure the coupling of the external trigger to the oscilloscope.

This setting is only available if the optional 2 GHz bandwidth extension is active.

"DC 50 Ω"	Direct connection with 50 Ω termination, passes both DC and AC components of the trigger signal.
"DC 1 MΩ"	Direct connection with 1 MΩ termination, passes both DC and AC components of the trigger signal.
"AC"	Connection through capacitor, removes unwanted DC and very low-frequency components.

Remote command:
`TRIGger[:SEQuence]:OSCilloscope:COUPling` on page 351

Hysteresis ← Trigger Source
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.

When using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) with an IF power trigger, the hysteresis refers to the robust width trigger.

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 370

Trigger Holdoff ← Trigger Source
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 370

Slope ← Trigger Source
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.

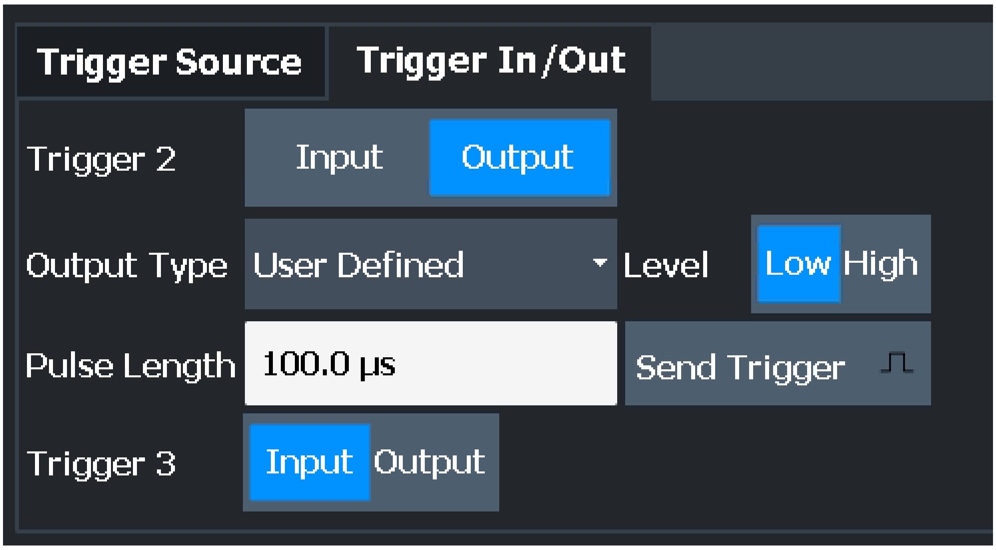
For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

When using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) with an IF power trigger, only rising slopes can be detected.

(For details see "IF Power trigger" on page 92)

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 373

Trigger 2/3



Defines the usage of the variable Trigger Input/Output connectors, where:

"Trigger 2" : Trigger Input/Output connector on the front panel

(not available for R&S FSW85 models with 2 RF input connectors)

"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<up>:TRIGger<tp>:DIRection` on page 376

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.

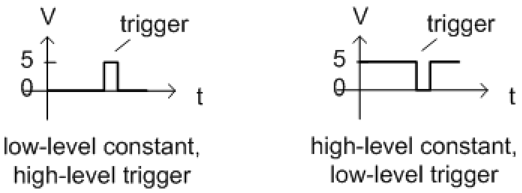
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).
For details, see the description of the `STATus:OPERation` register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

"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<up>:TRIGger<tp>:OTYPe on page 377

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<up>:TRIGger<tp>:LEVel on page 376

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<up>:TRIGger<tp>:PULSe:LENGth on page 377

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<up>:TRIGger<tp>:PULSe:IMMediate on page 377

6.7 Data Acquisition and Bandwidth Settings

Access: "Overview" > "Bandwidth"

6.7.1 Data Acquisition

Access: "Overview" > "Bandwidth" > "Data Acquisition" tab

The data acquisition settings define which parts of the input signal are captured for further evaluation in the applications.

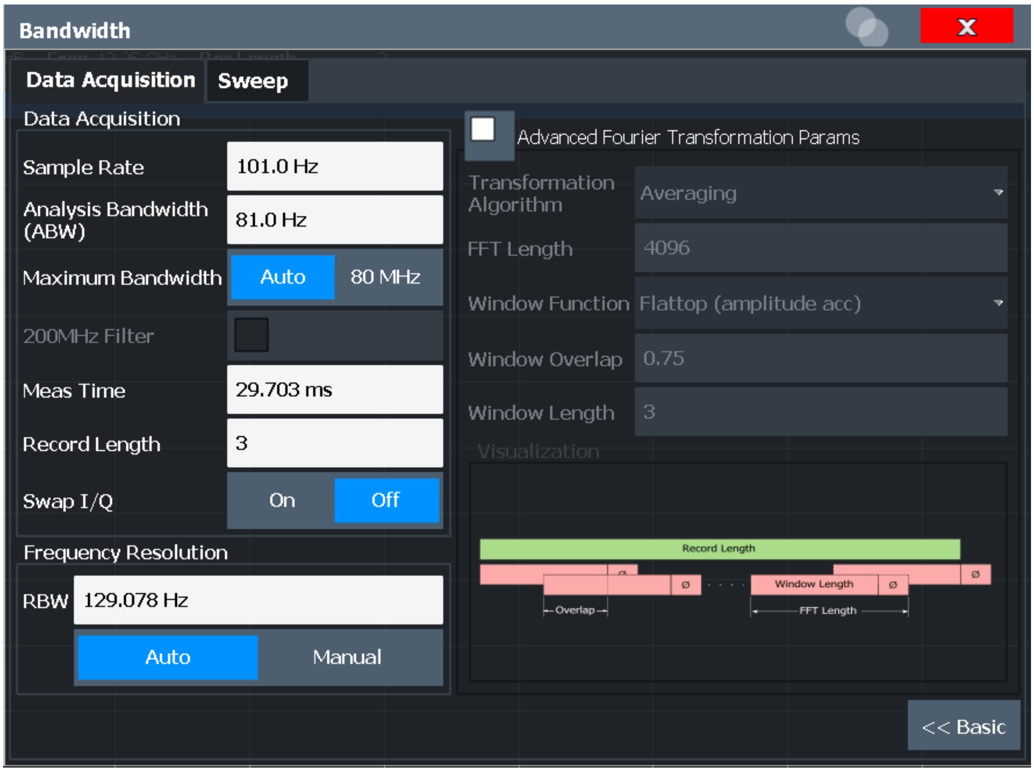


Figure 6-2: Data acquisition settings with advanced FFT parameters

MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT Master channel actually captures data from the input signal. The data acquisition settings for the I/Q Analyzer application in MSRA/MSRT mode define the analysis interval.

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.

The remote commands required to perform these tasks are described in Chapter 10.4.5, "Configuring Data Acquisition", on page 380.

Sample Rate
Defines the I/Q data sample rate of the R&S FSW. This value depends on the defined Analysis Bandwidth .

Up to the Maximum Bandwidth , the following rule applies:

sample rate = analysis bandwidth / 0.8

For details on the dependencies see Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.

In particular, note the irregularities mentioned in Chapter 5.1.1.9, "R&S FSW with Activated I/Q Bandwidth Extension Option -B512", on page 32 and "Irregular behavior in bandwidths between 480 MHz and 512 MHz with R&S FSW-B1200 option"
on page 35.

This rate may differ from the sample rate of the connected device (see " Input Sample Rate " on page 134).

If the Digital Baseband Interface (R&S FSW-B17) is active, restrictions to the sample rate apply, see Chapter 5.2.3, "Sample Rates and Bandwidths for Digital I/Q Data", on page 45.

Remote command:
`TRACe:IQ:SRATe` on page 387

Analysis Bandwidth
Defines the flat, usable bandwidth of the final I/Q data. This value depends on the defined Sample Rate .

Up to the Maximum Bandwidth , the following rule applies:

*analysis bandwidth = 0.8 * sample rate*

Note: Bandwidths up to 2 GHz / 5 GHz are only available if the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is installed *and active* (see "B2000/B5000 State" on page 151). The option is not activated automatically by defining a larger bandwidth.

Note: For input from the optional **Analog Baseband interface**: If the frequency range defined by the analysis bandwidth and the center frequency exceeds the minimum frequency (0 Hz for low IF evaluation) or the maximum frequency (for I+jQ evaluation), an error is displayed. In this case, adjust the center frequency or the analysis bandwidth to exclude possible unwanted signal components.
For details on frequency ranges and the analysis bandwidth see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48.

Remote command:
`TRACe:IQ:BWIDth` on page 384

Maximum Bandwidth

Defines the maximum bandwidth to be used by the R&S FSW for I/Q data acquisition. Which options are available depends on which bandwidth extension options are installed.

This setting is only available if a bandwidth extension option greater than 160 MHz is installed on the R&S FSW. Otherwise the maximum bandwidth is determined automatically.

Note: This setting is not available for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

"Auto"	(Default) All installed bandwidth extension options are enabled. The currently available maximum bandwidth is allowed. (See "Restricting the maximum bandwidth manually" on page 27). Note that using bandwidth extension options greater than 160 MHz may cause more spurious effects. **Note:** If a bandwidth extension greater than 160 MHz is active on the R&S FSW, the "IF WIDE OUTPUT" connector is automatically used to provide IF output. See the R&S FSW Getting Started manual for details on the connector.
"80 MHz"	Restricts the analysis bandwidth to a maximum of 80 MHz. The bandwidth extension options greater than 160 MHz are disabled.
"160 MHz"	Restricts the analysis bandwidth to a maximum of 160 MHz. The bandwidth extension option for 320 MHz is disabled. (Not available or required if other bandwidth extension options larger than 320 MHz are installed.)
"512 MHz"	Restricts the analysis bandwidth to a maximum of 512 MHz. Larger bandwidth extension options are disabled.
"1200 MHz"	Restricts the analysis bandwidth to a maximum of 1200 MHz. Larger bandwidth extension options are disabled.
"4400 MHz"	Restricts the analysis bandwidth to a maximum of 4400 MHz. Larger bandwidth extension options are disabled.

Remote command:
`TRACe:IQ:WBANd[:STATe]` on page 388
`TRACe:IQ:WBANd:MBWidth` on page 388

Omitting the Digital Decimation Filter (No Filter)

This setting is only available when using the optional Digital Baseband Interface.

If enabled, no digital decimation filter is used during data acquisition. Thus, the Analysis Bandwidth is identical to the input sample rate configured for the Digital I/Q input source (see " Input Sample Rate " on page 134).

Note, however, that in this case noise, artifacts, and the second IF side band may not be suppressed in the captured I/Q data.

Remote command:
`TRACe:IQ:DIQFilter` on page 384

200 MHz Filter
Activates a 200 MHz filter before the A/D converter, thus restricting the processed bandwidth to 200 MHz while using the wideband processing path in the R&S FSW.

This is useful for signals that have a bandwidth of approximately 200 MHz (for example Docsis 3.1). In this case, the R&S FSW can optimize signal processing for the relevant signal and filter out unwanted signal parts from adjacent channels, while taking advantage of a higher sample rate.

If you simply reduce the specified Analysis Bandwidth , the sample rate, which is coupled, is also reduced.

This function is only available under the following conditions:
- Bandwidth extension R&S FSW-B160/-B320 Extension Board 1, Revision 2 or higher, R&S FSW-B512, or the real-time option R&S FSW-B160R is installed (these options provide a separate wideband processing path in the R&S FSW)
- An I/Q bandwidth higher than 80 MHz is used (only in this case the wideband path is used)
- The optional Digital Baseband Interface is not active

If the filter is active, "200 MHz" is indicated in the channel information bar.

Remote command:
`TRACe:IQ:WFILter` on page 389

Meas Time
Defines the I/Q acquisition time. By default, the measurement time is calculated as the number of I/Q samples ("Record Length") divided by the sample rate. If you change the measurement time, the Record Length is automatically changed, as well.

For details on the maximum number of samples see also Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.

Remote command:
`[SENSe:]SWEep:TIME` on page 407

Record Length
Defines the number of I/Q samples to record. By default, the number of sweep points is used. The record length is calculated as the measurement time multiplied by the sample rate. If you change the record length, the Meas Time is automatically changed, as well.

Note: For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number of trace points to be displayed ("Sweep Points"). Thus, the sweep points are not editable for this result display. If the "Record Length" is edited, the sweep points are adapted automatically.
For record lengths outside the valid range of sweep points, i.e. fewer than 101 points or more than 100001 points, the diagram does not show valid results.

Note: If the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) or the optional Oscilloscope Baseband Input is used, the record length may be restricted by the connected oscilloscope (see its data sheet).

Remote command:
`TRACe:IQ:RLENgth` on page 385
`TRACe:IQ:SET` on page 385

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.

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 384

RBW
Defines the resolution bandwidth for Spectrum results. The available RBW values depend on the sample rate and record length.

(See Chapter 5.14.4, "Frequency Resolution of FFT Results - RBW", on page 105).

Depending on the selected RBW mode, the value is either determined automatically or can be defined manually. As soon as you enter a value in the input field, the RBW mode is changed to "Manual" .

If the "Advanced Fourier Transformation Params" option is enabled, advanced FFT mode is selected and the RBW cannot be defined directly.

Note that the RBW is correlated with the Sample Rate and Record Length (and possibly the Window Function and Window Length). Changing any one of these parameters may cause a change to one or more of the other parameters. For more information see Chapter 5.14, "Basics on FFT", on page 101.

"Auto mode" (Default) The RBW is determined automatically depending on the Sample Rate and Record Length .

"Manual mode" The RBW can be defined by the user.
The user-defined RBW is used and the Window Length (and possibly Sample Rate) are adapted accordingly.

"Advanced FFT mode" This mode is used if the "Advanced Fourier Transformation Params" option is enabled.
The RBW is determined by the advanced FFT parameters.

Remote command:
`[SENSe:]IQ:BWIDth:MODE` on page 381
`[SENSe:]IQ:BWIDth:RESolution` on page 382

Advanced FFT mode / Basic Settings
Shows or hides the "Advanced Fourier Transformation" parameters in the "Data Acquisition" dialog box.

These parameters are only available and required for the advanced FFT mode.

Note that if the advanced FFT mode is used, the RBW settings are not available.

For more information see Chapter 5.14.4, "Frequency Resolution of FFT Results - RBW", on page 105.

Transformation Algorithm ← Advanced FFT mode / Basic Settings
Defines the FFT calculation method.

"Single" One FFT is calculated for the entire record length; if the FFT Length is larger than the record length, zeros are appended to the captured data.

"Averaging" Several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record. The number of FFTs to be averaged is determined by the Window Overlap and the Window Length .

Remote command:
`[SENSe:]IQ:FFT:ALGorithm` on page 382

FFT Length ← Advanced FFT mode / Basic Settings
Defines 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.

In advanced FFT mode, the number of sweep points is set to the FFT length automatically.

Note: If you use the arrow keys or the rotary knob to change the FFT length, the value is incremented or decremented by powers of 2.
If you enter the value manually, any integer value from 3 to 524288 is available.

Remote command:
`[SENSe:]IQ:FFT:LENGth` on page 383

Window Function ← Advanced FFT mode / Basic Settings
In the I/Q analyzer you can select one of several FFT window types.

The following window types are available:
- Blackman-Harris
- Flattop
- Gauss
- Rectangular
- 5-Term

Remote command:
`[SENSe:]IQ:FFT:WINDow:TYPE` on page 383

Window Overlap ← Advanced FFT mode / Basic Settings
Defines the part of a single FFT window that is re-calculated by the next FFT calculation when using multiple FFT windows.

Remote command:
`[SENSe:]IQ:FFT:WINDow:OVERlap` on page 383

Window Length ← Advanced FFT mode / Basic Settings
Defines the number of samples to be included in a single FFT window in averaging mode. (In single mode, the window length corresponds to the " Record Length " on page 187.)

Values from 3 to 4096 are available in "Manual" mode; in "Advanced" FFT mode, values from 3 to 524288 are available.

However, the window length may not be longer than the FFT Length .

Remote command:
`[SENSe:]IQ:FFT:WINDow:LENGth` on page 383

Capture Offset
This setting is only available for client 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 client application data.

In MSRA mode, the offset must be a positive value, as the capture buffer starts at the trigger time = 0.

In MSRT mode, the offset can be negative if a pretrigger time is defined.

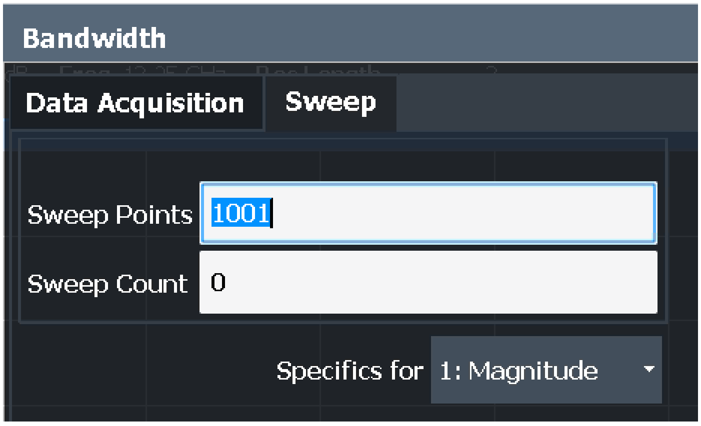
For details on the MSRA operating mode, see the R&S FSW MSRA User Manual.

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 467
MSRT mode:
`[SENSe:]RTMS:CAPTure:OFFSet` on page 469

6.7.2 Sweep Settings

Access: "Overview" > "Bandwidth" > "Sweep" tab



Sweep Points

In the I/Q Analyzer application, a specific frequency bandwidth is swept for a specified measurement time. During this time, a defined number of samples (= "Record Length") are captured. These samples are then evaluated by the applications. Therefore, in this case the number of sweep points does not define the amount of data to be acquired, but rather the number of trace points that are evaluated and displayed in the result diagrams.

Note: As opposed to previous versions of the I/Q Analyzer, the sweep settings are now window-specific.

For some result displays, the sweep points may not be editable as they are determined automatically, or restrictions may apply. For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number of trace points to be displayed ("Sweep Points"). Thus, the sweep points are not editable for this result display. If the "Record Length" is edited, the sweep points are adapted automatically. For record lengths outside the valid range of sweep points, i.e. less than 101 points or more than 100001 points, the diagram does not show valid results.

Using fewer than 4096 sweep points with a detector other than "Auto Peak" may lead to wrong level results. For details see "Combining results - trace detector" on page 103.

Remote command:

`[SENSe:]SWEep[:WINDow<n>]:POINts` on page 406

Sweep/Average Count

Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed.

The sweep count is applied to all the traces in all diagrams.

If the trace modes "Average" , "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if "Sweep Count" = 0 (default), averaging is performed over 10 sweeps. For "Sweep Count" =1, no averaging, maxhold or minhold operations are performed.

Remote command:

`[SENSe:]SWEep:COUNt` on page 406

`[SENSe:]AVERage<n>:COUNt` on page 413

Continuous Sweep / Run Cont

After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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. If the Sequencer is active, the "Continuous 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, a channel in continuous sweep mode is swept repeatedly.
If the Sequencer is active in MSRT mode, the "Continuous Sweep" function does not start data capturing. It merely affects trace averaging over multiple sequences. In this case, trace averaging is performed.

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 403

Single Sweep / Run Single
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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.
If the Sequencer is active in MSRT mode, the "Single Sweep" function does not start data capturing. It merely affects trace averaging over multiple sequences. In this case, no trace averaging is performed.

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 channel is updated.

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

Remote command:
`INITiate<n>[:IMMediate]` on page 404

Continue Single Sweep
After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

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 402

Select Frame
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see the R&S FSW User Manual.

Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 416

Continue Frame
Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold" , "Min Hold" , and "Average" .

This function is available in single sweep mode only.

- **On**
  When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also taken into account.
- **Off**
  The average or peak values are determined from the results of the newly swept frames only.

Remote command:
`CALCulate<n>:SPECtrogram:CONTinuous` on page 415

Frame Count
Determines how many frames are plotted during a single sweep (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see " History Depth " on page 205).

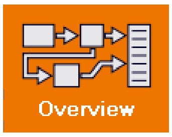
Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:COUNt` on page 416

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 415

6.8 Display Configuration



Access: "Overview" > "Display Config"

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the current application are displayed in the evaluation bar in SmartGrid mode.

For a description of the available evaluation methods see Chapter 4, "Measurement and Result Displays", on page 17.

Up to 6 evaluations can be displayed in the I/Q Analyzer at any time, including several graphical diagrams, marker tables or peak lists.

The selected evaluation method not only affects the result display in a window, but also the results of the trace data query in remote control (see `TRACe<n>[:DATA]?` on page 474).

6.9 Adjusting Settings Automatically

Access: [AUTO SET]

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings. In order to do so, a measurement is performed. You can configure this measurement.

MSRA/MSRT operating mode

In MSRA and MSRT operating mode, settings related to data acquisition can only be adjusted automatically for the MSRA/MSRT Master, not the applications.

Adjusting settings automatically during triggered measurements

When you select an auto adjust function, a measurement is performed to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how the R&S FSW should behave:

- (default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger.
  The trigger source is temporarily set to "Free Run" . After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows:
  - For IF Power and RF Power triggers:
    Trigger Level = Reference Level - 15 dB
  - For Video trigger:
    Trigger Level = 85 %

Remote command:

[SENSe:]ADJust:CONFigure:TRIGger on page 392

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level

Note: MSRA/MSRT operating modes. In MSRA/MSRT operating mode, this function is only available for the MSRA/MSRT Master, not the applications.

Remote command:
[SENSe:]ADJust:ALL on page 390

Adjusting the Center Frequency Automatically (Auto Frequency)

The R&S FSW adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest S/N ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

This function is not available for input from the optional Digital Baseband Interface.

Remote command:
[SENSe:]ADJust:FREQuency on page 392

Setting the Reference Level Automatically (Auto Level)
Automatically determines a reference level which ensures that no overload occurs at the R&S FSW for the current input data. At the same time, the internal attenuators and the preamplifier (for analog baseband input: the full scale level) are adjusted so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

Note: For Oscilloscope Baseband Input, the "Auto Level" function is not available.

To determine the required reference level, a level measurement is performed on the R&S FSW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

When using the optional 2 GHz / 5 GHz bandwidth extension (B2000/B5000) or the optional Oscilloscope Baseband Input, the level measurement is performed on the connected oscilloscope. For B2000/B5000, y-axis scaling on the oscilloscope is limited to a minimum of 5 mV per division.

You can change the measurement time for the level measurement if necessary (see " Changing the Automatic Measurement Time (Meastime Manual)" on page 196).

Remote command:
`[SENSe:]ADJust:LEVel` on page 392

Resetting the Automatic Measurement Time (Meastime Auto)
Resets the measurement duration for automatic settings to the default value.

Remote command:
`[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE` on page 391

Changing the Automatic Measurement Time (Meastime Manual)
This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Note: The maximum possible measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration actually used to determine the automatic settings may be shorter than the value you define here.

Remote command:
`[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE` on page 391
`[SENSe:]ADJust:CONFigure:LEVel:DURation` on page 390

Upper Level Hysteresis
When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
`[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer` on page 392

Lower Level Hysteresis
When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
`[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer` on page 391

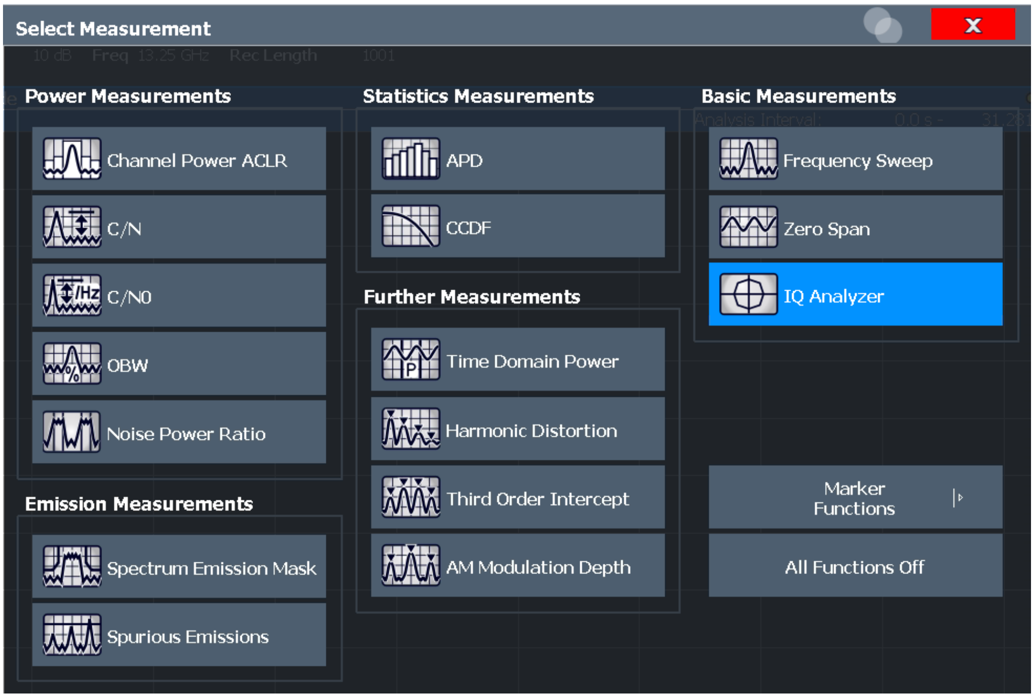
6.10 Configuring an I/Q Analyzer as an MSRA/MSRT Client Application

In principle, the I/Q Analyzer in MSRA/MSRT mode is configured as in Signal and Spectrum Analyzer mode.

However, the I/Q Analyzer client application (*not Master*) in MSRA/MSRT mode can also perform measurements on the captured I/Q data in the time and frequency domain (see also Chapter 5.15, "I/Q Analyzer in MSRA/MSRT Operating Mode", on page 107). Which type of measurement is to be performed - conventional I/Q data analysis or a time or frequency domain measurement - is selected in the "Select Measurement" dialog box, which is now displayed when you do one of the following:

- In the "I/Q Analyzer" menu, select the "Select Meas" softkey.
- Press the [MEAS] key.

The common measurements as in the Spectrum application are listed. In addition, "I/Q Analyzer" is provided under "Basic Measurements" to return to the default I/Q Analysis functions.



The time and frequency domain measurements and the required settings are described in detail in the R&S FSW User Manual.

Multiple measurements

Only one measurement type can be configured per channel; however, several channels for time or frequency-based measurements on I/Q data can be configured in parallel on the R&S FSW. Thus, you can configure one channel for conventional I/Q Analysis, for example, and another for an SEM or power measurement on the same data. Then you can switch through the results easily by switching tabs, or monitor all results at the same time in the "MSRA/MSRT View".

Remote command:

`CALCulate<n>:IQ:MODE` on page 268

7 Analysis

Access: "Overview" > "Analysis"

General result analysis settings concerning the trace, markers etc. are identical to the analysis functions in the Spectrum application, except for the lines and special marker functions, which are not available for I/Q data.

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 Realtime Spectrum Application and MSRT Operating Mode User Manual.

The remote commands required to perform these tasks are described in Chapter 7, "Analysis", on page 199.

7.1 Trace Settings

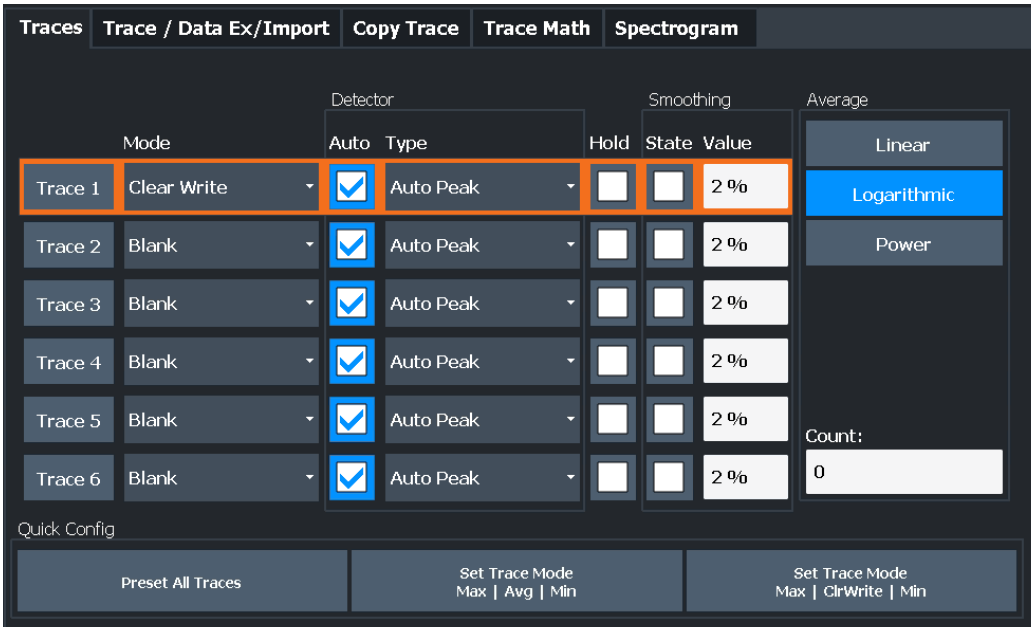
Access: "Overview" > "Analysis" > "Traces"

Or: [TRACE] > "Trace Config"

You can configure the settings for up to 6 individual traces.

Trace data can also be exported to an ASCII file for further analysis. For details see Chapter 7.3, "Trace / Data Export Configuration", on page 208.

For I/Q Vector evaluation mode, only 1 trace is available and the detector is not editable.



Trace 1 / Trace 2 / Trace 3 / Trace 4 / Trace 5 / Trace 6

Selects the corresponding trace for configuration. The currently selected trace is highlighted.

Remote command:
Selected via numeric suffix of:TRACe<1...6> commands
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] on page 410

Trace Mode

Defines the update mode for subsequent traces.

"Clear/ Write" Overwrite mode (default): the trace is overwritten by each sweep.

"Max Hold" The maximum value is determined over several sweeps and displayed. The R&S FSW saves each trace point in the trace memory only if the new value is greater than the previous one.

"Min Hold" The minimum value is determined from several measurements and displayed. The R&S FSW saves each trace point in the trace memory only if the new value is lower than the previous one.

"Average" The average is formed over several sweeps.
The Sweep/Average Count determines the number of averaging procedures.

"View" The current contents of the trace memory are frozen and displayed.

"Blank" Removes the selected trace from the display.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:MODE on page 408

Detector

Defines the trace detector to be used for trace analysis.

The trace detector is used to combine multiple FFT window results to create the final spectrum. (Note: in previous versions of the R&S FSW, the I/Q Analyzer always used the linear average detector.) If necessary, the trace detector is also used to reduce the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the Autopeak trace detector is used.

Note: Using a detector other than Auto Peak and fewer than 4096 sweep points may lead to wrong level results. For details see "Combining results - trace detector" on page 103.

"Auto" Selects the optimum detector for the selected trace and filter mode. This is the default setting.

"Type" Defines the selected detector type.

Note: If the EMI (R&S FSW-K54) measurement option is installed and the filter type "CISPR" is selected, additional detectors are available, even if EMI measurement is not active.

Remote command:
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] on page 412
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO on page 413

Hold

If activated, traces in "Min Hold" , "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous
on page 409

Smoothing

If enabled, the trace is smoothed by the specified value (between 1 % and 50 %). The smoothing value is defined as a percentage of the display width. The larger the smoothing value, the greater the smoothing effect.

For more information see the R&S FSW User Manual.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]`
on page 411
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture`
on page 411

Average Mode

Defines the mode with which the trace is averaged over several sweeps.

This setting is generally applicable if trace mode "Average" is selected.

For FFT sweeps, the setting also affects the VBW (regardless of whether or not the trace is averaged).

(See the chapter on ACLR power measurements in the R&S FSW User Manual.)

How many sweeps are averaged is defined by the " Sweep/Average Count " on page 191.

"Linear" The power level values are converted into linear units prior to averaging. After the averaging, the data is converted back into its original unit.

"Logarithmic" For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.

"Power" Activates linear power averaging.
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.
Use this mode to average power values in Volts or Amperes correctly.
In particular, for small VBW values (smaller than the RBW), use power averaging mode for correct power measurements in FFT sweep mode.

Remote command:
`[SENSe:]AVERage<n>:TYPE` on page 412

Predefined Trace Settings - Quick Config

Commonly required trace settings have been predefined and can be applied very quickly by selecting the appropriate button.

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write
	Traces 2-6:	Blank
Set Trace Mode Max | Avg | Min	Trace 1:	Max Hold
	Trace 2:	Average
	Trace 3:	Min Hold
	Traces 4-6:	Blank
Set Trace Mode Max | ClrWrite | Min	Trace 1:	Max Hold
	Trace 2:	Clear Write

Function	Trace Settings	
	Trace 3:	Min Hold
	Traces 4-6:	Blank

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>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 410

Copy Trace
Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"

Or: [TRACE] > "Copy Trace"

Copies trace data to another trace.

The first group of buttons (labeled "Trace 1" to "Trace 6") selects the source trace. The second group of buttons (labeled "Copy to Trace 1" to "Copy to Tace 6") selects the destination.

Remote command:
`TRACe<n>:COPY` on page 413

7.2 Spectrogram Settings

Access: [TRACE] > "Spectrogram Config"

The individual settings available for spectrogram display are described here. For settings on color mapping, see Chapter 7.2.2, "Color Map Settings", on page 207.

Settings concerning the frames and how they are handled during a sweep are provided as additional sweep settings for spectrogram display.

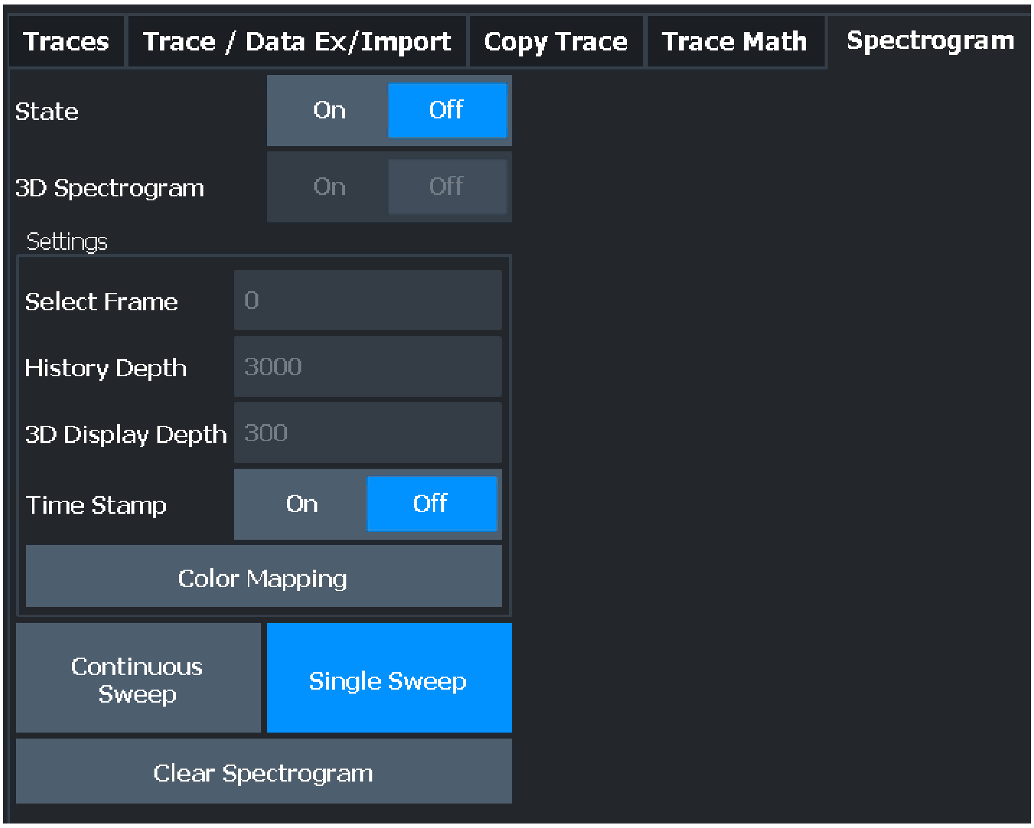
See Chapter 6.7.2, "Sweep Settings", on page 190.

Search functions for spectrogram markers are described in Chapter 7.4.2.2, "Marker Search Settings for Spectrograms", on page 220.

7.2.1 General Spectrogram Settings

Access: [TRACE] > "Spectrogram Config"

This section describes general settings for spectrogram display.



State

Activates and deactivates a Spectrogram subwindow.

"Split"	Displays the Spectrogram as a subwindow in the original result display.
"Full"	Displays the Spectrogram in a subwindow in the full size of the original result display.
"Off"	Closes the Spectrogram subwindow.

Remote command:

`CALCulate<n>:SPECtrogram:LAYout` on page 417

3D Spectrogram State

Activates and deactivates a 3-dimensional spectrogram. As opposed to the common 2-dimensional spectrogram, the power is not only indicated by a color mapping, but also in a third dimension, the z-axis.

For details see the R&S FSW User Manual.

Remote command:
`CALCulate<n>:SPECtrogram:THReedim[:STATe]` on page 418

Select Frame

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see the R&S FSW User Manual.

Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 416

History Depth

Sets the number of frames that the R&S FSW stores in its memory.

The maximum number of frames depends on the "Sweep Points" on page 191.

For an overview of the maximum number of frames depending on the number of sweep points, see the R&S FSW User Manual.

If the memory is full, the R&S FSW deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:
`CALCulate<n>:SPECtrogram:HDEPth` on page 417

3-D Display Depth

Defines the number of frames displayed in a 3-dimensional spectrogram.

For details see the R&S FSW User Manual.

Time Stamp

Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the timestamp shows the time and date of the end of the sweep.

When active, the timestamp replaces the display of the frame number.

Remote command:
`CALCulate<n>:SPECtrogram:TSTamp[:STATe]` on page 420
`CALCulate<n>:SPECtrogram:TSTamp:DATA?` on page 419

Color Mapping

Opens the "Color Mapping" dialog.

For details see the R&S FSW User Manual.

Continuous Sweep / Run Cont
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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. If the Sequencer is active, the "Continuous 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, a channel in continuous sweep mode is swept repeatedly.
If the Sequencer is active in MSRT mode, the "Continuous Sweep" function does not start data capturing. It merely affects trace averaging over multiple sequences. In this case, trace averaging is performed.

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 403

Single Sweep / Run Single
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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.
If the Sequencer is active in MSRT mode, the "Single Sweep" function does not start data capturing. It merely affects trace averaging over multiple sequences. In this case, no trace averaging is performed.

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 channel is updated.

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

Remote command:
`INITiate<n>[:IMMediate]` on page 404

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 415

7.2.2 Color Map Settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

or: [TRACE] > "Spectrogram Config" > "Color Mapping"

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

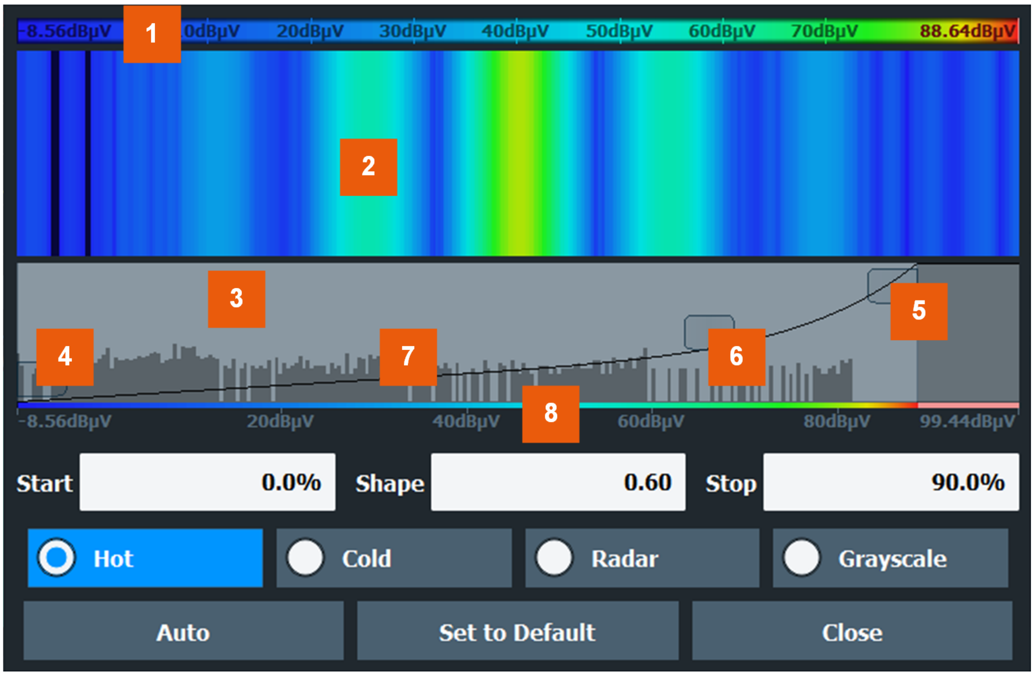


Figure 7-1: Color Mapping dialog box

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop
Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 421
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 421

Shape
Defines the shape and focus of the color curve for the spectrogram result display.

"-1 to <0"	More colors are distributed among the lower values
"0"	Colors are distributed linearly among the values
">0 to 1"	More colors are distributed among the higher values

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe` on page 421

Hot / Cold / Radar / Grayscale
Sets the color scheme for the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]` on page 422

Auto
Defines the color range automatically according to the existing measured values for optimized display.

Set to Default
Sets the color mapping to the default settings.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault` on page 420

Close
Saves the changes and closes the dialog box.

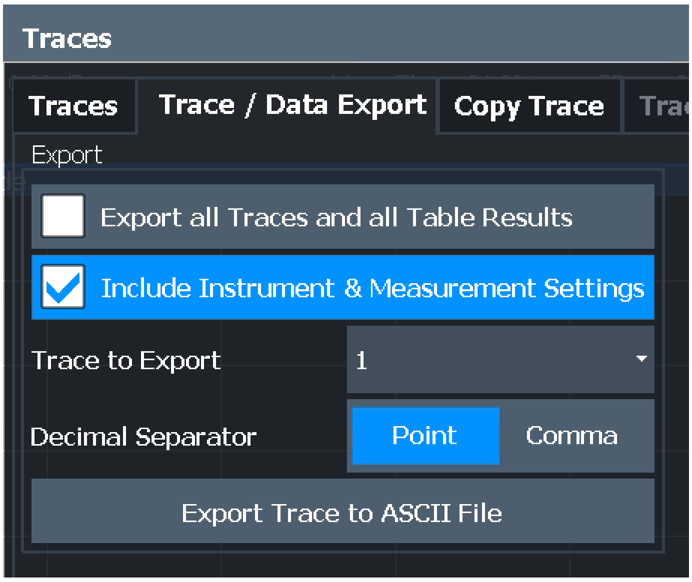
7.3 Trace / Data Export Configuration

Access: "Save" > "Export" > "Trace Export Configuration"

Or: [TRACE] > "Trace Config" > "Trace / Data Export"

The R&S FSW provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with other, external applications. In this case, you can export the measurement data to an ASCII file.

The standard data management functions (e.g. saving or loading instrument settings) that are available for all R&S FSW applications are not described here.



Export all Traces and all Table Results

Selects all displayed traces and result tables (e.g. Result Summary, marker table etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:
`FORMat:DEXPort:TRACes` on page 478

Include Instrument & Measurement Settings

Includes additional instrument and measurement settings in the header of the export file for result data.

Remote command:
`FORMat:DEXPort:HEADer` on page 478

Trace to Export

Defines an individual trace to be exported to a file.

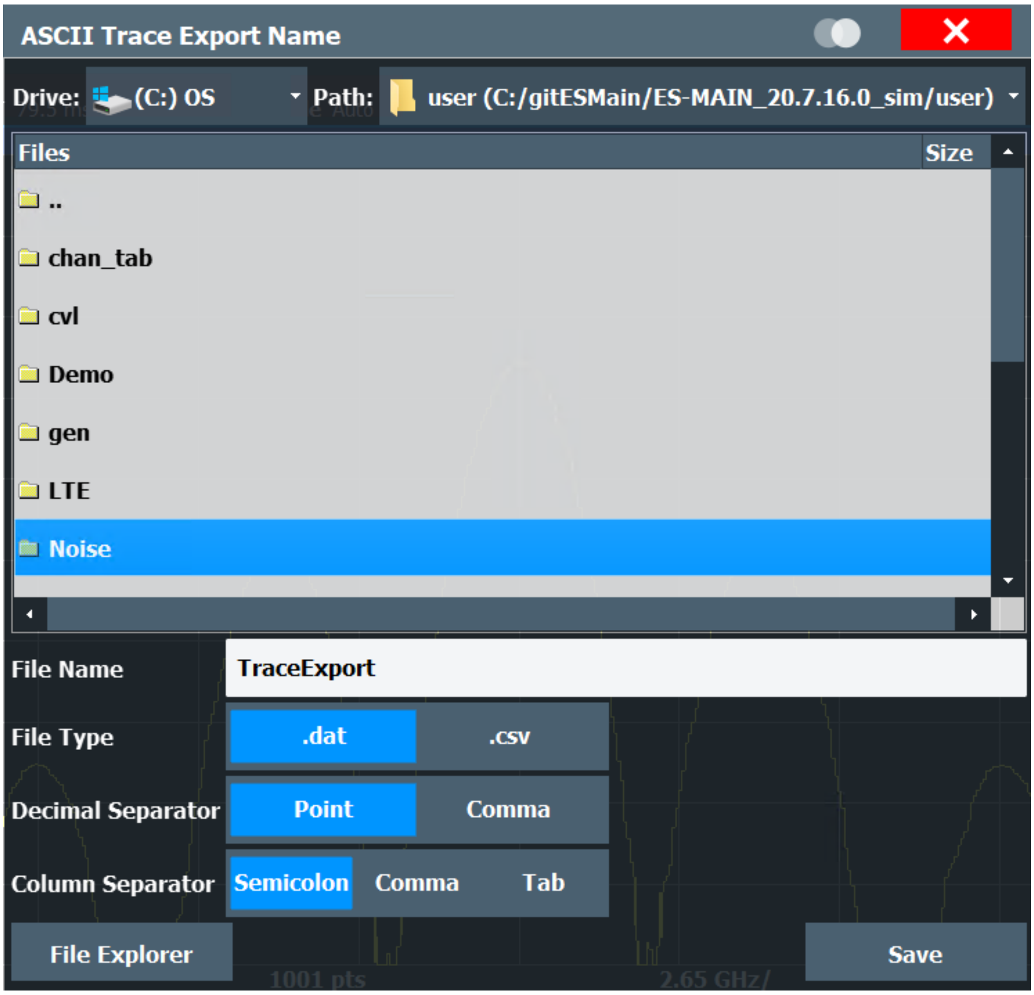
This setting is not available if Export all Traces and all Table Results is selected.

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 478

Export Trace to ASCII File
Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

"File Explorer": Instead of using the file manager of the R&S FSW firmware, you can also use the Microsoft Windows File Explorer to manage files.



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 limit reached" 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 base unit user manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 479

File Type ← Export Trace to ASCII File
Determines the format of the ASCII file to be imported or exported.

Depending on the external program in which the data file was created or is evaluated, a comma-separated list (`CSV`) or a plain data format (`DAT`) file is required.

Remote command:
`FORMat:DEXPort:FORMat` on page 478

Decimal Separator ← Export Trace to ASCII File
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 478

Column Separator ← Export Trace to ASCII File
Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;FSW13;Version;1.80;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSW13,
Version,1.80,
Date,01.Jan 3000,
```

Example for tabulator (tab after the last column is not visible):

```
Type	FSW13
Version	1.80
Date	01.Jan 3000
```

The selected column separator settings remains the same, even after a preset.

Remote command:
`FORMat:DEXPort:CSEParator` on page 477

File Explorer ← Export Trace to ASCII File
Opens the Microsoft Windows File Explorer.

Remote command:
not supported

Export Spectrogram to ASCII File
Opens a file selection dialog box and saves the selected spectrogram in ASCII format (**`.dat`**) to the specified file and directory.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation can take some time.

For details on the file format, see the R&S FSW base unit user manual.

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 limit reached" 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 base unit user manual.

Remote command:
`MMEMory:STORe<n>:SPECtrogram` on page 479

7.4 Marker Usage

Access: "Overview" > "Analysis"

The following marker settings and functions are available in the I/Q Analyzer application.

For "I/Q-Vector" displays markers are not available.

In the I/Q Analyzer application, the resolution with which the frequency can be measured with a marker is always the filter bandwidth, which is derived from the defined sample rate.

(See Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24).

Marker settings are now window-specific.

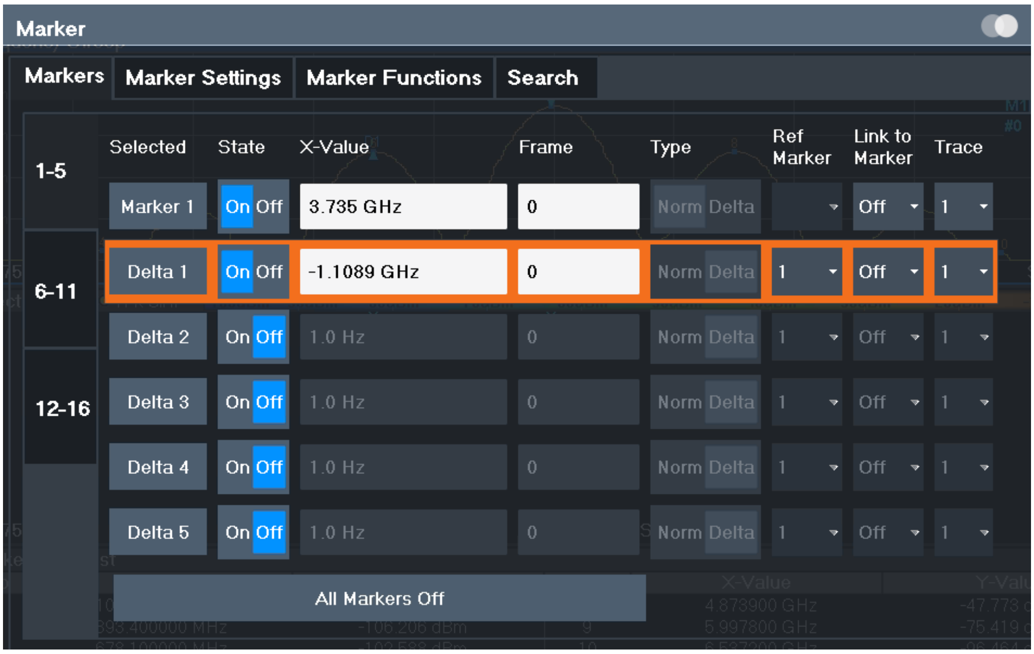
7.4.1 Marker Settings

Or: [MKR] > "Marker Config"

The remote commands required to define these settings are described in Chapter 10.7.3.1, "Setting Up Individual Markers", on page 422.

7.4.1.1 Individual Marker Setup

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.



The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

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 427
CALCulate<n>:DELTamarker<m>[:STATe] on page 425

Marker Position X-value

Defines the position (x-value) of the marker in the diagram. For normal markers, the absolute position is indicated. For delta markers, the position relative to the reference marker is provided.

Remote command:
CALCulate<n>:MARKer<m>:X on page 428
CALCulate<n>:DELTamarker<m>:X on page 426

Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe on page 435
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe on page 439

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 427
CALCulate<n>:DELTamarker<m>[:STATe] on page 425

Reference Marker

Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If the reference marker is deactivated, the delta marker referring to it is also deactivated.

Remote command:
CALCulate<n>:DELTamarker<m>:MREFerence on page 424

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:
`CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>` on page 426
`CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>` on page 423
`CALCulate<n>:DELTamarker<m>:LINK` on page 423

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 427

Select Marker

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.

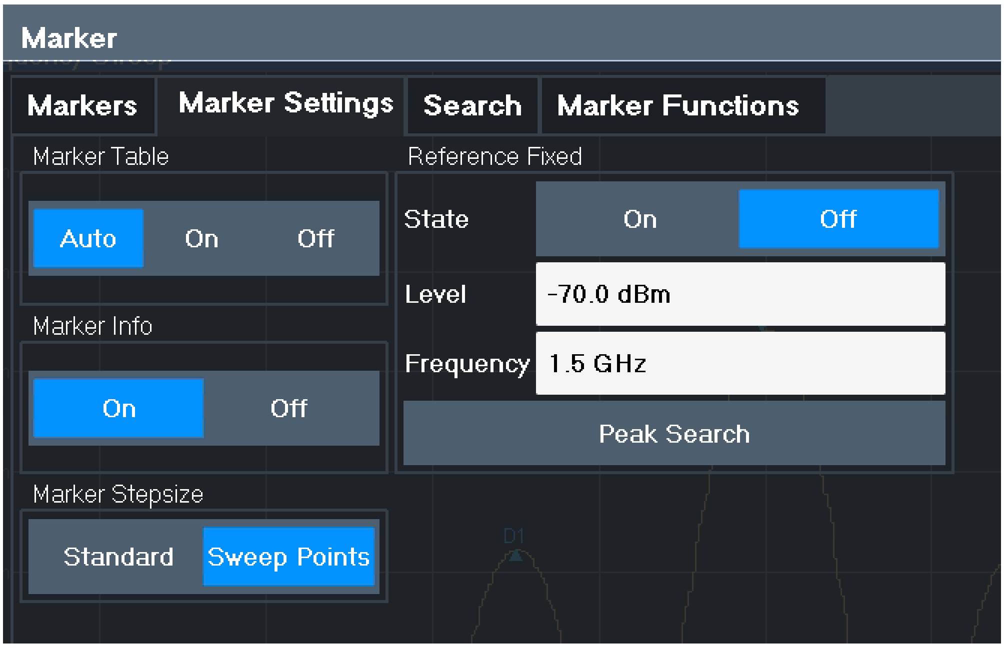
Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 427
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 425

All Markers Off
Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 426

7.4.1.2 General Marker Settings

Some general marker settings allow you to influence the marker behavior for all markers.



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.

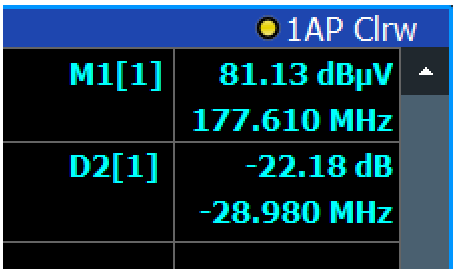
"Off" No separate marker table is displayed.
If Marker Info is active, the marker information is displayed within the diagram area.

"Auto" (Default) If more than two markers are active, the marker table is displayed automatically.
If Marker Info is active, the marker information for up to two markers is displayed in the diagram area.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 428

Marker Info

Turns the marker information displayed in the diagram on and off.



Remote command:
DISPlay[:WINDow<n>]:MINFo[:STATe] on page 429

Marker Stepsize

Defines the size of the steps that the marker position is moved using the rotary knob.

"Standard" The marker position is moved in steps of (Span/1000), which corresponds approximately to the number of pixels for the default display of 1001 sweep points. This setting is most suitable to move the marker over a larger distance.

"Sweep Points" The marker position is moved from one sweep point to the next. This setting is required for a very precise positioning if more sweep points are collected than the number of pixels that can be displayed on the screen. It is the default mode.

Remote command:
CALCulate<n>:MARKer<m>:X:SSIZe on page 429

7.4.2 Marker Search Settings and Positioning Functions

Access: "Overview" > "Analysis" > "Marker" > "Search"

or: [MKR TO]

Several functions are available to set the marker to a specific position very quickly and easily, or to use the current marker position to define another characteristic value. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

For more information on searching for signal peaks see Chapter 7.4.4.3, "Marker Peak List", on page 235.

In I/Q Analyzer mode, the search settings for "Real/Imag (I/Q)" evaluation include an additional parameter, see " Branch for Peaksearch " on page 220.

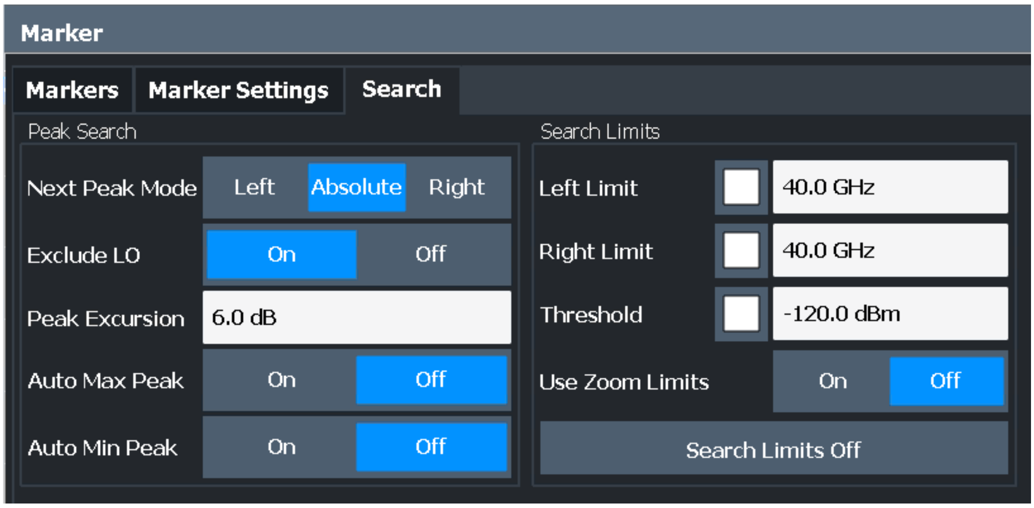
The remote commands required to define these settings are described in Chapter 10.7.3.5, "Positioning the Marker", on page 443.

7.4.2.1 Marker Search Settings

Access: [MKR TO] > "Search Config"

Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Configuration settings allow you to influence the peak search results.

For Spectrograms, special marker settings are available, see Chapter 7.4.2.2, "Marker Search Settings for Spectrograms", on page 220.



Search Mode for Next Peak

Selects the search mode for the next peak search.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Chapter 10.7.3.5, "Positioning the Marker", on page 443

Exclude LO

If activated, restricts the frequency range for the marker search functions.

"On" The minimum frequency included in the peak search range is ≥ 5 × resolution bandwidth (RBW).
Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"Off" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

Remote command:
`CALCulate<n>:MARKer<m>:LOEXclude` on page 430

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 7.4.4.3, "Marker Peak List", on page 235.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 430

Auto Max Peak Search / Auto Min Peak Search

If activated, a maximum or minimum peak search is performed automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 444
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 445

Search Limits

The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits

If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 432
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 432

Search Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:
`CALCulate<n>:THReshold` on page 433

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]` on page 433

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:THReshold:STATe` on page 434

Branch for Peaksearch
Defines which data is used for marker search functions in I/Q data.

This function is only available for the display configuration "Real/Imag (I/Q)" (see " Real/Imag (I/Q) " on page 19).

Note: The search settings apply to all markers, not only the currently selected one.

"Real"
Marker search functions are performed on the real trace of the I/Q measurement.

"Imag"
Marker search functions are performed on the imaginary trace of the I/Q measurement.

"Magnitude"
Marker search functions are performed on the magnitude of the I and Q data.

Remote command:
`CALCulate<n>:MARKer<m>:SEARch` on page 431

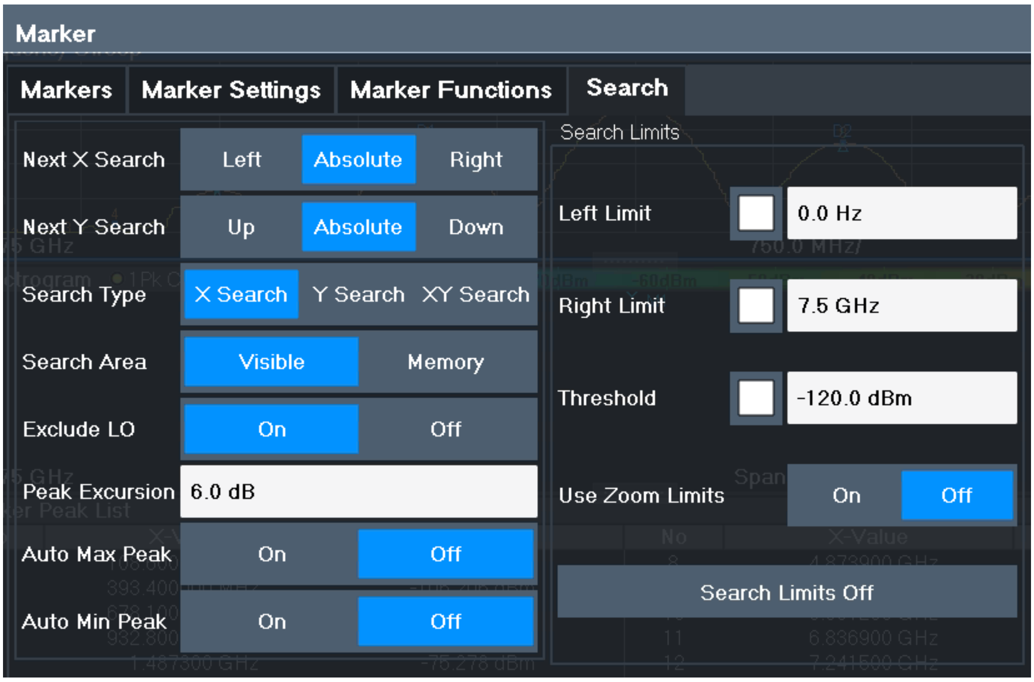
7.4.2.2 Marker Search Settings for Spectrograms

Access: "Overview" > "Analysis" > "Markers" > "Search"

or: [MKR TO] > "Search Config"

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.



Search Mode for Next Peak in X-Direction

Selects the search mode for the next peak search within the currently selected frame.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Chapter 10.7.3.5, "Positioning the Marker", on page 443

Search Mode for Next Peak in Y-Direction

Selects the search mode for the next peak search within all frames at the current marker position.

"Up"	Determines the next maximum/minimum above the current peak (in more recent frames).
"Absolute"	Determines the next maximum/minimum above or below the current peak (in all frames).
"Down"	Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 436
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe` on page 442
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow` on page 438
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow` on page 442
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT` on page 438
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT` on page 443

Marker Search Type

Defines the type of search to be performed in the spectrogram.

"X-Search"	Searches only within the currently selected frame.
"Y-Search"	Searches within all frames but only at the current frequency position.
"XY-Search"	Searches in all frames at all positions.

Remote command:
Defined by the search function, see Chapter 10.7.3.4, "Marker Search (Spectrograms)", on page 434

Marker Search Area

Defines which frames the search is performed in.

"Visible"	Only the visible frames are searched.
"Memory"	All frames stored in the memory are searched.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:SARea` on page 435
`CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea` on page 440

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 7.4.4.3, "Marker Peak List", on page 235.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 430

Search Limits
The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 432
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 432

Search Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:
`CALCulate<n>:THReshold` on page 433

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]` on page 433

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:THReshold:STATe` on page 434

7.4.2.3 Positioning Functions

Access: [MKR ->]

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

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 445

`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 448

Search Next Peak

Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

Remote command:

`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 444

`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 445

`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 444

`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 447

`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 448

`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 447

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 446

`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 449

Search Next Minimum

Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next minimum is to be searched in.

Remote command:

`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 446

`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 446

`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 446

`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 448

`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 448

`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 449

Center Frequency = Marker Frequency
Sets the center frequency to the selected marker or delta marker frequency. A peak can thus be set as center frequency, for example to analyze it in detail with a smaller span.

This function is not available for zero span measurements.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 366

Reference Level = Marker Level
Sets the reference level to the selected marker level.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:REFerence` on page 356

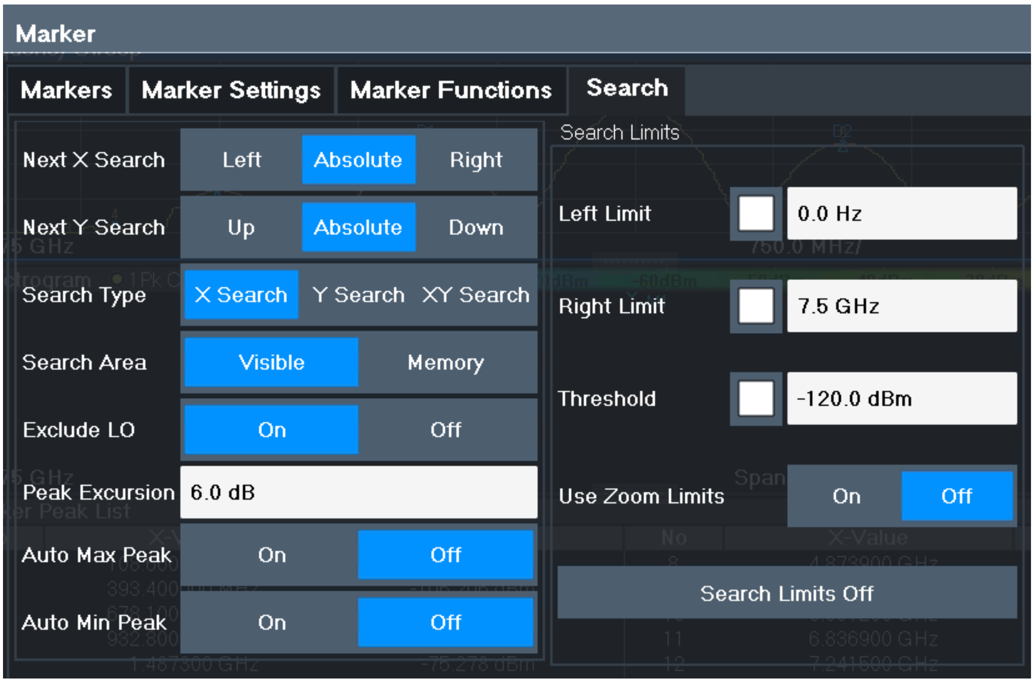
7.4.3 Marker Search Settings for Spectrograms

Access: "Overview" > "Analysis" > "Markers" > "Search"

or: [MKR TO] > "Search Config"

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.



Search Mode for Next Peak in X-Direction

Selects the search mode for the next peak search within the currently selected frame.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Chapter 10.7.3.5, "Positioning the Marker", on page 443

Search Mode for Next Peak in Y-Direction

Selects the search mode for the next peak search within all frames at the current marker position.

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 436
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT` on page 441
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe` on page 437
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe` on page 442
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow` on page 438
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow` on page 442
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT` on page 438
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT` on page 443

Marker Search Type

Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current frequency position.

"XY-Search" Searches in all frames at all positions.

Remote command:
Defined by the search function, see Chapter 10.7.3.4, "Marker Search (Spectrograms)", on page 434

Marker Search Area

Defines which frames the search is performed in.

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:SARea` on page 435
`CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea` on page 440

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 7.4.4.3, "Marker Peak List", on page 235.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 430

Search Limits

The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits

If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 432
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 432

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:
`CALCulate<n>:THReshold` on page 433

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]` on page 433

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 431
`CALCulate<n>:THReshold:STATe` on page 434

7.4.4 Marker Functions

Some special marker functions are available in the I/Q Analyzer application.

7.4.4.1 Measuring the Power in a Channel (Band Power Marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "Band Power Config"

or: [MKR FUNC] > "Select Marker Function" > "Band Power"

To determine the noise power in a transmission channel, you can use a noise marker and multiply the result with the channel bandwidth. However, the results are only accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.

Relative band power markers

The results for band power markers which are defined as *delta* markers and thus have a reference value can also be calculated as reference power values (in dB).

For Analog Modulation Analysis, relative band power markers are not available.

In this case, the result of the band power deltamarker is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

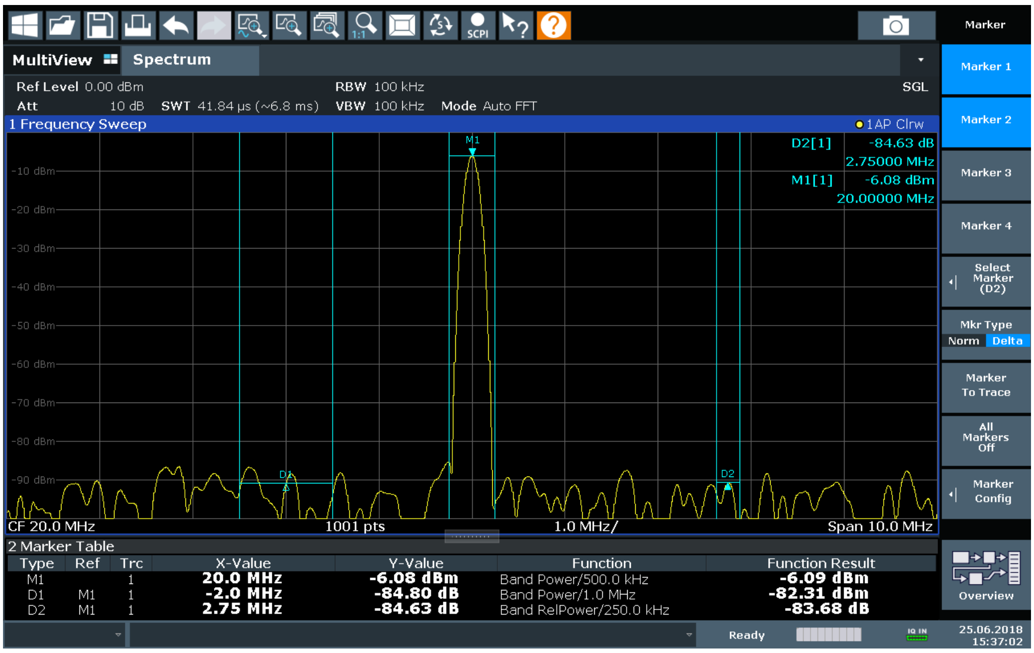
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]

The measured power for the reference marker may be an absolute power at a single point (if the reference marker is not a band power marker), or the power in a band (if the reference marker is a band power marker itself).

If the reference marker for the band power marker is also a delta marker, the absolute power level for the reference marker is used for calculation.

For the I/Q Analyzer application, band power markers are only available for Spectrum displays.

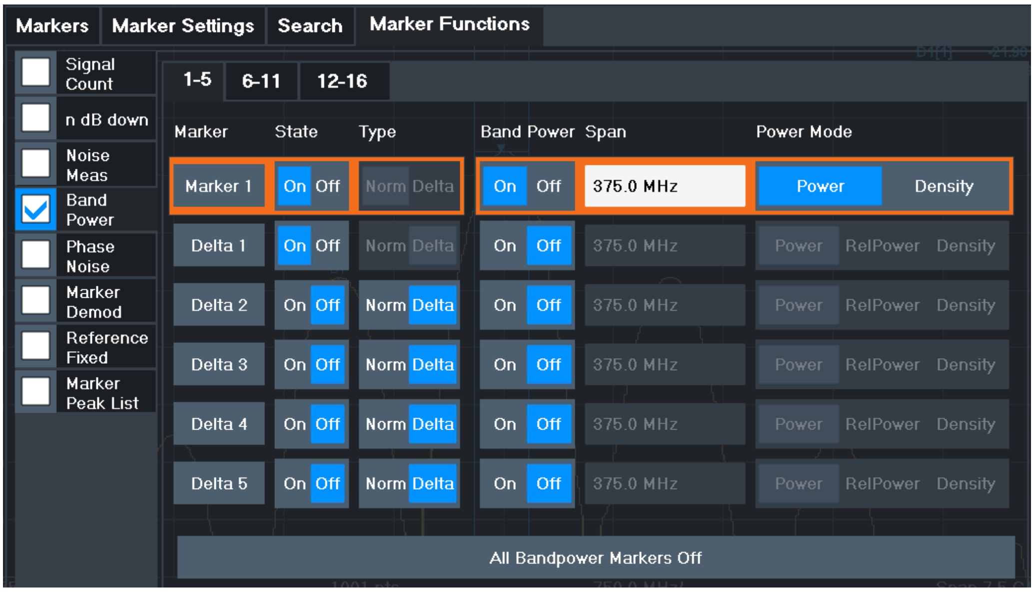
The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto" , the RMS detector is used.

The individual marker settings correspond to those defined in the "Marker" dialog box (see Chapter 7.4.1.1, "Individual Marker Setup", on page 213). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



Remote commands:

`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 451

`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?` on page 450

Band Power Measurement State

Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see Chapter 7.4.4.1, "Measuring the Power in a Channel (Band Power Marker)", on page 228.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 451
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]` on page 453

Span

Defines the span (band) around the marker for which the power is measured.

The span is indicated by lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN` on page 451
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN` on page 452

Power Mode
Defines the mode of the power measurement result.

For Analog Modulation Analysis, the power mode is not editable for AM, FM, or PM spectrum results. In this case, the marker function does not determine a power value, but rather the deviation within the specified span.

"Power" The result is an absolute power level.
The power unit depends on the Unit setting.

"Relative Power" This setting is only available for a delta band power marker.
The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker (see " Reference Marker " on page 214). The powers are subtracted logarithmically, so the result is a dB value.
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]
For details see "Relative band power markers" on page 229

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE` on page 450
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 451

Switching All Band Power Measurements Off
Deactivates band power measurement for all markers.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 451
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]` on page 453

7.4.4.2 Time Domain Power Measurement

The Time Domain Power measurement determines the power of a signal in the time domain.

A time domain power measurement is only possible for zero span.

About the Measurement

Using the Time Domain Power measurement function, the R&S FSW determines the power of the signal in zero span by summing up the power at the individual measurement points and dividing the result by the number of measurement points. Thus it is possible to measure the power of TDMA signals during transmission, for example, or during the muting phase. Both the mean power and the RMS power can be measured.

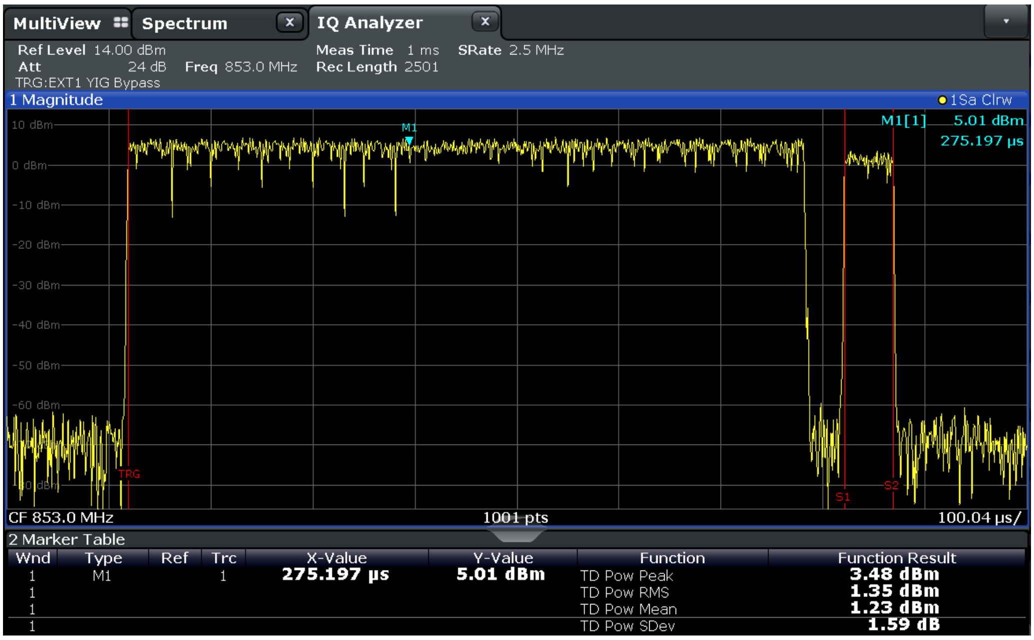
For this measurement, the sample detector is activated.

Time Domain Power Results

Several different power results can be determined simultaneously:

Mode	Description
Peak	Peak value from the points of the displayed trace or a segment thereof.
RMS	RMS value from the points of the displayed trace or a segment thereof.
Mean	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated. For example to measure the mean power during a GSM burst
Std Dev	The standard deviation of the measurement points from the mean value.

The result is displayed in the marker results, indicated by "Power" and the selected power mode, e.g. "RMS" . The measured values are updated after each sweep or averaged over a user-defined number of sweeps (trace averaging).



The results can also be queried using the remote commands described in Chapter 10.7.3.8, "Measuring the Time Domain Power", on page 457.

Time Domain Power Basics - Range Definition Using Limit Lines

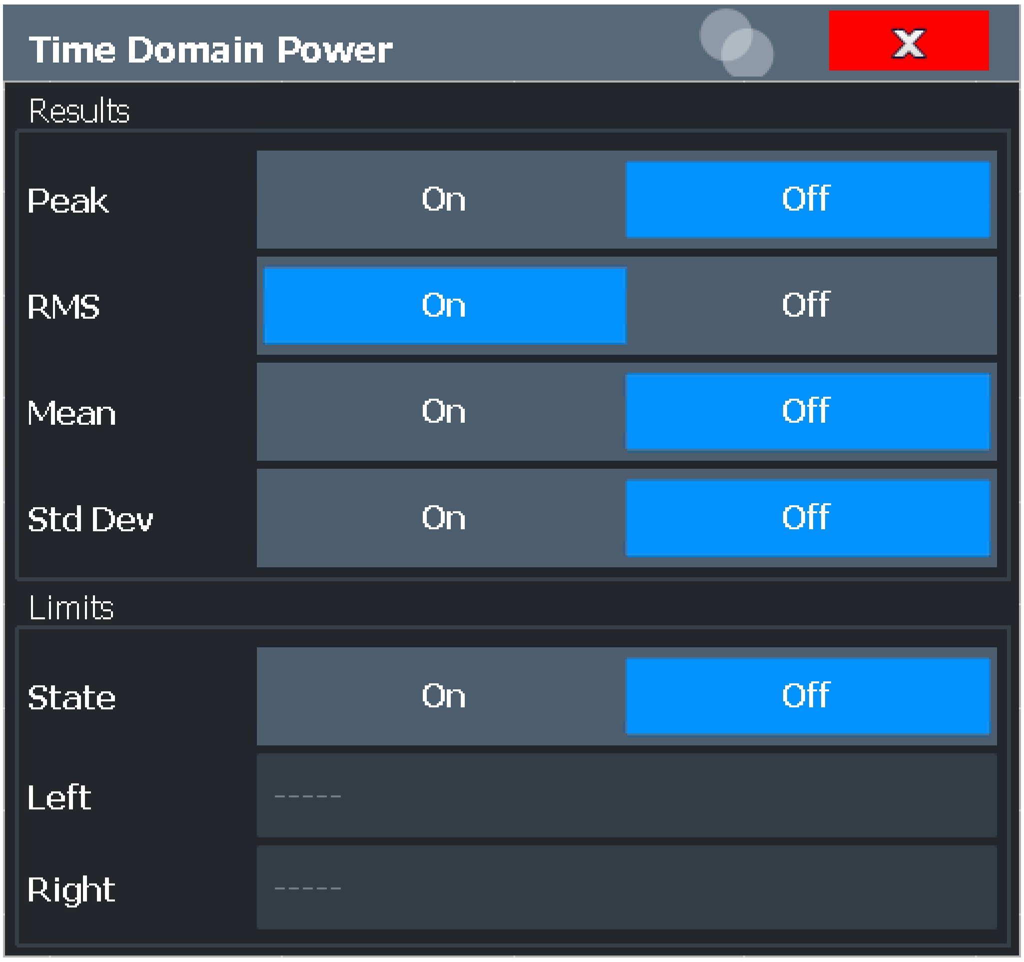
The range of the measured signal to be evaluated for the power measurement can be restricted using limit lines. The left and right limit lines (S1, S2) define the evaluation range and are indicated by vertical red lines in the diagram. If activated, the power results are only calculated from the levels within the limit lines.

For example, if both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase. The ratio between signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and then varying the measurement range.

In order to get stable measurement results for a limited evaluation range, usually a trigger is required.

Time Domain Power Configuration

Access: [MARK FUNC] > "Select Marker Function" > "Time Domain Power" > "Time Dom Power Config"



The remote commands required to perform these tasks are described in Chapter 10.7.3.8, "Measuring the Time Domain Power", on page 457.

Results

Activates the power results to be evaluated from the displayed trace or a limited area of the trace.

"Peak" Peak power over several measurements (uses trace averaging, Max Hold)

"RMS" RMS value from the points of the displayed trace or a segment thereof.

"Mean" Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated.

"Std Dev" The standard deviation of the measurement points from the mean value.
The measurement of the mean power is automatically switched on at the same time.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] on page 459
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult? on page 463
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] on page 460
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult? on page 464
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] on page 459
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult? on page 461

Limit State

Switches the limitation of the evaluation range on or off. Default setting is off.

If deactivated, the entire sweep time is evaluated. If switched on, the evaluation range is defined by the left and right limit. If only one limit is set, it corresponds to the left limit and the right limit is defined by the stop frequency. If the second limit is also set, it defines the right limit.

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 431

Left Limit / Right Limit

Defines a power level limit for line S1 (left) or S2 (right).

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 432
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt on page 432

How to Measure Powers in the Time Domain

The step-by-step procedure to measure powers in the time domain is described here in detail.

To measure the power in the time domain

1. Select a result window in the time domain, for example a "Magnitude" window.
2. Select the [MARK FUNC] key.
3. From the "Select Marker Function" dialog box, select the "Time Domain Power" function.
4. Select the type of power measurement results to be determined by selecting the corresponding softkeys.
5. To restrict the power evaluation range, define limits:
   a) Select the "Time Dom Power Config" softkey to display the "Time Domain Power" configuration dialog box.
   b) Switch on the limits by setting the "Limit State" to "On" .
   The limit lines S1 and S2 are displayed.
   c) Define the left limit (limit line S1), the right limit (S2), or both.
6. Start a sweep.

   The measured powers are displayed in the marker results.

7.4.4.3 Marker Peak List

Access: "Overview" > "Analysis" > "Marker Functions" > "Marker Peak List"

Or: [MKR FUNC] > "Marker Peak List"

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The R&S FSW provides various peak search functions and applications:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area (Search Limits)
- Creating a marker table with all or a defined number of peak values for one sweep (Marker Peak List)
- Updating the marker position to the current peak value automatically after each sweep (Auto Peak Search)
- Creating a fixed reference marker at the current peak value of a trace (Fixed Reference)

Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

When is a peak a peak? - Peak excursion

During a peak search, for example when a marker peak table is displayed, noise values may be detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak Excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

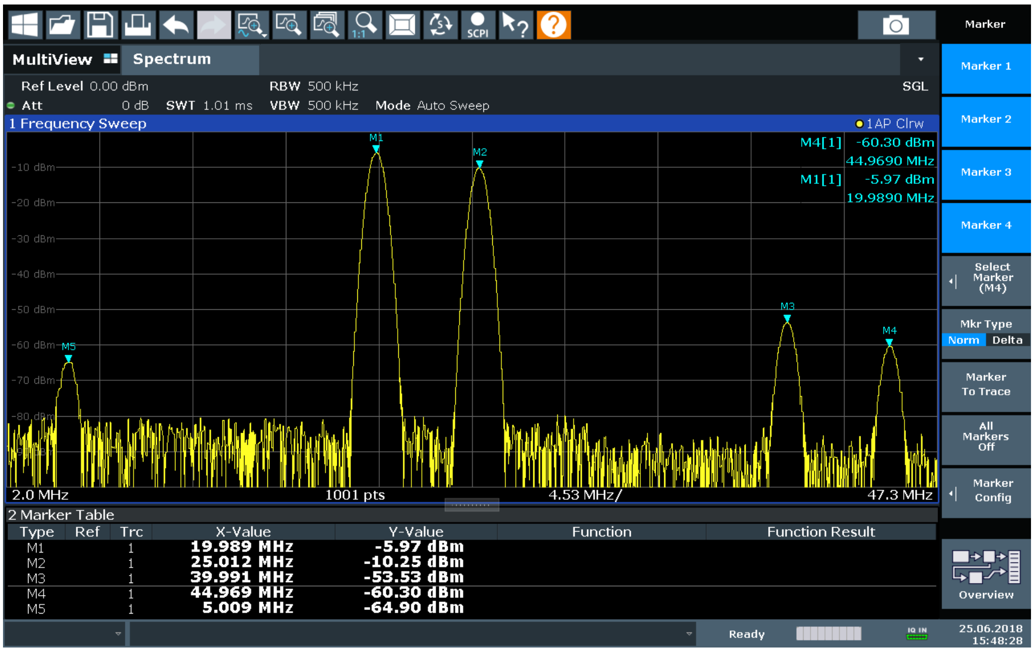


Figure 7-2: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	80 dB
2	80 dB
3	55 dB
4	39 dB
5	32 dB

In order to eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 60 dB is required. In this case, the amplitude must rise at least 60 dB before falling again before a peak is detected.

Marker peak list

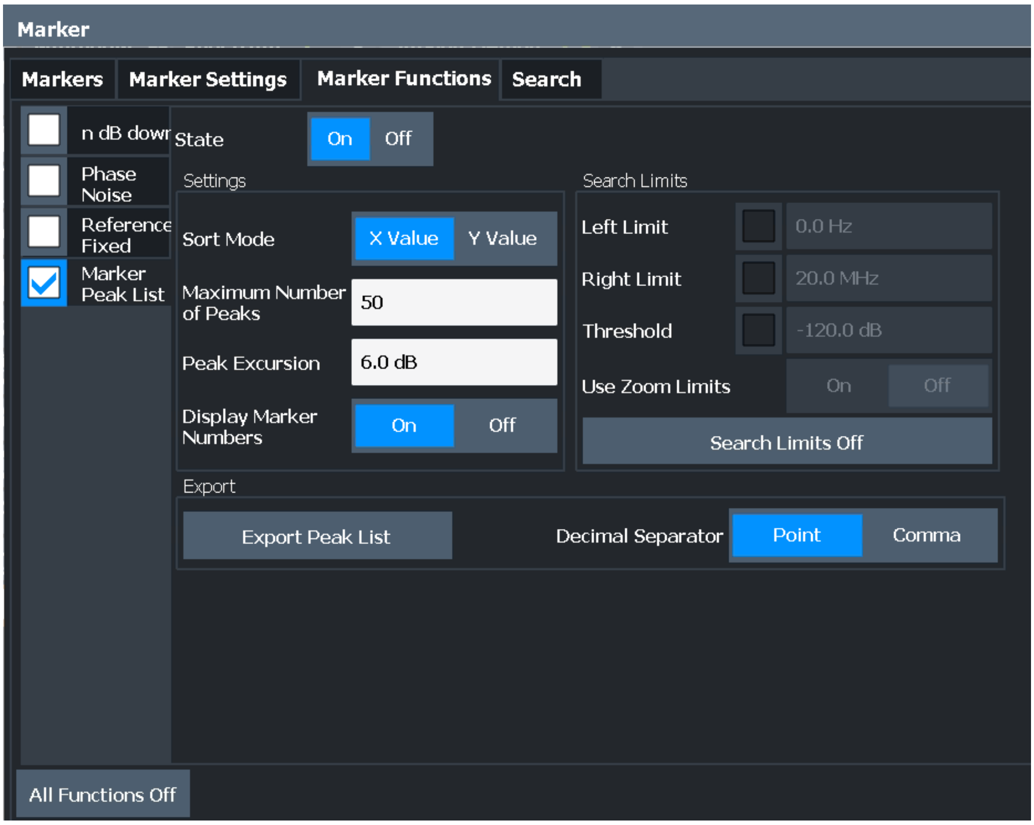
The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each sweep in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.



Remote commands:

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe on page 455

TRAC? LIST, see TRACe<n>[:DATA]? on page 474

Peak List State

Activates/deactivates the marker peak list. If activated, the peak list is displayed and the peaks are indicated in the trace display.

For each listed peak the frequency/time ("X-value") and level ("Y-Value") values are given.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe` on page 455

Sort Mode

Defines whether the peak list is sorted according to the x-values or y-values. In either case the values are sorted in ascending order.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT` on page 455

Maximum Number of Peaks

Defines the maximum number of peaks to be determined and displayed.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE` on page 455

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 7.4.4.3, "Marker Peak List", on page 235.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 430

Display Marker Numbers

By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks the marker numbers may decrease readability; in this case, deactivate the marker number display.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe]`
on page 453

Export Peak List

The peak list can be exported to an ASCII file (`.DAT`) for analysis in an external application.

Remote command:

`MMEMory:STORe<n>:PEAK` on page 456

`FORMat:DEXPort:DSEParator` on page 478

7.4.4.4 Deactivating All Marker Functions

Access: "Overview" > "Analysis" > "Marker Functions" > "All Functions Off"

Or: [MKR FUNC] > "All Functions Off"

All special marker functions can be deactivated in one step.

Remote command:

7.5 Analysis in MSRA/MSRT Mode

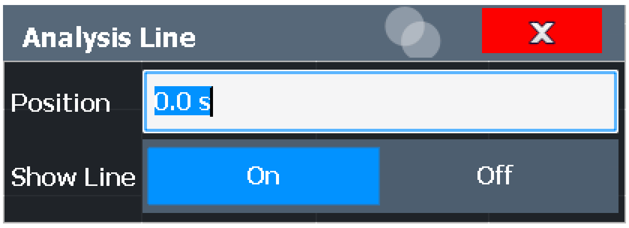
The data that was captured by the MSRA or MSRT Master can be analyzed in the I/Q Analyzer application.

The analysis settings and functions available in MSRA/MSRT mode are those described for common Signal and Spectrum Analyzer mode.

Analysis line settings

In addition, an analysis line can be positioned. The analysis line is a common time marker for all MSRA/MSRT applications.

To hide or show and position the analysis line, a dialog box is available. To display the "Analysis Line" dialog box, tap the "AL" icon in the toolbar (only available in MSRA/MSRT mode). The current position of the analysis line is indicated on the icon.



Position

Defines the position of the analysis line in the time domain. The position must lie within the measurement time of the multistandard measurement.

Remote command:

`CALCulate<n>:MSRA:ALINe[:VALue]` on page 466

`CALCulate<n>:RTMS:ALINe[:VALue]` on page 468

Show Line
Hides or displays the analysis line in the time-based windows. By default, the line is displayed.

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 client application remains in the window title bars.

Remote command:
`CALCulate<n>:MSRA:ALINe:SHOW` on page 466
`CALCulate<n>:RTMS:ALINe:SHOW` on page 468

8 How to Work with I/Q Data

The following step-by-step procedures demonstrate in detail how to perform various tasks when working with I/Q data.

8.1 How to Perform Measurements in the I/Q Analyzer Application

The following step-by-step instructions demonstrate how to capture I/Q data on the R&S FSW and how to analyze data in the I/Q Analyzer application.

How to perform a measurement in the time or frequency domain on I/Q data (in MSRA/ MSRT mode only) is described in the R&S FSW MSRA/MSRT User Manual.

8.1.1 How to Capture Baseband (I/Q) Data as RF Input

By default, the I/Q Analyzer assumes the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the R&S FSW.

1. Select the [MODE] key and select the "I/Q Analyzer" application.
2. Select the "Overview" softkey to display the "Overview" for an I/Q Analyzer measurement.
3. Select the "Input" button to select and configure the "RF Input" signal source.
4. Select the "Amplitude" button to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.
5. Select the "Frequency" button to define the input signal's center frequency.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an I/Q Power trigger to start capturing data only when a specific power is exceeded.
7. Select the "Bandwidth" button and define the bandwidth parameters for data acquisition:

- "Sample Rate" or "Analysis Bandwidth" the span of the input signal to be captured for analysis, or the rate at which samples are captured (both values are correlated)
- Optionally, if R&S FSW-B160/-B320 is installed, the "Maximum Bandwidth" , depending on whether you require a larger bandwidth or fewer spurious emissions.
- "Measurement Time" how long the data is to be captured
- "Record Length" : the number of samples to be captured (also defined by sample rate and measurement time)

8. Select the "Display Config" button and select up to six displays that are of interest to you.
   Arrange them on the display to suit your preferences.
9. Exit the SmartGrid mode.
10. Start a new sweep with the defined settings.
    In MSRA/MSRT mode you may want to stop the continuous measurement mode by the Sequencer and perform a single data acquisition:
    a) Select the Sequencer icon () from the toolbar.
    b) Set the Sequencer state to "Off" .
    c) Select the [RUN SINGLE] key.

8.1.2 How to Analyze Data in the I/Q Analyzer

1. Select the [MODE] key and select the "I/Q Analyzer" application.
2. Select the "Overview" softkey to display the "Overview" for an I/Q Analyzer measurement.
3. Select the "Display Config" button and select up to six displays that are of interest to you.
   Arrange them on the display to suit your preferences.
4. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
5. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the displays.
   - Configure a trace to display the average over a series of sweeps (on the "Trace" tab; if necessary, increase the "Average Count").
   - Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab).

8.2 How to Capture or Output I/Q Data via Optional Interfaces

The following step-by-step instructions demonstrate how to capture I/Q data on the R&S FSW using the optional Digital Baseband Interface (R&S FSW-B17) or the Analog Baseband Interface (R&S FSW-B71).

8.2.1 How to Capture Data via the Optional Digital Baseband Interface

Alternatively to capturing (analog) I/Q data from the standard RF Input connector of the R&S FSW, digital I/Q data can be captured from the optional **Digital Baseband Interface**, if installed.

The digital input and output cannot be used simultaneously.

1. Connect the device that provides digital input to the "Digital Baseband Input" connector at the rear of the R&S FSW.
2. Press the [INPUT/OUTPUT] key of the R&S FSW.
3. Select "Input Source Config" and switch to the "Digital I/Q" tab to configure the Digital Baseband Interface.

   Information on the detected input device is shown under "Connected Instrument".
4. Set the state of the "Digital I/Q" signal source to "On".
5. Define the "Sample Rate" as provided by the connected device, or select "Auto" mode to have it set automatically according to the detected device.
6. Define the level and unit that corresponds to an I/Q sample with the magnitude "1" as the "Full scale level", or select "Auto" mode to have it set automatically according to the input from the detected device.
7. Enable the "Adjust Reference Level to Full Scale Level" option to adjust the reference level to input changes continuously, or press the [AMPT] key to define the reference level manually. Select the "Amplitude Config" softkey to change the reference level offset or to set the level automatically only once.
8. Select the "Frequency" button to define the input signal's center frequency.

9. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example a Baseband Power trigger to start capturing data only when a specific input power is exceeded.
10. Select the "Bandwidth" button and define the bandwidth parameters for data acquisition:
    - "Sample rate" (the rate at which samples are captured) or "Analysis Bandwidth" (the span of the input signal to be captured for analysis); both values are correlated
    - Optionally, enable "No Filter" to suppress the use of the digital decimation filter and increase the analysis bandwidth to the input sample rate from the connected device.
    - "Measurement Time:" how long the data is to be captured
    - "Record Length": the number of samples to be captured (also defined by sample rate and measurement time)
11. Select the "Display Config" button and select up to six displays that are of interest to you.
    Arrange them on the display to suit your preferences.
12. Exit the SmartGrid mode.
13. Start a new sweep with the defined settings.

8.2.2 How to Capture Analog Baseband Input via the Optional Analog Baseband Interface (R&S FSW-B71)

Analog baseband signals can also be captured via the optional **Analog Baseband Interface (R&S FSW-B71)**, if installed.

1. Connect the device that provides analog baseband input to the "Baseband Input" connectors at the front of the R&S FSW.
   For single-ended input signals, use the I or Q connector, or both.
   For differential input signals, connect the positive input to the I and Q connectors, and the negative input to the $\bar{I}$ and $\bar{Q}$ connectors.
2. Press the [INPUT/OUTPUT] key of the R&S FSW.
3. Select "Input Source Config" and switch to the "Analog Baseband" tab to configure the Analog Baseband Interface.
   a) Set the state of the "Analog Baseband" signal source to "On".
   b) Select the "I/Q Mode" depending on the signal at the input connectors, or how you want to interpret it.

c) If necessary, change the input configuration setting depending on whether a single-ended or differential signal is being input.
Note that both differential and single-ended active probes are supported. However, since a probe only uses a single connector (either "Baseband Input I" or Q), the input configuration must be set to single-ended. The type of probe is indicated in the "Probes" subtab of the Input dialog box.
d) If necessary, for example due to a mixed up connection or inverse data from the connected device, swap the I and Q values for correct analysis.
e) If only one component of the input signal is of interest (I/Q mode: "I only/ Low IF I" or "Q only/ Low IF Q"), define how to interpret the signal: as modulated or real data. For modulated data, change the "Center Frequency" to use for down-conversion. Select a value between 10 Hz and +40 MHz (or 80 MHz with option R&S FSW-B71E).

4. Press the [Ampt] key and select "Amplitude Config".
5. Define the reference level for the input. If a probe is connected, consider the probe's attenuation when defining the reference level.
6. Select the maximum power level you expect to input at the "Baseband Input" connector as the "Full scale level", or select "Auto" mode to have it set automatically according to the selected reference level.
7. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example a Baseband Power trigger to start capturing data only when a specific input power is exceeded.
8. Press the [MEAS CONFIG] key and select "Data Acquisition" to configure the signal capture.
   - "Sample rate" selected for analysis data or "Analysis Bandwidth" (the bandwidth range in which the signal remains unchanged by the digital decimation filter and thus remains undistorted; this range can be used for accurate analysis by the R&S FSW); both values are correlated
   - "Measurement Time:" how long the signal is to be captured
   - "Record Length": the number of samples to be captured (also defined by sample rate and measurement time)
9. Select the "Display Config" button and select up to six displays that are of interest to you.
   To analyze the complex spectrum of the analog baseband signal, for instance, select the Spectrum result display (and the I/Q mode "I+jQ" in the input settings). The displayed span corresponds to the selected sample rate.
   Arrange the windows on the display to suit your preferences.
10. Exit the SmartGrid mode.
11. Start a new sweep with the defined settings.

8.2.3 How to Capture Data from the Optional Analog Baseband Input Connectors (R&S FSW-B71) as RF Input

RF signals can also be input via the optional "Baseband Input" connectors, if the Analog Baseband Interface (option R&S FSW-B71) is installed. Thus, RF signals can also be input using an active R&S probe. The probe input can then be processed as common RF input.

1. Connect the device (for example a probe) that provides analog baseband data modulated on a carrier frequency to the "Baseband Input I" connector at the front of the R&S FSW.
2. Press the [INPUT/OUTPUT] key of the R&S FSW.
3. Select the "Input Source Config" button to configure the "Radio Frequency" signal source.
4. Set the state of the "Radio Frequency" signal source to "On".
5. As the "Input Connector", select "Baseband Input I".
6. Select the "Amplitude" button to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.
7. Select the "Frequency" button to define the input signal's center frequency.
8. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an I/Q Power trigger to start capturing data only when a specific power is exceeded.
9. Select the "Bandwidth" button and define the bandwidth parameters for data acquisition:
   - "Sample rate" or "Analysis Bandwidth:" the span of the input signal to be captured for analysis, or the rate at which samples are captured (both values are correlated)
   - Optionally, if R&S FSW-B160/-B320/-B512/-B1200/-B2001/-B4001/-B6001/-B8001 is installed, the "Maximum Bandwidth", depending on whether you require a larger or smaller bandwidth.
   - "Measurement Time:" how long the data is to be captured
   - "Record Length": the number of samples to be captured (also defined by sample rate and measurement time)
10. Select the "Display Config" button and select up to six displays that are of interest to you.
    Arrange them on the display to suit your preferences.
11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.

8.2.4 How to Capture Analog Baseband Input via the Oscilloscope Baseband Input Option (R&S FSW-B2071)

Analog baseband signals can also be captured by a connected oscilloscope if the Oscilloscope Baseband Input option is installed. In this case, a Rohde & Schwarz oscilloscope (e.g. R&S RTO) is inserted in the measurement setup. (For details and prerequisites see Chapter 5.4, "Processing Oscilloscope Baseband Input", on page 55.)

Determine the oscilloscope's computer name or TCPIP address *before* activating the Oscilloscope Baseband Input option. Once activated, manual operation on the oscilloscope, or remote operation other than by the R&S FSW controlling the option, is not possible.

If the LAN connection is lost for any reason, the oscilloscope remains locked. Restart the oscilloscope to unlock it.

To determine the oscilloscope's computer name

► On the oscilloscope, press the [Setup] key and select the "System" tab or "LXI" tab.

The current computer name is displayed.

To determine the oscilloscope's TCPIP address

1. Press the [Setup] key and select the "System" tab.
2. Tap "Network".
3. Touch and hold (or right-click) "Local Area Connection" and select "Properties".
4. On the "Networking" tab, select "Internet Protocol Version 4 (TCP/IPv4)" and then select "Properties".

   The address is indicated under "Use the following IP address".

1. Connect the device that provides analog baseband input to the channel input ("CH <x>") connectors at the front of the oscilloscope.
   For single-ended input signals, use "CH1" (for I data) and "CH3" (for Q data).
   For differential input signals, connect the positive input to "CH1" (for I data) and "CH3" (for Q data), and the negative input to "CH2" (for $\bar{I}$ data) and "CH4" (for $\bar{Q}$ data).
2. Connect the oscilloscope to the R&S FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope.
   If the reference is supplied by the R&S FSW, connect the "REF OUTPUT 10 MHz" connector of the R&S FSW to the "REF IN" connector of the oscilloscope.
4. Press the [INPUT/OUTPUT] key of the R&S FSW.
5. Select "Input Source Config" and switch to the "Oscilloscope Baseband" tab to configure the Oscilloscope Baseband Input.
   a) Set the state of the Oscilloscope Baseband Input to "On".

b) Select the "I/Q Mode" depending on the signal at the input connectors, or how you want to interpret it.
c) If necessary, change the input configuration setting depending on whether a single-ended or differential signal is being input.
d) If necessary, for example due to different cable lengths for I and Q data, define the required deskew values.
e) If necessary, adapt the impedance settings.

6. Press the [Ampt] key and select "Amplitude Config".
7. Define the reference level for the input, or select the maximum power level you expect to capture on the oscilloscope as the "Full scale level".
8. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example a Baseband Power trigger to start capturing data only when a specific input power is exceeded.
9. Press the [MEAS CONFIG] key and select "Data Acquisition" to configure the signal capture.
   - "Sample rate" selected for analysis data or "Analysis Bandwidth" (the bandwidth range in which the signal remains unchanged by the digital decimation filter and thus remains undistorted; this range can be used for accurate analysis by the R&S FSW); both values are correlated
   - "Measurement Time:" how long the signal is to be captured
   - "Record Length": the number of samples to be captured (also defined by sample rate and measurement time)
10. Select the "Display Config" button and select up to six displays that are of interest to you.
    To analyze the complex spectrum of the analog baseband signal, for instance, select the Spectrum result display (and the I/Q mode "I+jQ" in the input settings). The displayed span corresponds to the selected sample rate.
    Arrange the windows on the display to suit your preferences.
11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.

8.2.5 How to Output I/Q Data via the Optional Digital Baseband Interface

The I/Q data processed by the I/Q Analyzer can also be output to the optional **Digital Baseband Interface**, if installed.

The digital input and output cannot be used simultaneously.

1. Connect the device to which digital output will be provided to the "Digital Baseband Output" connector at the rear of the R&S FSW.

2. Press the [INPUT/OUTPUT] key of the R&S FSW.
3. Select "Output Config" and switch to the "Digital I/Q" tab to configure the Digital Baseband output.

   Information on the detected output device is shown under "Connected Instrument". The output settings only become available once a device has been detected.
4. Set the state of the "Digital Baseband Output" to "On".
5. If the maximum sample rate displayed for the detected output device is lower than the currently defined sample rate for the I/Q Analyzer, press the [MEAS CONFIG] key and select "Data Acquisition" to change the "Sample Rate" setting.
6. Select the "Frequency" button to define the center frequency for the measurement.
7. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an I/Q Power trigger to start capturing data only when a specific power is exceeded.
8. Select the "Display Config" button and select up to six displays that are of interest to you.
   Arrange them on the display to suit your preferences.
9. Exit the SmartGrid mode.
10. Start a new sweep with the defined settings.

    The captured data is written to the Digital Baseband Output connector continuously.

8.3 How to Configure Data Acquisition via the Optional 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)

The optional 2 GHz / 5 GHz bandwidth extensions (R&S FSW-B2000/B5000) allow you to analyze signals with a bandwidth of up to 2 GHz / 5 GHz. In order to process the data with this bandwidth, a Rohde & Schwarz oscilloscope (e.g. R&S RTO) is inserted in the measurement setup. (For details and prerequisites see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85).

Determine the oscilloscope's computer name or TCPIP address *before* activating the B2000/B5000 option. Once activated, manual operation on the oscilloscope, or remote operation other than by the R&S FSW controlling the option, is not possible.

If the LAN connection is lost for any reason, the oscilloscope remains locked. Restart the oscilloscope to unlock it.

To determine the oscilloscope's computer name

► On the oscilloscope, press the [Setup] key and select the "System" tab or "LXI" tab.

The current computer name is displayed.

To determine the oscilloscope's TCPIP address

1. Press the [Setup] key and select the "System" tab.
2. Tap "Network".
3. Touch and hold (or right-click) "Local Area Connection" and select "Properties".
4. On the "Networking" tab, select "Internet Protocol Version 4 (TCP/IPv4)" and then select "Properties".

   The address is indicated under "Use the following IP address".

How to align the IF OUT 5 GHz connector and the oscilloscope for initial use

1. Connect the "IF OUT 5 GHz" connector on the rear panel of the R&S FSW to the "Ch1" input on the front panel of the oscilloscope.
2. Connect the oscilloscope to the R&S FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope.
   If the reference is supplied by the R&S FSW, connect the "REF OUTPUT 10 MHz" connector of the R&S FSW to the "REF IN" connector of the oscilloscope.
4. On the R&S FSW, press the [Input/Output] key.
5. Select the "B5000 Config" softkey.
6. In the "B5000" tab of the "Input" dialog box, enter the IP address of the oscilloscope.
   To enter the computer name instead of the IP address of the oscilloscope, select the "ABC" button first.
7. Set the B5000 "State" to "On".
8. Select the "Alignment" subtab.
9. Select the "Alignment" button.

   When the alignment was successfully completed, a green alignment message and the date are displayed in the dialog box.
   The alignment data is stored on the oscilloscope.
   If alignment fails, an error message is displayed. See Table 9-5 for possible solutions.

   The measurement setup is now ready for measurement.

How to align the IF OUT 2 GHz connector and the oscilloscope for initial use

1. Connect the "REF OUTPUT 640 MHz" connector on the rear panel of the R&S FSW to the "Ch1" input on the front panel of the oscilloscope.

2. Connect the oscilloscope to the R&S FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope.
   If the reference is supplied by the R&S FSW, connect the "REF OUTPUT 10 MHz" connector of the R&S FSW to the "REF IN" connector of the oscilloscope.
4. On the R&S FSW, press the [Input/Output] key.
5. Select the "B2000 Config" softkey.
6. In the "B2000" tab of the "Input" dialog box, enter the IP address of the oscilloscope.
   To enter the computer name instead of the IP address of the oscilloscope, select the "ABC" button first.
7. Set the B2000 "State" to "On".
8. Select the "Alignment" subtab.
9. Select the "Alignment" button.

   When the first alignment step was completed successfully, a new dialog box is displayed.
10. Disconnect the cable from the "REF OUTPUT 640 MHz" connector and instead connect it to the "FSW B2000 Alignment Signal Source" connector on the R&S FSW.
11. Select the "Continue Alignment" button.

    When the second alignment step was successfully completed, a green alignment message and the date are displayed in the dialog box.
    The alignment data is stored on the oscilloscope.
    If alignment fails, an error message is displayed. See Table 9-5 for possible solutions.
12. Remove the cable from the "Alignment signal source" on the R&S FSW and connect it to the "IF OUT 2 GHz" connector.
13. Select the "Continue" button.

    The measurement setup is now ready for measurement.

How to capture data with the 2 GHz / 5 GHz bandwidth extension

1. Check the following connections on the R&S FSW and the oscilloscope:
   (For details see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.)
   - The "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW is connected to the "Ch1" input of the oscilloscope
   - An external reference (for example the "REF OUTPUT 10 MHz" connector of the R&S FSW) is connected to the "REF IN" connector of the oscilloscope
   - The oscilloscope is connected to the R&S FSW via LAN

- Optionally, the "TRIG OUT" connector of the R&S FSW (or any other trigger signal) is connected to the "CH3" input connector of the oscilloscope

Note: In previous firmware versions, the external trigger was connected to the "Ch2" input on the oscilloscope. As of firmware version R&S FSW 2.30, the **"Ch3"** input on the oscilloscope must be used!

2. On the R&S FSW, press the [Input/Output] key.
3. Select the "B2000/B5000 Config" softkey.
4. In the "B2000/B5000" tab of the "Input" dialog box, enable the "State" of the B2000/B5000 option to activate its use.
5. If necessary, enter the IP address or computer name of the connected oscilloscope.
6. Check the alignment status displayed under the IP address or computer name of the oscilloscope.

   If UNCAL or an error message is displayed, perform an alignment first as described in "How to align the IF OUT 2 GHz connector and the oscilloscope for initial use" on page 250.
   If the green alignment message is displayed, the R&S FSW is ready to perform a measurement.
7. Define the measurement settings as described in Chapter 8.1.1, "How to Capture Baseband (I/Q) Data as RF Input", on page 241.
   To use an external trigger, use the "External CH3" trigger source and define which type of coupling the trigger connector on the oscilloscope is to use.
8. Start a new sweep with the defined settings.

How to align the B5000 power splitter

Before **initial use** of the power splitter, perform an **alignment**:

1. Connect the "IF OUT 5 GHz" connector on the rear panel of the R&S FSW to the power splitter provided with the B5000 option.
2. Connect the power splitter to the "Ch1" and "Ch3" inputs on the oscilloscope.
3. Connect the oscilloscope to the R&S FSW via LAN.
4. Connect an external reference to the "REF IN" connector of the oscilloscope.
   If the reference is supplied by the R&S FSW, connect the "REF OUTPUT 10 MHz" connector of the R&S FSW to the "REF IN" connector of the oscilloscope.
5. On the R&S FSW, press the [Input/Output] key.
6. Select the "B5000 Config" softkey.
7. In the "B5000" tab of the "Input" dialog box, enter the IP address of the oscilloscope.
   To enter the computer name instead of the IP address of the oscilloscope, select the "ABC" button first.

8. Set the B5000 "State" to "On".
9. Set the "Power Splitter Mode" to "On".
10. Select the "Alignment" subtab.
11. Select the "Alignment" button.
    When the alignment was successfully completed, a green alignment message and the date are displayed in the dialog box.
    The alignment data is stored on the oscilloscope.
    If alignment fails, an error message is displayed. See Table 9-5 for possible solutions.

How to align the B2000 power splitter

Before **initial use** of the power splitter, perform an **alignment**:

1. Connect the "REF OUTPUT 640 MHz" connector on the rear panel of the R&S FSW to the power splitter provided with the B2000 option.
2. Connect the power splitter to the "Ch1" and "Ch3" inputs on the oscilloscope.
3. Connect the oscilloscope to the R&S FSW via LAN.
4. Connect an external reference to the "REF IN" connector of the oscilloscope.
   If the reference is supplied by the R&S FSW, connect the "REF OUTPUT 10 MHz" connector of the R&S FSW to the "REF IN" connector of the oscilloscope.
5. On the R&S FSW, press the [Input/Output] key.
6. Select the "B2000 Config" softkey.
7. In the "B2000" tab of the "Input" dialog box, enter the IP address of the oscilloscope.
   To enter the computer name instead of the IP address of the oscilloscope, select the "ABC" button first.
8. Set the B2000 "State" to "On".
9. Set the "Power Splitter Mode" to "On".
10. Select the "Alignment" subtab.
11. Select the "Alignment" button.
    When the first alignment step was completed successfully, a new dialog box is displayed.
12. Disconnect the cable from the "REF OUTPUT 640 MHz" connector and instead connect it to the "FSW B2000 Alignment Signal Source" connector on the R&S FSW.
13. Select the "Continue Alignment" button.
    When the second alignment step was successfully completed, a green alignment message and the date are displayed in the dialog box.
    The alignment data is stored on the oscilloscope.

If alignment fails, an error message is displayed. See Table 9-5 for possible solutions.

14. Remove the cable from the "Alignment signal source" on the R&S FSW and connect it to the "IF OUT 2 GHz" connector.
15. Select the "Continue" button.

How to use the B2000/B5000 power splitter mode

1. Before initial use of the power splitter, perform an alignment, as described in "How to align the B5000 power splitter" on page 252 and "How to align the B2000 power splitter" on page 253.
2. Check the following connections on the R&S FSW and the oscilloscope:
   (For details see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.)
   - The "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW is connected to the power splitter, which is connected to the "Ch1" and "Ch3" inputs on the oscilloscope
   - An external reference (for example the "REF OUTPUT 10 MHz" connector of the R&S FSW) is connected to the "REF IN" connector of the oscilloscope
   - The oscilloscope is connected to the R&S FSW via LAN
   - Optionally, the "TRIG OUT" connector of the R&S FSW (or any other trigger signal) is connected to the "EXT TRIGGER INPUT" connector of the oscilloscope
3. On the R&S FSW, press the [Input/Output] key.
4. Select the "B2000/B5000 Config" softkey.
5. In the "B2000/B5000" tab of the "Input" dialog box, enable the "State" of the B2000/B5000 option to activate its use.
6. Set the "Power Splitter Mode" to "On".
7. Check the alignment status displayed under the IP address or computer name of the oscilloscope.

   If UNCAL or an error message is displayed, perform an alignment first as described in "How to align the B5000 power splitter" on page 252 and "How to align the B2000 power splitter" on page 253.
   If the green alignment message is displayed, the R&S FSW is ready to perform a measurement.
8. Define the measurement settings as described in Chapter 8.1.1, "How to Capture Baseband (I/Q) Data as RF Input", on page 241.
   To use an external trigger, use the "External Analog" trigger source and define which type of coupling the trigger connector on the oscilloscope is to use.
9. Start a new sweep with the defined settings.

8.4 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 I/Q Analyzer 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" .

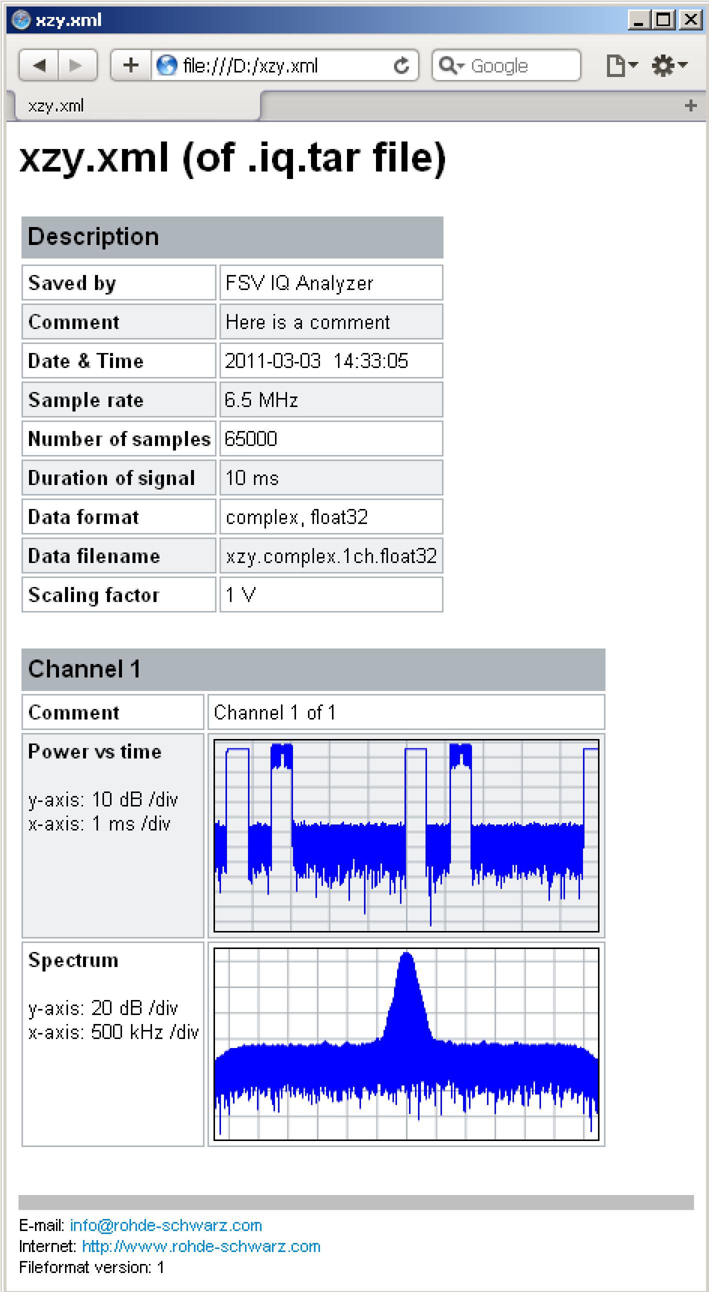
   The stored data is loaded from the file and displayed in the current application.

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 Troubleshooting the Measurement

If errors or problems occur, try the following methods to correct the measurement.

9.1 Error Messages

If errors occur during I/Q data acquisition or data output using the optional Digital Baseband Interface, a message is displayed in the status bar. When data acquisition errors occur, a status bit in the `STATus:QUEStionable:SYNC` register is also set.

Errors concerning the Digital Baseband Interface connection between instruments are indicated by a status bit in the `STATus:QUEStionable:DIQ` register. See Chapter 10.10.2, "STATus:QUEStionable:DIQ Register", on page 486.

The following tables describe the most common errors and possible solutions.

Table 9-1: I/Q data acquisition errors using the optional Digital Baseband Interface and possible solutions

Message	Possible solutions
"Sample rate too high in respect to input sample rate!"	• Reduce the sample rate • Increase the input sample rate (See Table 5-11)
"Sample rate too low in respect to input sample rate!"	• Increase the sample rate • Reduce the input sample rate (See Table 5-11)
"Number of IQ Capture samples too high!"	• Reduce the number of I/Q samples to capture • Decrease the sample rate or increase the input sample rate to reduce the ratio of sample rate / input sample rate
Keyword "DATA ERR"	• Re-establish the Digital I/Q connection NOTE: If this error is indicated repeatedly either the Digital I/Q LVDS connection cable or the receiving or transmitting device might be defect.
Keyword "PLL UNLOCKED"	• Re-establish the Digital I/Q connection after the clock from the input device has been restored

Table 9-2: I/Q data output errors using the optional Digital Baseband Interface and possible solutions

Message	Possible solutions
"Sample rate exceeds limit of connected instrument on Digital I/Q OUT port!"	• Reduce the sample rate
Keyword: "FIFO OVLD"	The sample rate on the connected instrument is higher than the input sample rate setting on the R&S FSW. • Reduce the sample rate on the connected instrument • Increase the input sample rate setting on the R&S FSW

Table 9-3: Errors using the optional Analog Baseband Interface and possible solutions

Message	Possible solutions
"Check Cable for High Accuracy Timing"	For R&S FSW models with a serial number lower than 103000 only: The preconditions required for High Accuracy Timing Trigger - Baseband - RF were not met. Make sure the cable required for high accuracy timing is connected to trigger ports 1 and 2. Unless it is explicitly deactivated, the high accuracy timing setting remains active. The error message is cleared when one of the following occurs: ● Analog Baseband input is deactivated (see "Analog Baseband Input State" on page 135) ● High accuracy timing is deactivated (see " High Accuracy Timing Trigger - Baseband - RF " on page 136) ● The cable was successfully detected
"High Accuracy Timing inactive"	Activation of High Accuracy Timing failed.

Table 9-4: Errors using the optional Oscilloscope Baseband Input bandwidth extension (R&S FSW-B2071) and possible solutions

Message	Possible solutions
"Unsupported capturing device"	Connected oscilloscope is not supported by the option (see data sheet)
"Oscilloscope LAN connection failed"	● Check the LAN connection between R&S FSW and oscilloscope ● Check the IP address of the oscilloscope defined in the Oscilloscope Baseband Input settings dialog box (see Chapter 6.3.1.6, "Oscilloscope Baseband Input", on page 137)
"Oscilloscope: No reference"	Check the connection of the external reference to the oscilloscope
"Invalid oscilloscope options: B4 (OCXO) not found"	Install the external reference option (B4) on the oscilloscope
"Invalid oscilloscope firmware version"	Install a newer firmware version on the oscilloscope (see data sheet), then switch the Oscilloscope Baseband Input state off and back on in the Oscilloscope Baseband Input settings dialog box (see "Oscilloscope Baseband Input State" on page 138)
"Invalid IP Address (Localhost)"	Define a correct IP address for the oscilloscope in the Oscilloscope Baseband Input settings dialog box (see "Oscilloscope Baseband Input State" on page 138). The currently defined address refers to the local host and is invalid.
"Invalid IP Address (empty)"	Define a correct IP address for the oscilloscope in the Oscilloscope Baseband Input settings dialog box (see "Oscilloscope Baseband Input State" on page 138).
"Wait for connection"	The connection to the oscilloscope is currently being established.
"Oscilloscope communication failed"	An error occurred during communication, e.g. a timeout. Start a new sweep.

Message	Possible solutions
"B2071: Waiting for trigger"	The oscilloscope is waiting for an external trigger signal at its external analog trigger input connector on the rear panel. ● Provide a trigger signal to the oscilloscope, either from an external device such as a signal generator, or from the R&S FSW by connecting the "TRIG OUT" connector of the R&S FSW to the external analog trigger input connector of the oscilloscope. ● Use a trigger other than External Analog on the R&S FSW.
"IF_OVLD"	An overload was detected on the oscilloscope; increase the reference level.
"UNCAL"/ "Oscilloscope is not aligned"	Perform a self-alignment on the oscilloscope (see the oscilloscope documentation)

Table 9-5: Errors using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) and possible solutions

Message	Possible solutions
"Unsupported capturing device"	Connected oscilloscope is not supported by the option (see data sheet) Make sure the connected oscilloscope supports at least a 10 GHz sample rate and 4 GHz bandwidth (20 GHz sample rate and 6 GHz bandwidth for B5000)
"Oscilloscope LAN connection failed"	● Check the LAN connection between R&S FSW and oscilloscope ● Check the IP address of the oscilloscope defined in the B2000/B5000 settings dialog box (see Chapter 6.3.1.9, "Settings for 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)", on page 151)
"Oscilloscope: No reference"	Check the connection of the external reference to the oscilloscope
"Invalid oscilloscope options"	Install the external reference option (B4) on the oscilloscope
"Invalid oscilloscope firmware version"	Install a firmware version 2.45.1.1 or higher on the oscilloscope, then switch the B2000/B5000 state off and back on in the B2000/B5000 settings dialog box (see "B2000/B5000 State" on page 151)
"Alignment failed"	● Check the connection from the "Alignment signal source output" connector (B2000) or "IF OUT" connector (B5000) on the R&S FSW to the "CH1" input on the oscilloscope. ● For alignment using the power splitter mode, make sure the cables between the power splitter output connectors on the R&S FSW and the input connectors on the oscilloscope have the same length. The difference between the two must not be larger than 10 cm.
"B2000 is not aligned" / "B5000 is not aligned"	Perform an alignment for the "IF OUT 2 GHz/ IF OUT 5 GHz " connection (see "Alignment" on page 152).
"Oscilloscope is not aligned"	Perform the initial alignment on the oscilloscope (see "Alignment" on page 152).
"Oscilloscope communication failed"	An error occurred during communication, e.g. a timeout. Start a new sweep.

Message	Possible solutions
"B2000: Waiting for trigger"	The oscilloscope is waiting for an external trigger signal at its "Ch3" input. ● Provide a trigger signal to the oscilloscope, either from an external device such as a signal generator, or from the R&S FSW by connecting the "TRIG OUT" connector of the R&S FSW to the "Ch3" input connector of the oscilloscope **Note:** In previous firmware versions, the external trigger was connected to the "CH2" input on the oscilloscope. As of firmware version R&S FSW 2.30, the **"Ch3"** input on the oscilloscope must be used! ● Use a trigger other than External Channel 3 on the R&S FSW
"IF_OVLD"	An overload was detected on the oscilloscope; increase the reference level.
"UNCAL"	A bandwidth extension option larger than 512 MHz and an external mixer are active, but only a common `.acl` file or no conversion loss table are assigned. Assign a special conversion loss table for large bandwidths (`.b2g` or `.b5g` file). See Chapter 5.6.5, "External Mixers and Large Bandwidth Extension Options", on page 70 and "Managing Conversion Loss Tables" on page 128.

Oscilloscope is inoperable

As soon as the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is activated (see "B2000/B5000 State" on page 151), the R&S FSW takes control of the oscilloscope. The display on the oscilloscope is turned off to improve performance during data export. As soon as the R&S FSW closes the connection to the oscilloscope, the display is reactivated and the oscilloscope can be operated as usual. However, if the LAN connection is lost for any reason, the display of the oscilloscope remains deactivated. Restart the oscilloscope to reactivate the display.

Alternatively, re-establish the connection and then close it properly, or use the remote command to re-activate the display (see `EXPort:WAVeform:DISPlayoff` on page 346).

10 Remote Commands to Perform Measurements with I/Q Data

The following commands are specific to performing measurements in the I/Q Analyzer application or using the optional Digital Baseband Interface (R&S FSW-B17) in a remote environment. The R&S FSW must already be set up for remote operation in a network as described in the base unit 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:

- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

SCPI Recorder - automating tasks with remote command scripts

The I/Q Analyzer application also supports the SCPI Recorder functionality.

Using the SCPI Recorder functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, the instrument supports you by showing the corresponding command syntax for the current setting value.

For details see the "Network and Remote Operation" chapter in the R&S FSW User Manual.

The following tasks specific to the I/Q Analyzer application are described here:

10.1 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.

10.1.1 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**
  The default unit is 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.

10.1.2 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`.

10.1.3 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.

10.1.4 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.

10.1.5 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`.

10.1.6 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.

10.1.6.1 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.

10.1.6.2 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`

10.1.6.3 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 10.1.2, "Long and Short Form", on page 263.

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`

10.1.6.4 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'`

10.1.6.5 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.

10.2 Common Suffixes

In the I/Q Analyzer application, the following common suffixes are used in remote commands:

Table 10-1: Common suffixes used in remote commands in the I/Q Analyzer application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 6	Window (**in the currently selected channel**)

Suffix	Value range	Description
<t>	1 to 6	Trace
	1 to 8	Limit line

10.3 Activating I/Q Analyzer Measurements

I/Q Analyzer measurements require a special channel on the R&S FSW. It can be activated using the common `INSTrument:CREate[:NEW]` or `INSTrument:CREate:REPLace` commands. In this case, some - but not all - parameters from the previously selected application are passed on to the I/Q Analyzer channel. In order to retain *all* relevant parameters from the current application for the I/Q measurement, use the `TRACe:IQ[:STATe]` command to change the application of the current channel.

A measurement is started immediately with the default settings when the channel is activated.

Different remote modes available

In remote control, two different modes for the I/Q Analyzer measurements are available:

- A quick mode for pure data acquisition
  This mode is activated by default with the `TRACe:IQ[:STATe]` command. The evaluation functions are not available; however, performance is slightly improved.
- A more sophisticated mode for acquisition and analysis.
  This mode is activated when a new channel is opened for the I/Q Analyzer application (`INST:CRE:NEW`/ `INST:CRE:REPL`) or by an additional command (see `TRACe:IQ:EVAL` on page 272).

Switching the data basis for measurement

By default, the I/Q Analyzer captures and processes I/Q data. However, the I/Q Analyzer application (*not Master*) **in MSRA mode** can also perform measurements on the captured I/Q data in the time and frequency domain. In order to do so, the I/Q Analyzer performs an FFT sweep on the captured I/Q data, providing power vs frequency results, or uses the RBW filter to obtain power vs time (zero span) results. This data is then used for the common frequency or time domain measurements. In order to switch between these measurements, you must select the data basis before performing a measurement.

For a description of remote commands required to perform measurements in the time and frequency domain, see the R&S FSW User Manual.

CALCulate<n>:IQ:MODE <EvalMode>

This command defines whether the captured I/Q data is evaluated directly, or if it is converted (via FFT) to spectral or time data first.

It is currently only available for I/Q Analyzer client applications in multistandard mode (not the MSRA Master).

Suffix:

<n> irrelevant

Parameters:

<EvalMode>

TDOMain
Evaluation in time domain (zero span).

FDOMain
Evaluation in frequency domain.

IQ
Evaluation using I/Q data.

INSTrument:CREate:DUPLicate

This command duplicates the currently selected channel, i.e creates a new 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" -> "IQAnalyzer 2").

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 channel named 'IQAnalyzer2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 270.

<ChannelName> String containing the name of the channel.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds an additional spectrum display named "Spectrum 2".

INStrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 270.

<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 270).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named "IQAnalyzer2" by a new channel of type "IQ Analyzer" named "IQAnalyzer".

Usage: Setting only

INStrument:DELete <ChannelName>

This command deletes a channel.

If you delete the last channel, the default "Spectrum" channel is activated.

Setting parameters:

<ChannelName> String containing the name of the channel you want to delete.
A channel must exist in order to be able delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Setting only

INSTrument:LIST?

This command queries all active channels. This is useful in order to obtain the names of the existing 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 channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage:
Query only

Table 10-2: Available 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
802.11ay (R&S FSW-K97)	EDMG	802.11ay EDMG
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
AM/FM/PM Modulation Analysis (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
Fast Spur Search (R&S FSW-K50)	SPUR	Spurious
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
NB-IoT (R&S FSW-K106)	NIOT	NB-IoT
*) If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> parameter	Default Channel name*)
Noise (R&S FSW-K30)	NOISE	Noise
5G NR (R&S FSW-K144)	NR5G	5G NR
OneWeb (R&S FSW-K201)	OWEB	OneWeb
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Pulse (R&S FSW-K6)	PULSE	Pulse
Real-Time Spectrum	RTIM	Real-Time Spectrum
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
Verizon 5GTF Measurement Application (V5GTF, R&S FSW-K118)	V5GT	V5GT
VSA (R&S FSW-K70)	DDEM	VSA
WLAN (R&S FSW-K91)	WLAN	WLAN
*) 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 channel.

Setting 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.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new channel with the defined channel type, or selects an existing channel with the specified name.

Also see

- `INSTrument:CREate[:NEW]` on page 268

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 270.

<ChannelName> String containing the name of the channel.

Example: `INST IQ`
Activates a channel for the I/Q Analyzer application (evaluation mode).
To start a channel in the simple I/Q Analyzer mode (see "Different remote modes available" on page 267), use `TRACe:IQ[:STATe]` on page 273.
`INST 'MyIQSpectrum'`
Selects the channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

SYSTem:PRESet:CHANnel[:EXEC]

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 112

TRACe:IQ:EVAL <State>

This command turns I/Q data analysis on and off.

Before you can use this command, you have to turn on the I/Q data acquisition using `INST:CRE:NEW IQ` or `INST:CRE:REPL`, or using the `TRACe:IQ[:STATe]` command to replace the current channel while retaining the settings.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `TRAC:IQ ON`
Enables I/Q data acquisition
`TRAC:IQ:EVAL ON`
Enables the I/Q data analysis mode.

TRACe:IQ[:STATe] <State>

This command changes the application of the current channel to I/Q Analyzer, activating the simple I/Q data acquisition mode (see "Different remote modes available" on page 267).

Executing this command also has the following effects:

- The sweep, amplitude, input and trigger settings from the previous application are retained
- All measurements from the previous application (e.g. Spectrum) are turned off
- All traces are set to "Blank" mode
- The I/Q data analysis mode is turned off (`TRAC:IQ:EVAL OFF`, if previous application was also I/Q Analyzer)

Note: To turn trace display back on or to enable the evaluation functions of the I/Q Analyzer, execute the `TRAC:IQ:EVAL ON` command (see `TRACe:IQ:EVAL` on page 272).

Parameters:

<State>	ON | OFF | 0 | 1 **OFF | 0** Switches the function off **ON | 1** Switches the function on
Example:	`TRAC:IQ ON` Switches on I/Q data acquisition

10.4 Configuring I/Q Analyzer Measurements

The following commands configure the I/Q Analyzer measurements.

10.4.1 Configuring the Data Input and Output

The following commands are required to configure data input and output.

10.4.1.1 RF Input

INPut<ip>:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer for the R&S FSW 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.

For details on the protection mechanism see "RF Input Protection" on page 118.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Example: `INP:ATT:PROT:RES`

INPut<ip>:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

Suffix:
<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<ConnType>
RF
RF input connector
AIQI
Analog Baseband I connector
This setting 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.
RFPRobe
Active RF probe
*RST: RF

Example:
`INP:CONN RF`
Selects input from the RF input connector.

Manual operation: See " Input Connector " on page 120

INPut<ip>:COUPling <CouplingType>

This command selects the coupling type of the RF input.

The command is not available for measurements with the optional Digital Baseband Interface.

Suffix:
<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<CouplingType>
AC | DC
AC
AC coupling
DC
DC coupling
*RST: AC

Example:
`INP:COUP DC`

Manual operation: See " Input Coupling " on page 118

INPut<ip>:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See " Direct Path " on page 119

INPut<ip>: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.)

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Manual operation: See " High Pass Filter 1 to 3 GHz " on page 120

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

Enables or disables the YIG filter.

Suffix:

<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

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 120

INPut<ip>:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

The command is not available for measurements with the optional Digital Baseband Interface.

Suffix:

<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for the Spectrum application, the I/Q Analyzer, and some optional applications.
(In MSRA mode, master only)

*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See " Impedance " on page 119
See " Unit " on page 164

INPut<ip>:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for RF input.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:
```
INP:IMP 100
INP:IMP:PTYP MLP
```

Manual operation: See " Impedance " on page 119

INPut<ip>: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 or file input is supported.

For R&S FSW85 models with two RF input connectors you must select the input connector to configure first using `INPut<ip>:TYPE`.

Suffix:
<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Source>

OBB
Oscilloscope Baseband signal
For details on Oscilloscope Baseband Input see the R&S FSW I/Q Analyzer User Manual.
Not available for Input2.

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file
(selected by `INPut<ip>:FILE:PATH` on page 281)
Not available for Input2.

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.
Not available for Input2.

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.
Not available for Input2.

*RST: RF

Example:
`INP:TYPE INP1`
For R&S FSW85 models with two RF input connectors: selects the 1.00 mm RF input connector for configuration.
`INP:SEL RF`

Manual operation:
See " Radio Frequency State " on page 118
See "I/Q Input File State" on page 121
See "Digital I/Q Input State" on page 133
See "Analog Baseband Input State" on page 135

INPut<ip>:TYPE <Input>

The command selects the input path.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Input> **INPUT1**
Selects RF input 1.
1 mm [RF Input] connector

INPUT2
Selects RF input 2.
For R&S FSW85 models with two RF input connectors:
1.85 mm [RF2 Input] connector
For all other models: not available

*RST: INPUT1

Example: //Select input path
`INP:TYPE INPUT1`

Manual operation: See " Radio Frequency State " on page 118

INPut<ip>:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSW.

See the R&S FSW Getting Started manual for details.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> **ON | 1**
User port is switched to INPut

OFF | 0
User port is switched to OUTPut

*RST: 1

INPut<ip>:UPORt[:VALue]

This command queries the control lines of the user ports.

For details see `OUTPut<up>:UPORt[:VALue]` on page 354.

Suffix:

<ip>	1 | 2 For R&S FSW85 models with two RF input connectors: 1: Input 1 (1 mm [RF Input] connector) 2: Input 2 (1.85 mm [RF2 Input] connector) For all other models: irrelevant

Return values:

<Level>	bit values in hexadecimal format TTL type voltage levels (max. 5V) Range: #B00000000 to #B00111111

Example:
```
INP:UPOR?
//Result: #B00100100
```
Pins 5 and 7 are active.

10.4.1.2 Input from I/Q Data Files

The input for measurements can be provided from I/Q data files. The commands required to configure the use of such files are described here.

For details see Chapter 5.8, "Basics on Input from I/Q Data Files", on page 84.

Useful commands for retrieving results described elsewhere:

- `INPut<ip>:SELect` on page 278

Remote commands exclusive to input from I/Q data files:

INPut<ip>:FILE:PATH <FileName>[, <AnalysisBW>]

This command selects the I/Q data file to be used as input for further measurements.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

For details, see Table D-1.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<FileName> String containing the path and name of the source file.
The file extension is `*.iq.tar`.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.
Default unit: HZ

Example:

```
INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'
```
Uses I/Q data from the specified file as input.

Example:

```
//Load an IQW file
INP:SEL:FIQ
INP:FILE:PATH 'C:\R_S\Instr\user\data.iqw'
//Define the sample rate
TRAC:IQ:SRAT 10MHz
//Define the measurement time
SENSe:SWEep:TIME  0.001001
//Start the measurement
INIT:IMM
```

Manual operation: See " Select I/Q data file " on page 122

MMEMory:LOAD:IQ:STReam <Channel>

Only available for files that contain more than one data stream from multiple channels: selects the data stream to be used as input for the currently selected channel.

Automatic mode (`MMEMory:LOAD:IQ:STReam:AUTO`) is set to OFF.

Parameters:

<Channel> String containing the channel name.

Example:

```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
MMEM:LOAD:IQ:STR 'Channel2'
```

Manual operation: See "Selected Channel" on page 122

MMEMory:LOAD:IQ:STReam:AUTO <State>

Only available for files that contain more than one data stream from multiple channels: automatically defines which data stream in the file is used as input for the channel.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The data stream specified by `MMEMory:LOAD:IQ:STReam` is used as input for the channel.

ON | 1
The first data stream in the file is used as input for the channel. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc.

*RST: 1

Manual operation: See "Selected Channel" on page 122

MMEMory:LOAD:IQ:STReam:LIST?

Returns the available channels in the currently loaded input file.

Example:
```
MMEM:LOAD:IQ:STR?
//Result: 'Channel1','Channel2'
```

Usage: Query only

Manual operation: See "Selected Channel" on page 122

TRACe:IQ:FILE:REPetition:COUNt <RepetitionCount>

Determines how often the data stream is repeatedly copied in the I/Q data memory. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Parameters:
<RepetitionCount> integer

Example:
```
TRAC:IQ:FILE:REP:COUN 3
```

Manual operation: See "File Repetitions" on page 122

10.4.1.3 Configuring Digital I/Q Input and Output

Useful commands for digital I/Q data described elsewhere:

- `INP:SEL DIQ` (see `INPut<ip>:SELect` on page 278)
- `TRIGger[:SEQuence]:LEVel:BBPower` on page 371
- `TRACe:IQ:DIQFilter` on page 384

Remote commands exclusive to digital I/Q data input and output

INPut<ip>: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.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Return values:

<Value>

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 134

INPut<ip>: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.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Manual operation: See " Adjust Reference Level to Full Scale Level " on page 134

INPut<ip>: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.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Level> Range: 1 µV to 7.071 V
*RST: 1 V
Default unit: DBM

Manual operation: See " Full Scale Level " on page 134

INPut<ip>: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.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Manual operation: See " Full Scale Level " on page 134

INPut<ip>:DIQ:RANGe[:UPPer]:UNIT <Level>

Defines the unit of the full scale level. 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.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Level> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere
*RST: Volt

Manual operation: See " Full Scale Level " on page 134

INPut<ip>: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 134).

Note: the final user sample rate of the R&S FSW may differ and is defined using `TRAC:IQ:SRAT` (see `TRACe:IQ:SRATe` on page 387).

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<SampleRate> Range: 1 Hz to 20 GHz
*RST: 32 MHz
Default unit: HZ

Example: `INP:DIQ:SRAT 200 MHz`

Manual operation: See " Input Sample Rate " on page 134

INPut<ip>: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.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Manual operation: See " Input Sample Rate " on page 134

OUTPut<up>:DIQ[:STATe] <State>

This command turns continuous output of I/Q data to the optional Digital Baseband Interface on and off.

Using the digital input and digital output simultaneously is not possible.

If digital baseband output is active, the sample rate is restricted to 100 MHz (200 MHz if enhanced mode is possible; max. 160 MHz bandwidth).

See also "Digital I/Q enhanced mode" on page 46.

Suffix:
<up>

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `OUTP:DIQ ON`

Manual operation: See " Digital Baseband Output " on page 160

OUTPut<up>:DIQ:CDEVice?

This command queries the current configuration and the status of the digital I/Q data output to the optional Digital Baseband Interface.

Suffix:
<up>

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>	Current data transfer rate of the connected device in Hz
<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**
<NotUsed>	to be ignored
<Placeholder>	for future use; currently "0"

Example:	`OUTP:DIQ:CDEV?`
	Result:
	`1,SMW200A,101190,CODER 1 IN,`
	`0,200000000,Passed,Done,0,0`

Usage:	Query only
Manual operation:	See "Output Settings Information" on page 160 See " Connected Instrument " on page 160

10.4.1.4 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.

For more information on the Analog Baseband Interface see Chapter 5.3, "Processing Data from the Analog Baseband Interface", on page 48.

For a programming example, see Chapter 10.11.6, "Data Acquisition via the Optional Analog Baseband Interface", on page 495.

Useful commands for Analog Baseband data described elsewhere:

- `INP:SEL AIQ` (see `INPut<ip>:SELect` on page 278)
- `[SENSe:]FREQuency:CENTer` on page 367

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<ip>: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.

Suffix:

<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State>
ON | OFF | 1 | 0

ON | 1
Differential

OFF | 0
Single ended

*RST: 1

Example: `INP:IQ:BAL OFF`

Manual operation: See "Input Configuration" on page 136

INPut<ip>: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.

Suffix:

<ip>	1 | 2 For R&S FSW85 models with two RF input connectors: 1: Input 1 (1 mm [RF Input] connector) 2: Input 2 (1.85 mm [RF2 Input] connector) For all other models: irrelevant

Parameters:

<State>	**ON | 1** Automatic definition **OFF | 0** Manual definition according to `INPut<ip>:IQ:FULLscale[:LEVel]` on page 290 *RST: 1

Example: `INP:IQ:FULL:AUTO OFF`

Manual operation: See "Full Scale Level Mode / Value" on page 170

INPut<ip>: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<ip>:IQ:FULLscale:AUTO` on page 290).

Suffix:

<ip>	1 | 2 For R&S FSW85 models with two RF input connectors: 1: Input 1 (1 mm [RF Input] connector) 2: Input 2 (1.85 mm [RF2 Input] connector) For all other models: irrelevant

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 Default unit: V

Example: `INP:IQ:FULL 0.5V`

Manual operation: See "Full Scale Level Mode / Value" on page 170

INPut<ip>:IQ:IMPedance <Impedance>

This command selects the nominal input impedance of the analog baseband input.

The command is not available for measurements with the optional Digital Baseband Interface.

For input from the RF input, use the `INPut<ip>:IMPedance` command.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for the Spectrum application, the I/Q Analyzer (and thus MSRA mode, Master only) and the optional Docsis 3.1 application.

*RST: 50
Default unit: OHM

Example: `INP:IQ:IMP 75`

Manual operation: See " Impedance " on page 119

INPut<ip>:IQ:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for analog baseband input.

For RF input, use the `INPut<ip>:IMPedance:PTYPe` command.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:
```
INP:IQ:IMP 100
INP:IQ:IMP:PTYP MLP
```

Manual operation: See " Impedance " on page 119

INPut<ip>:IQ:TYPE <DataType>

This command defines the format of the input signal.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

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 135

CALibration:AIQ:DCOFfset:I <Offset>

This command defines a DC offset of the I input from the Analog Baseband interface (R&S FSW-B71).

Parameters:

<Offset> numeric value

DC offset

*RST: 0

Default unit: V

Example: `CAL:AIQ:DCOF:I 0.001`

CALibration:AIQ:DCOFfset:Q <Offset>

This command defines a DC offset of the Q input from the Analog Baseband interface (R&S FSW-B71).

Parameters:

<Offset> numeric value

DC offset

*RST: 0

Default unit: V

Example: `CAL:AIQ:DCOF:Q 0.001`

CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

For more information see "High-accuracy timing" on page 51.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CAL:AIQ:HAT:STAT ON`

Manual operation: See " High Accuracy Timing Trigger - Baseband - RF " on page 136

TRACe:IQ:APCon[:STATe] <State>

If enabled, the average power consumption is calculated at the end of the I/Q data measurement. This command must be set *before* the measurement is performed!

The conversion factors A and B for the calculation are defined using `TRACe:IQ:APCon:A` and `TRACe:IQ:APCon:B`.

The results can be queried using `TRACe:IQ:APCon:RESult?` on page 294.

For details see Chapter 5.3.6, "Average Power Consumption", on page 55.

Parameters:

<State>	ON | OFF | 0 | 1
	OFF | 0 Switches the function off
	ON | 1 Switches the function on

Example:

```
*RST
TRAC:IQ:STAT ON
TRAC:IQ:SRAT 1MHZ
TRAC:IQ:RLEN 1000000
TRAC:IQ:APC:STAT ON
TRAC:IQ:APC:A 3.0
TRAC:IQ:APC:B 0.6
INIT;*WAI
TRAC:IQ:APC:RES?
```

TRACe:IQ:APCon:A <ConvFact>

Defines the conversion factor A for the calculation of the average power consumption.

For details see Chapter 5.3.6, "Average Power Consumption", on page 55.

Parameters:

<ConvFact>	numeric value
	*RST: 1.0

TRACe:IQ:APCon:B <ConvFact>

Defines the conversion factor B for the calculation of the average power consumption.

For details see Chapter 5.3.6, "Average Power Consumption", on page 55.

Parameters:

<ConvFact>	numeric value
	*RST: 0.0

TRACe:IQ:APCon:RESult?

Queries the average power consumption for an analog baseband input. This value is only calculated at the end of the I/Q data measurement if the `TRACe:IQ:APCon[:STATe]` command is set to ON *before* the measurement is performed!

For details see Chapter 5.3.6, "Average Power Consumption", on page 55.

Return values:

<Average>	numeric value
	Default unit: W

Usage: Query only

10.4.1.5 Configuring Oscilloscope Baseband Input

The following commands define settings for analog baseband input from an oscilloscope.

The commands for analog baseband input from an oscilloscope are similar, but *not identical* to those used for analog baseband using the optional Analog Baseband interface on the R&S FSW.

INPut<ip>:IQ:OSC:BALanced[:STATe] <State>

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Single ended

ON | 1
Differential

*RST: 1

Example: `INP:IQ:OSC:BAL OFF`

Manual operation: See "Input Configuration" on page 139

INPut<ip>:IQ:OSC:CONState?

Returns the state of the LAN connection to the oscilloscope for the optional Oscilloscope Baseband Input.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Return values:

<ConnectionState> CONNECTED | NOT_CONNECTED | ESTABLISHING_CONNECTION

CONNECTED
Connection to the instrument has been established successfully.

ESTABLISHING_CONNECTION
Connection is currently being established.

NOT_CONNECTED
Connection to the instrument could not be established.
Check the connection between the R&S FSW and the oscilloscope, and make sure the IP address of the oscilloscope has been defined (see INPut<ip>:IQ:OSC:TCPip on page 302).

Usage: Query only

INPut<ip>:IQ:OSC:COUPling <Coupling>

Determines the coupling of the oscilloscope to the R&S FSW.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Coupling> DC | DCLimit | AC

DC
DC coupling shows all parts of an input signal. DC 50 Ω coupling is the default for 50Ω input impedance to connect, for example, active probes.

DCLimit
DC coupling with 1 M Ω input impedance to connect standard passive probes.

AC
AC coupling is useful if the DC component of a signal is of no interest. AC coupling blocks the DC component of the signal so that the waveform is centered on zero volts.

Manual operation: See "Oscilloscope Coupling" on page 139

INPut<ip>:IQ:OSC:FULLscale[:LEVel] <Level>

The full scale level defines the maximum power for baseband input possible without clipping the signal.

For manual input, this setting corresponds to the setting on the oscilloscope. Thus, possible scaling values of the oscilloscope are allowed.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Level> Default unit: V

Example: `INP:IQ:OSC:FULL:AUTO OFF`

Example: `INP:IQ:OSC:FULL:LEV 1.0`

Manual operation: See "Full Scale Level Mode / Value" on page 170

INPut<ip>:IQ:OSC:IDN?

Returns the identification string of the oscilloscope connected to the R&S FSW.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Return values:
<IDN> string

Example:
```
INP:IQ:OSC:IDN?
//Result: Rohde&Schwarz,RTO,
1316.1000k14/200153,2.45.1.1
```

Usage: Query only

Manual operation: See " TCPIP Address / Computer Name " on page 138

INPut<ip>:IQ:OSC:IMPedance <Impedance>

This command selects the nominal input impedance of the analog baseband input.

The command is not available for measurements with the optional Digital Baseband Interface.

For input from the RF input, use the `INPut<ip>:IMPedance` command.

For analog baseband input without an oscilloscope, use the `INPut<ip>:IQ:IMPedance` command.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for the Spectrum application, the I/Q Analyzer (and thus MSRA mode, Master only) and the optional Docsis 3.1 application.

*RST: 50
Default unit: Ohm

Example: `INP:IQ:OSC:IMP 75`

Manual operation: See " Impedance " on page 119

INPut<ip>:IQ:OSC:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for analog baseband input.

For RF input, use the `INPut<ip>:IMPedance:PTYPe` command.

For analog baseband input without an oscilloscope, use the `INPut<ip>:IQ:IMPedance:PTYPe` command.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:
```
INP:IQ:OSC:IMP 100
INP:IQ:OSC:IMP:PTYP MLP
```

Manual operation: See " Impedance " on page 119

INPut<ip>:IQ:OSC:SKEW:I <Value>

Compensates for skewed values in the positive I path, e.g. due to different input cables.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Value> Default unit: S

Example:
```
INP:IQ:OSC:SKEW:I 0.2
```

Manual operation: See "I/Q Skew" on page 140

INPut<ip>:IQ:OSC:SKEW:I:INVerted <Value>

Compensates for skewed values in the negative I path, e.g. due to different input cables.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Value> Default unit: S

Example: `INP:IQ:OSC:SKEW:I:INV 0.2`

Manual operation: See "I/Q Skew" on page 140

INPut<ip>:IQ:OSC:SKEW:Q <Value>

Compensates for skewed values in the positive Q path, e.g. due to different input cables.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Value> Default unit: S

Example: `INP:IQ:OSC:SKEW:Q 0.2`

Manual operation: See "I/Q Skew" on page 140

INPut<ip>:IQ:OSC:SKEW:Q:INVerted <Value>

Compensates for skewed values in the negative Q path, e.g. due to different input cables.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Value> Default unit: S

Example: `INP:IQ:OSC:SKEW:Q:INV 0.2`

Manual operation: See "I/Q Skew" on page 140

INPut<ip>:IQ:OSC:SRATe <SampleRate>

Returns the used oscilloscope acquisition sample rate, which depends on the used I/Q mode (see `INPut<ip>:IQ:OSC:TYPE` on page 302).

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<SampleRate> 10 GHz | 20 GHz

10 GHz
differential mode

20 GHz
single-ended mode

Default unit: Hz

Example: `INP:IQ:OSC:SRAT?`

INPut<ip>:IQ:OSC[:STATe] <State>

Activates or deactivates Oscilloscope Baseband Input from a connected oscilloscope. This input requires optional firmware.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Oscilloscope Baseband Input not active

ON | 1
Oscilloscope Baseband Input active

*RST: 0

Example: `INP:IQ:OSC:STAT ON`
This command has the same effect as `INP:SEL OBB`, see `INPut<ip>:SELect` on page 278.

Manual operation: See "Oscilloscope Baseband Input State" on page 138

INPut<ip>:IQ:OSC:TCPip <Tcpip>

Defines the TCPIP address or computer name of the oscilloscope connected to the R&S FSW via LAN.

Note: The IP address is maintained after a [PRESET], and is transferred between applications.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Tcpip> computer name or IP address

Example: `INP:IQ:OSC:TCP '192.0.2.0'`

Example: `INP:IQ:OSC:TCP 'FSW43-12345'`

Manual operation: See " TCPIP Address / Computer Name " on page 138

INPut<ip>:IQ:OSC:TYPE <Type>

Defines the format of the input signal.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Type> IQ | I

IQ
Both components of the complex input signal (in-phase component, quadrature component) are filtered and resampled to the sample rate of the application.
The input signal is down-converted with the center frequency (**Low IF I**).

I
The input signal at the channel providing I data is resampled to the sample rate of the application.
The input signal is down-converted with the center frequency (**Low IF I**).

Example: `INP:IQ:OSC:TYPE I`

Manual operation: See " I/Q Mode " on page 139

INPut<ip>:IQ:OSC:VDEVice?

Queries whether the connected instrument is supported for Oscilloscope Baseband Input.

For details see the data sheet.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Return values:

<Device> ON | OFF | 0 | 1

OFF | 0
Instrument is not supported.

ON | 1
Instrument is supported

Example: `INP:IQ:OSC:VDEV?`

Usage: Query only

Manual operation: See " TCPIP Address / Computer Name " on page 138

INPut<ip>:IQ:OSC:VFIRmware?

Queries whether the firmware on the connected oscilloscope is supported for Oscilloscope Baseband Input.

For details see the data sheet.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Return values:

<FirmwareState> ON | OFF | 0 | 1

OFF | 0
Firmware is not supported

ON | 1
Firmware is supported

Example: `INP:IQ:OSC:VFIR?`

Usage: Query only

Manual operation: See " TCPIP Address / Computer Name " on page 138

10.4.1.6 Using External Mixers

The commands required to work with external mixers in a remote environment are described here. Note that these commands require the R&S FSW to have an external mixer option installed and an external mixer to be connected to the R&S FSW.

In MSRA/MSRT mode, external mixers are not supported.

For details on working with external mixers see the R&S FSW User Manual.

Basic Settings

The basic settings concern general usage of an external mixer.

[SENSe:]MIXer<x>[:STATe] <State>

Activates or deactivates the use of a connected external mixer as input for the measurement. This command is only available if the optional External Mixer is installed and an external mixer is connected.

Suffix:
<x> 1..n
irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `MIX ON`

Manual operation: See " External Mixer (State)" on page 124

[SENSe:]MIXer<x>:BIAS:HIGH <BiasSetting>

This command defines the bias current for the high (last) range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer<x>[:STATe]` on page 304).

Suffix:
<x> 1..n
irrelevant

Parameters:

<BiasSetting> *RST: 0.0 A
Default unit: A

Manual operation: See " Bias Value " on page 127

[SENSe:]MIXer<x>:BIAS[:LOW] <BiasSetting>

This command defines the bias current for the low (first) range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer<x>[:STATe]` on page 304).

Suffix:

<x> 1..n
irrelevant

Parameters:

<BiasSetting> *RST: 0.0 A
Default unit: A

Manual operation: See " Bias Value " on page 127

[SENSe:]MIXer<x>:LOPower <Level>

This command specifies the LO level of the external mixer's LO port.

Suffix:

<x> 1..n
irrelevant

Parameters:

<Level> numeric value

Range: 13.0 dBm to 17.0 dBm
Increment: 0.1 dB
*RST: 15.5 dBm

Example: `MIX:LOP 16.0dBm`

Manual operation: See " LO Level " on page 127

Mixer Settings

The following commands are required to configure the band and specific mixer settings.

[SENSe:]MIXer<x>:FREQuency:HANDover <Frequency>

This command defines the frequency at which the mixer switches from one range to the next (if two different ranges are selected). The handover frequency for each band can be selected freely within the overlapping frequency range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer<x>[:STATe]` on page 304).

Suffix:

<x>	1..n irrelevant

Parameters:

<Frequency>	Default unit: HZ

Example:	`MIX ON`
	Activates the external mixer.
	`MIX:FREQ:HAND 78.0299GHz`
	Sets the handover frequency to 78.0299 GHz.

Manual operation:	See " Handover Freq " on page 124

[SENSe:]MIXer<x>:FREQuency:STARt

This command sets or queries the frequency at which the external mixer band starts.

Suffix:

<x>	1..n irrelevant
Example:	`MIX:FREQ:STAR?` Queries the start frequency of the band.
Manual operation:	See " RF Start / RF Stop " on page 124

[SENSe:]MIXer<x>:FREQuency:STOP

This command sets or queries the frequency at which the external mixer band stops.

Suffix:

<x>	1..n irrelevant
Example:	`MIX:FREQ:STOP?` Queries the stop frequency of the band.

Manual operation: See " RF Start / RF Stop " on page 124

[SENSe:]MIXer<x>:HARMonic:BAND:PRESet

This command restores the preset frequency ranges for the selected standard waveguide band.

Note: Changes to the band and mixer settings are maintained even after using the [PRESET] function. Use this command to restore the predefined band ranges.

Suffix:
<x> 1..n
irrelevant

Example: `MIX:HARM:BAND:PRES`
Presets the selected waveguide band.

Manual operation: See " Preset Band " on page 125

[SENSe:]MIXer<x>:HARMonic:BAND <Band>

This command selects the external mixer band. The query returns the currently selected band.

This command is only available if the external mixer is active (see `[SENSe:]MIXer<x>[:STATe]` on page 304).

Suffix:
<x> 1..n
irrelevant

Parameters:
<Band> KA | Q | U | V | E | W | F | D | G | Y | J | USER
Standard waveguide band or user-defined band.

Manual operation: See " Band " on page 124

Table 10-3: Frequency ranges for pre-defined bands

Band	Frequency start [GHz]	Frequency stop [GHz]
KA (A) *)	26.5	40.0
Q	33.0	50.0
U	40.0	60.0
V	50.0	75.0
E	60.0	90.0
W	75.0	110.0
F	90.0	140.0
D	110.0	170.0
***)** The band formerly referred to as "A" is now named "KA".		

Band	Frequency start [GHz]	Frequency stop [GHz]
G	140.0	220.0
J	220.0	325.0
Y	325.0	500.0
USER	32.18 (default)	68.22 (default)
*) The band formerly referred to as "A" is now named "KA".		

[SENSe:]MIXer<x>:HARMonic:HIGH:STATe <State>

This command specifies whether a second (high) harmonic is to be used to cover the band's frequency range.

Suffix:
<x> 1..n

Parameters:
<State> ON | OFF
*RST: ON

Example: `MIX:HARM:HIGH:STAT ON`

Manual operation: See " Range 1 / Range 2 " on page 125

[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue] <HarmOrder>

This command specifies the harmonic order to be used for the high (second) range.

Suffix:
<x> 1..n
irrelevant

Parameters:
<HarmOrder numeric value
Range: 2 to 128 (USER band); for other bands: see band definition

Example:
```
MIX:HARM:HIGH:STAT ON
MIX:HARM:HIGH 2
```

Manual operation: See " Harmonic Order " on page 126

[SENSe:]MIXer<x>:HARMonic:TYPE <OddEven>

This command specifies whether the harmonic order to be used should be odd, even, or both.

Which harmonics are supported depends on the mixer type.

Suffix:
<x> 1..n
irrelevant

Parameters:
<OddEven> ODD | EVEN | EODD
ODD | EVEN | EODD
*RST: EVEN

Example: `MIX:HARM:TYPE ODD`

Manual operation: See " Harmonic Type " on page 126

[SENSe:]MIXer<x>:HARMonic[:LOW] <HarmOrder>

This command specifies the harmonic order to be used for the low (first) range.

Suffix:
<x> 1..n
irrelevant

Parameters:
<HarmOrder> Range: 2 to 128 (USER band); for other bands: see band definition
*RST: 2 (for band F)

Example: `MIX:HARM 3`

Manual operation: See " Harmonic Order " on page 126

[SENSe:]MIXer<x>:LOSS:HIGH <Average>

This command defines the average conversion loss to be used for the entire high (second) range.

Suffix:
<x> 1..n
irrelevant

Parameters:
<Average> Range: 0 to 100
*RST: 24.0 dB
Default unit: dB

Example: `MIX:LOSS:HIGH 20dB`

Manual operation: See " Conversion Loss " on page 126

[SENSe:]MIXer<x>:LOSS:TABLe:HIGH <FileName>

This command defines the conversion loss table to be used for the high (second) range.

Suffix:

<x> 1..n
irrelevant

Setting parameters:

<FileName> String containing the path and name of the file, or the serial number of the external mixer whose file is required. The R&S FSW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (`.acl` file).

Return values:

<FileName> As the result of a query, the actually used file is returned.

Example:

```
MIX:LOSS:TABL:HIGH '101567'
MIX:LOSS:TABL:HIGH?
//Result for installed B5000, bw<= 4.4 GHz: 101567_B5000_2G8.B5G:
//'101567_MAG_6_B5000_2G8.B5G'
//Result for installed B5000, bw> 4.4 GHz: 101567_B5000_2G8.B5G:
//'101567_MAG_6_B5000_3G5.B5G'
//Result for installed B2001 and bw> 80 MHz:
//'101567_MAG_6_B1200_B2001.B2G'
//Result for installed B2001 and bw<= 80 MHz:
//'101567_MAG_6.ACL'
```

Manual operation: See " Conversion Loss " on page 126

[SENSe:]MIXer<x>:LOSS:TABLe[:LOW] <FileName>

This command defines the file name of the conversion loss table to be used for the low (first) range.

Suffix:

<x> 1..n
irrelevant

Parameters:

<FileName> String containing the path and name of the file, or the serial number of the external mixer whose file is required. The R&S FSW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (`.acl` file).

Example:

```
MIX:LOSS:TABL '101567'
MIX:LOSS:TABL?
//Result:
'101567_MAG_6_B5000_3G5.B5G'
```

Manual operation: See " Conversion Loss " on page 126

[SENSe:]MIXer<x>:LOSS[:LOW] <Average>

This command defines the average conversion loss to be used for the entire low (first) range.

Suffix:
<x> 1..n
irrelevant

Parameters:
<Average> Range: 0 to 100
*RST: 24.0 dB
Default unit: dB

Example: `MIX:LOSS 20dB`

Manual operation: See " Conversion Loss " on page 126

[SENSe:]MIXer<x>:PORTs <PortType>

This command selects the mixer type.

Suffix:
<x> 1..n
irrelevant

Parameters:
<PortType> **2 | 3**

2
Two-port mixer.

3
Three-port mixer.

*RST: 2

Example: `MIX:PORT 3`

Manual operation: See " Mixer Type " on page 125

[SENSe:]MIXer<x>:RFOVerrange[:STATe] <State>

If enabled, the band limits are extended beyond "RF Start" and "RF Stop" due to the capabilities of the used harmonics.

Suffix:
<x> 1..n
irrelevant

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Manual operation: See " RF Overrange " on page 125

Conversion Loss Table Settings

The following settings are required to configure and manage conversion loss tables.

[SENSe:]CORRection:CVL:BAND <Band>

This command defines the waveguide band for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Band> K | KA | Q | U | V | E | W | F | D | G | Y | J | USER
Standard waveguide band or user-defined band.
For a definition of the frequency range for the pre-defined bands, see Table 10-3).
*RST: F (90 GHz - 140 GHz)

Example:
`CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:BAND KA`
Sets the band to KA (26.5 GHz - 40 GHz).

Manual operation: See " Band " on page 131

[SENSe:]CORRection:CVL:BIAS <BiasSetting>

This command defines the bias setting to be used with the conversion loss table.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<BiasSetting> *RST: 0.0 A
Default unit: A

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:BIAS 3A`

Manual operation: See " Write to CVL table " on page 128
See " Bias " on page 131

[SENSe:]CORRection:CVL:CATalog?

This command queries all available conversion loss tables saved in the `C:\R_S\INSTR\USER\cvl\` directory on the instrument.

This command is only available with option B21 (External Mixer) installed.

Return values:
<Files> 'string'
Comma-separated list of strings containing the file names.

Example: CORR:CVL:CAT?

Usage: Query only

[SENSe:]CORRection:CVL:CLEar

This command deletes the selected conversion loss table. Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:CLE`

Manual operation: See " Delete Table " on page 129

[SENSe:]CORRection:CVL:COMMent <Text>

This command defines a comment for the conversion loss table. Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:
<Text>

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:COMM 'Conversion loss table for FS_Z60'`

Manual operation: See " Comment " on page 131

[SENSe:]CORRection:CVL:DATA {<Freq>, <Level>}...

This command defines the reference values of the selected conversion loss tables. The values are entered as a set of frequency/level pairs. A maximum of 50 frequency/level pairs may be entered. Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Freq> The frequencies have to be sent in ascending order.

Default unit: HZ

<Level> Default unit: DB

Example:
`CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:DATA 1MHZ,-30DB,2MHZ,-40DB`

Manual operation: See " Position / Value " on page 132

[SENSe:]CORRection:CVL:HARMonic <HarmOrder>

This command defines the harmonic order for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<HarmOrder> Range: 2 to 65

Example:
`CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:HARM 3`

Manual operation: See " Harmonic Order " on page 131

[SENSe:]CORRection:CVL:MIXer <Type>

This command defines the mixer name in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Type> string

Name of mixer with a maximum of 16 characters

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:MIX 'FS_Z60'`

Manual operation: See " Mixer Name " on page 132

[SENSe:]CORRection:CVL:PORTs <PortType>

This command defines the mixer type in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<PortType> 2 | 3

*RST: 2

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:PORT 3`

Manual operation: See " Mixer Type " on page 132

[SENSe:]CORRection:CVL:SELect <FileName>

This command selects the conversion loss table with the specified file name. If <file_name> is not available, a new conversion loss table is created.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<FileName> String containing the path and name of the file.

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`

Manual operation: See " New Table " on page 128
See " Edit Table " on page 128
See " File Name " on page 131

[SENSe:]CORRection:CVL:SNUMber <SerialNo>

This command defines the serial number of the mixer for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [SENSe:]CORRection:CVL:SELect on page 315).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<SerialNo> Serial number with a maximum of 16 characters

Example:
```
CORR:CVL:SEL 'LOSS_TAB_4'
```
Selects the conversion loss table.
```
CORR:CVL:MIX '123.4567'
```

Manual operation: See " Mixer S/N " on page 132

Programming Example: Working with an External Mixer

This example demonstrates how to work with an external mixer in a remote environment. It is performed in the Spectrum application in the default layout configuration. Note that without a real input signal and connected mixer, this measurement will not return useful results.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//----------- Configuring basic mixer behavior -------------
//Set the LO level of the mixer's LO port to 15 dBm.
SENS:MIX:LOP 15dBm
//Set the bias current to -1 mA .
SENS:MIX:BIAS:LOW -1mA
//----------- Configuring the mixer and band settings -------------
//Use band "V" to full possible range extent for assigned harmonic (6).
SENS:MIX:HARM:BAND V
SENS:MIX:RFOV ON
//Query the possible range
SENS:MIX:FREQ:STAR?
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)
//Use a 3-port mixer type
SENS:MIX:PORT 3
//Split the frequency range into two ranges;
//range 1 covers 47.48 GHz GHz to 80 GHz; harmonic 6, average conv. loss of 20 dB
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:LOW  20dB
SENS:MIX:HARM:HIGH 8
SENS:MIX:LOSS:HIGH 30dB
```

```
//--------- Activating automatic signal identification functions -----------
//Activate both automatic signal identification functions.
SENS:MIX:SIGN ALL
//Use auto ID threshold of 8 dB.
SENS:MIX:THR 8dB

//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
//---------------Retrieving Results-------------
//Return the trace data for the input signal without distortions
//(default screen configuration)
TRAC:DATA? TRACE3
```

Configuring a conversion loss table for a user-defined band

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//--------------Configuring a new conversion loss table --------------
//Define cvl table for range 1 of band as described in previous example
// (extended V band)
SENS:CORR:CVL:SEL 'UserTable'
SENS:CORR:CVL:COMM 'User-defined conversion loss table for USER band'
SENS:CORR:CVL:BAND USER
SENS:CORR:CVL:HARM 6
SENS:CORR:CVL:BIAS -1mA
SENS:CORR:CVL:MIX 'FS_Z60'
SENS:CORR:CVL:SNUM '123.4567'
SENS:CORR:CVL:PORT 3
//Conversion loss is linear from 55 GHz to 75 GHz
SENS:CORR:CVL:DATA 55GHZ,-20DB,75GHZ,-30DB
//----------- Configuring the mixer and band settings -------------
//Use user-defined band and assign new cvl table.
SENS:MIX:HARM:BAND USER
//Define band by two ranges;
//range 1 covers 47.48 GHz to 80 GHz; harmonic 6, cvl table 'UserTable'
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:TABL:LOW 'UserTable'
SENS:MIX:HARM:HIGH 8
```

```
SENS:MIX:LOSS:HIGH 30dB
//Query the possible range
SENS:MIX:FREQ:STAR?
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)

//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
//---------------Retrieving Results-------------
//Return the trace data (default screen configuration)
TRAC:DATA? TRACe1
```

10.4.1.7 Setting up Probes

Modular probes can be connected to the RF input connector of the R&S FSW.

For details see Chapter 5.5, "Using Probes", on page 60.

Probes can also be connected to the optional "Baseband Input" connectors, if the Analog Baseband interface (option R&S FSW-B71) is installed.

[SENSe:]PROBe<pb>:ID:PARTnumber?

Queries the R&S part number of the probe.

Suffix:

<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Return values:

<PartNumber>

Example: //Query part number
`PROB3:ID:PART?`

Usage: Query only

Manual operation: See "Part Number" on page 142

[SENSe:]PROBe<pb>:ID:SRNumber?

Queries the serial number of the probe.

Suffix:

<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Return values:

<SerialNo>

Example: //Query serial number
`PROB3:ID:SRN?`

Usage: Query only

Manual operation: See "Serial Number" on page 142

[SENSe:]PROBe<pb>:SETup:ATTRatio <AttenuationRatio>

Defines the attenuation applied to the input at the probe. This setting is only available for modular probes.

Suffix:

<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Parameters:

<AttenuationRatio> **10**
Attenuation by 20 dB (ratio= 10:1)

2
Attenuation by 6 dB (ratio= 2:1)

*RST: 10
Default unit: DB

Manual operation: See "Attenuation" on page 143

[SENSe:]PROBe<pb>:SETup:CMOFfset <CMOffset>

Sets the common mode offset. The setting is only available if a differential probe in CM-mode 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.

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see Chapter 5.5.1.1, "Common Mode Offset (for Differential Probes)", on page 62 or Chapter 5.5.2.1, "MultiMode Function and Offset Compensation for Modular RF Probes", on page 64.

Suffix:

<pb>	1..n Selects the connector: 1 = Baseband Input I 2 = Baseband Input Q 3 = RF

Parameters:

<CMOffset>	Offset of the mean voltage between the positive and negative input terminal vs. ground Range: -16 V to +16 V Default unit: V
Manual operation:	See "Common Mode Offset / Diff. Mode Offset / P Offset / N Offset / " on page 142

[SENSe:]PROBe<pb>:SETup:DMOFfset <DMOffset>

Sets the DM-mode offset. The setting is only available if a modular probe in DM-mode is connected to the R&S FSW.

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

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see Chapter 5.5.2.1, "MultiMode Function and Offset Compensation for Modular RF Probes", on page 64.

Suffix:

<pb>	1..n Selects the connector: 1 = Baseband Input I 2 = Baseband Input Q 3 = RF

Parameters:

<DMOffset>	Voltage offset between the positive and negative input terminal Default unit: V

Manual operation: See "Common Mode Offset / Diff. Mode Offset / P Offset / N Offset / " on page 142

[SENSe:]PROBe<pb>:SETup:MODE <Mode>

Suffix:
<pb>
1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Parameters:
<Mode> RSINgle | NOACtion

RSINgle
Run single: starts one data acquisition.

NOACtion
Nothing is started on pressing the micro button.

Manual operation: See " Microbutton Action " on page 143

[SENSe:]PROBe<pb>:SETup:NAME?

Queries the name of the probe.

Suffix:
<pb>
1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Return values:
<Name> String containing the name of the probe.

Example:
//Query name of the probe
`PROB3:SET:NAME?`

Usage: Query only

Manual operation: See "Name" on page 142

[SENSe:]PROBe<pb>:SETup:NMOFfset <NMOffset>

Sets the N-mode offset. The setting is only available if a modular probe in N-mode is connected to the R&S FSW. The maximum voltage difference between the positive and negative input terminals is 16 V.

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

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see Chapter 5.5.2.1, "MultiMode Function and Offset Compensation for Modular RF Probes", on page 64.

Suffix:
<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Parameters:
<NMOffset> The voltage offset between the negative input terminal and ground.
Default unit: V

Manual operation: See "Common Mode Offset / Diff. Mode Offset / P Offset / N Offset / " on page 142

[SENSe:]PROBe<pb>:SETup:PMODe <Mode>

Determines the mode of a multi-mode modular probe.

For details see Chapter 5.5.2.1, "MultiMode Function and Offset Compensation for Modular RF Probes", on page 64.

Suffix:
<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Parameters:
<Mode> CM | DM | PM | NM

DM
Voltage between the positive and negative input terminal

CM
Mean voltage between the positive and negative input terminal vs. ground

PM
Voltage between the positive input terminal and ground

NM
Voltage between the negative input terminal and ground

Example: `SENS:PROB:SETU:PMOD PM`
Sets the probe to P-mode.

Manual operation: See "Mode" on page 142

[SENSe:]PROBe<pb>:SETup:PMOFfset <PMOffset>

Sets the P-mode offset. The setting is only available if a modular probe in P-mode is connected to the R&S FSW. The maximum voltage difference between the positive and negative input terminals is 16 V.

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

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see Chapter 5.5.2.1, "MultiMode Function and Offset Compensation for Modular RF Probes", on page 64.

Suffix:
<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Parameters:
<PMOffset> The voltage offset between the positive input terminal and ground.
Default unit: V

Manual operation: See "Common Mode Offset / Diff. Mode Offset / P Offset / N Offset / " on page 142

[SENSe:]PROBe<pb>: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<ip>:SELect` on page 278).

Suffix:
<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Return values:
<State> DETected | NDETected

Example: //Query connector state
`PROB3:SET:STAT?`

Usage: Query only

[SENSe:]PROBe<pb>:SETup:TYPE?

Queries the type of the probe.

Suffix:

<pb> 1..n
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF

Return values:

<Type> String containing one of the following values:
–"None" (no probe detected)
–"active differential"
–"active single-ended"
–"active modular"

Example: //Query probe type
`PROB3:SET:TYPE?`

Usage: Query only

Manual operation: See "Type" on page 142

10.4.1.8 External Generator Control

External generator control commands are available if the R&S FSW External Generator Control option (R&S FSW-B10) is installed.

For each measurement channel one external generator can be configured. To switch between different configurations define multiple measurement channels.

For more information on external generator control see Chapter 5.7, "Basics on External Generator Control", on page 72.

Measurement Configuration

The following commands are required to activate external generator control and to configure a calibration measurement with an external tracking generator.

SOURce<si>:EXTernal<gen>:FREQuency <Frequency>

This command defines a fixed source frequency for the external generator.

Suffix:

<si> irrelevant

<gen>

Parameters:

<Frequency> Source frequency of the external generator.

*RST: 1100050000
Default unit: HZ

Example: //Define frequency of the generator
`SOUR:EXT:FREQ 10MHz`

Manual operation: See "(Manual) Source Frequency" on page 147

SOURce<si>:EXTernal<gen>:FREQuency:COUPling[:STATe] <State>

This command couples the frequency of the external generator output to the R&S FSW.

Suffix:

<si> irrelevant

<gen>

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S FSW; the RF frequency range covers the currently defined span of the R&S FSW (unless limited by the range of the signal generator)

OFF | 0
The generator uses a single fixed frequency, defined by `SOURce<si>:EXTernal<gen>:FREQuency`.

*RST: 1

Example: `SOUR:EXT:FREQ:COUP ON`

Manual operation: See "Source Frequency Coupling" on page 147

SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:DENominator <Value>

This command defines the denominator of the factor with which the analyzer frequency is multiplied in order to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

Suffix:
<si> irrelevant

<gen>

Parameters:
<Value> <numeric value>

*RST: 1

Example: //Define multiplication factor of 4/3; the transmit frequency of the generator is 4/3 times the analyzer frequency
```
SOUR:EXT:FREQ:NUM 4
SOUR:EXT:FREQ:DEN 3
```

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 147

SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:NUMerator <Value>

This command defines the numerator of the factor with which the analyzer frequency is multiplied in order to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

Suffix:
<si> irrelevant

<gen>

Parameters:
<Value> <numeric value>

*RST: 1

Example: //Define multiplication factor of 4/3; the transmit frequency of the generator is 4/3 times the analyzer frequency
```
SOUR:EXT:FREQ:NUM 4
SOUR:EXT:FREQ:DEN 3
```

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 147

SOURce<si>:EXTernal<gen>:FREQuency:OFFSet <Offset>

This command defines the frequency offset of the generator with reference to the analyzer frequency.

Select the offset such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

Suffix:

<si>	irrelevant
<gen>	

Parameters:

<Offset> <numeric value>, specified in Hz, kHz, MHz or GHz, rounded to the nearest Hz

*RST: 0 Hz
Default unit: HZ

Example: //Define an offset between generator output frequency and analyzer frequency
```
SOUR:EXT:FREQ:OFFS 10HZ
```

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 147

SOURce<si>:EXTernal<gen>:POWer[:LEVel] <Level>

This command sets the output power of the selected generator.

Suffix:

<si>	irrelevant
<gen>	

Parameters:

<Level> <numeric value>

*RST: -20 dBm
Default unit: DBM

Example: //Define generator output level
```
SOUR:EXT:POW -30dBm
```

Manual operation: See " Source Power " on page 146

SOURce<si>:EXTernal<gen>[:STATe] <State>

This command activates or deactivates the connected external generator.

Suffix:

<si> irrelevant

<gen>

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See " Source State " on page 146

SOURce<si>:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

This command defines a level offset for the external generator level. Thus, for example, attenuators or amplifiers at the output of the external generator can be taken into account for the setting.

Suffix:

<si> irrelevant

Parameters:

<Offset> Range: -200 dB to +200 dB
*RST: 0dB
Default unit: DB

Example: //Define a level offset on the external generator
`SOUR:POW:OFFS -10dB`

Manual operation: See " Source Offset " on page 146

Interface Configuration

The following commands are required to configure the interface for the connection to the external generator.

SOURce<si>:EXTernal<gen>:ROSCillator[:SOURce] <Source>

This command controls selection of the reference oscillator for the external generator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Suffix:

<si> irrelevant

<gen> irrelevant

Parameters:

<Source> **INTernal**
Uses the internal reference.

EXTernal
Uses the external reference; if none is available, an error flag is displayed in the status bar.

*RST: INT

Example: //Select an external reference oscillator
`SOUR:EXT:ROSC EXT`

Manual operation: See " Reference " on page 145

SYSTem:COMMunicate:GPIB:RDEVice:GENerator<gen>:ADDRess <Number>

Changes the IEC/IEEE-bus address of the external generator.

Suffix:

<gen> 1..n

Parameters:

<Number> Range: 0 to 30
*RST: 28

Example: `SYST:COMM:GPIB:RDEV:GEN:ADDR 15`

Manual operation: See " GPIB Address / TCPIP Address / Computer Name " on page 145

SYSTem:COMMunicate:RDEVice:GENerator<gen>:INTerface <Type>

Defines the interface used for the connection to the external generator.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Suffix:

<gen>

Parameters:

<Type> **GPIB**

TCPip

Example: `SYST:COMM:RDEV:GEN:INT TCP`

Manual operation: See " Interface " on page 144

SYSTem:COMMunicate:RDEVice:GENerator<gen>:LINK <Type>

This command selects the link type of the external generator if the GPIB interface is used.

The difference between the two GPIB operating modes is the execution speed. While, during GPIB operation, each frequency to be set is transmitted to the generator separately, a whole frequency list can be programmed in one go if the TTL interface is also used. Frequency switching can then be performed per TTL handshake which results in considerable speed advantages.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Suffix:
<gen>

Parameters:

<Type> GPIB | TTL

GPIB
GPIB connection without TTL synchronization (for all generators of other manufacturers and some Rohde & Schwarz devices)

TTL
GPIB connection with TTL synchronization (if available; for most Rohde&Schwarz devices)

*RST: GPIB

Example: `SYST:COMM:RDEV:GEN:LINK TTL`
Selects GPIB + TTL interface for generator operation.

Manual operation: See " TTL Handshake " on page 145

SYSTem:COMMunicate:RDEVice:GENerator<gen>:TYPE <Type>

This command selects the type of external generator.

For a list of the available generator types see the "External Generator Control Basics" section in the R&S FSW User Manual.

Suffix:
<gen>

Parameters:

<Name> <Generator name as string value>

*RST: SMU02

Example: //Select an external generator
`SYST:COMM:RDEV:GEN:TYPE 'SMW06'`

Manual operation: See " Generator Type " on page 144

SYSTem:COMMunicate:TCPip:RDEVice:GENerator<gen>:ADDRess <Address>

Configures the TCP/IP address for the external generator.

Suffix:
<gen>

Parameters:

<Address> TCP/IP address between 0.0.0.0 and 0.255.255.255

*RST: 0.0.0.0

Example: `SYST:COMM:TCP:RDEV:GEN:ADDR 130.094.122.195`

Manual operation: See " GPIB Address / TCPIP Address / Computer Name " on page 145

Source Calibration

The following commands are required to activate the calibration functions of the external tracking generator. However, they are only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Useful commands for source calibration described elsewhere:

- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 365

Remote commands exclusive to source calibration:

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

This command defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:

<n> Window

<w> subwindow

<t> irrelevant

Parameters:

<Value> *RST: AM time domain: 0 PCT; FM time domain: 0 Hz; PM time domain: 0 rad; AM spectrum: 100 PCT; FM spectrum: 250 kHz; PM spectrum: 10 rad;

Default unit: DB

Example: `DISP:TRAC:Y:RVAL 0`
Sets the value assigned to the reference position to 0 Hz

Manual operation: See " Reference Value " on page 150

[SENSe:]CORRection:COLLect[:ACQuire] <MeasType>

This command initiates a reference measurement (calibration). The reference measurement is the basis for the measurement normalization. The result depends on whether a reflection measurement or transmission measurement is performed (see `[SENSe:]CORRection:METHod` on page 332).

To obtain a correct reference measurement, a complete sweep with synchronization to the end of the sweep must have been carried out. This is only possible in the single sweep mode.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Setting parameters:

<MeasType> THRough | OPEN

THRough
"TRANsmission" mode: calibration with direct connection between generator and device input
"REFLection" mode: calibration with short circuit at the input

OPEN
only allowed in "REFLection" mode: calibration with open input

Example:

`INIT:CONT OFF`
Selects single sweep operation
`CORR:METH TRAN`
Selects a transmission measurement.
`CORR:COLL THR;*WAI`
Starts the measurement of reference data using direct connection between generator and device input and waits for the sweep end.

Usage: Setting only

Manual operation: See "Calibrate Reflection Short" on page 149
See "Calibrate Reflection Open" on page 149

[SENSe:]CORRection:METHod <Type>

This command selects the type of measurement to be performed with the generator.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Parameters:

<Type>

REFLection
Selects reflection measurements.

TRANsmission
Selects transmission measurements.

*RST: TRANsmission

Example:

`CORR:METH TRAN`
Sets the type of measurement to "transmission".

Manual operation: See "Calibrate Transmission" on page 149
See "Calibrate Reflection Short" on page 149
See "Calibrate Reflection Open" on page 149

[SENSe:]CORRection:RECall

This command restores the measurement configuration used for calibration.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Example: `CORR:REC`

Manual operation: See "Recall Cal. Settings" on page 149

[SENSe:]CORRection[:STATe] <State>

This command turns correction of measurement results (normalization) on and off.

The command is available after you have created a reference trace for the selected measurement type with `[SENSe:]CORRection:COLLect[:ACQuire]` on page 332.

This command is only available if external generator control is active (see `SOURce<si>:EXTernal<gen>[:STATe]` on page 327).

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: `CORR ON`
Activates normalization.

Manual operation: See " Normalization state" on page 149

[SENSe:]CORRection:TRANsducer:GENerate <Name>

This command uses the normalized measurement data to generate a transducer factor with up to 1001 points. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under `C:\Program Files (x86)\Rohde-Schwarz\FSW\<version>\trd`. The frequency points are allocated in equidistant steps between start and stop frequency.

The generated transducer factor can be further adapted using the commands described in the "Remote Commands > Configuring the R&S FSW > Working with Transducers" section in the R&S FSW User Manual.

Parameters:

<Name> '<name>'

Example: `CORR:TRAN:GEN 'MyGenerator'`
Creates the transducer file
`C:\r_s\instr\trd\MyGenerator.trd`.

Manual operation: See " Save as Trd Factor " on page 150

Programming Example for External Generator Control

The following example demonstrates how to work with an external generator in a remote environment.

It assumes a signal generator of the type SMW06 is connected to the R&S FSW, including TTL synchronization, as described in the R&S FSW User Manual.

```
//--------------Preparing the instrument -----------

//Reset the instrument
*RST

//Set the frequency span.
SENS:FREQ:STAR 10HZ
SENS:FREQ:STOP 1MHZ

//--------------Configuring the interface -----------

//Set the generator type to SMW06 with a frequency range of 100 kHz to 4GHz
SYST:COMM:RDEV:GEN:TYPE 'SMW06'

//Set the interface used to the GPIB address 28
SYST:COMM:RDEV:GEN:INT GPIB
SYST:COMM:GPIB:RDEV:GEN:ADDR 28

//Activate the use of TTL synchronization to optimize measurement speed
SYST:COMM:RDEV:GEN:LINK TTL

//Activate the use of the external reference frequency at 10 MHz on the generator
SOUR:EXT:ROSC EXT

//--------------Configuring the calibration measurement -----------

//Activate external generator control.
SOUR:EXT:STAT ON
//Set the generator output level to -10 dBm.
SOUR:EXT:POW -10DBM
//Set the frequency coupling to automatic
SOUR:EXT:FREQ:COUP:STAT ON

//--------------Configuring the generator frequency range -----------

//Define a series of frequencies (one for each sweep point) based on the current
//frequency at the RF input of the analyzer; the generator frequency is half the
```

```
//frequency of the analyzer, with an offset of 100 kHz;
// analyzer start:            10 Hz
// analyzer stop:             1 MHz
// analyzer span:             999.99 KHz
// generator frequency start: 100.005 KHz
// generator frequency stop:  600 KHz
// generator span:            499.995 KHz

SOUR:EXT:FREQ:FACT:NUM 1
SOUR:EXT:FREQ:FACT:DEN 2
SOUR:EXT:FREQ:OFFS 100KHZ

//--------------Performing the calibration measurement -----------

//Perform a transmission measurement with direct connection between the generator
//and the analyzer and wait till the end
SENS:CORR:METH TRAN
SENS:CORR:COLL:ACQ THR; *WAI

//--------------Retrieving the calibration trace results -----------

//Retrieve the measured frequencies (10 Hz - 600 kHz)
TRAC:DATA:X? TRACE1

//Retrieve the measured power levels; = 0 between 10 Hz and 100 kHz (below
//generator minimum frequency); nominal -5dBm as of 100 kHz;
TRAC:DATA? TRACE1

//--------------Normalizing the calibration trace results -----------

//Retrieve the normalized power levels (= power offsets from calibration results)
//Should be 0 for all sweep points directly after calibration
SENS:CORR:STAT ON
TRAC:DATA? TRACE1

//--------------Changing the display of the calibration results -----------
//Shift the reference line so the -5 dB level is displayed in the center
DISP:TRAC:Y:SCAL:RVAL -5DB
DISP:TRAC:Y:SCAL:RPOS 50PCT
```

10.4.1.9 Working with Power Sensors

The following commands describe how to work with power sensors.

These commands require the use of a Rohde & Schwarz power sensor. For a list of supported sensors, see the data sheet.

Configuring Power Sensors

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

This command turns automatic assignment of a power sensor to the power sensor index on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?

This command queries the number of power sensors currently connected to the R&S FSW.

Suffix:
<p> Power sensor index

Return values:
<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

This command assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:
<p> Power sensor index

Parameters:
<Placeholder> Currently not used

<Type> Detected power sensor type, e.g. "NRP-Z81".

<Interface>	Interface the power sensor is connected to; always "USB"
<SerialNo>	Serial number of the power sensor assigned to the specified index

Example:	`SYST:COMM:RDEV:PMET2:DEF '','NRP-Z81','', '123456'`
	Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".
	`SYST:COMM:RDEV:PMET2:DEF?`
	Queries the sensor assigned to "Power Sensor 2".
	Result:
	`'','NRP-Z81','USB','123456'`
	The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Configuring Power Sensor Measurements

CALibration:PMETer<p>:ZERO:AUTO ONCE

This command zeroes the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, results are invalid.

Suffix:

<p>	Power sensor index
Example:	`CAL:PMET2:ZERO:AUTO ONCE;*WAI` Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.
Usage:	Event

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

This command defines the reference value for relative measurements.

Suffix:

<n> Window

<p> Power sensor index

Parameters:

<RefValue> Range: -200 dBm to 200 dBm
*RST: 0
Default unit: DBM

Example:
`CALC:PMET2:REL -30`
Sets the reference value for relative measurements to -30 dBm for power sensor 2.

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

This command sets the current measurement result as the reference level for relative measurements.

Suffix:

<n> Window

<p> Power sensor index

Example:
`CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

CALCulate<n>:PMETer<p>:RELative:STATe <State>

This command turns relative power sensor measurements on and off.

Suffix:

<n> Window

<p> Power sensor index

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
`CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

FETCh:PMETer<p>?

This command queries the results of power sensor measurements.

Suffix:
<p> Power sensor index

Usage: Query only

READ:PMETer<p>?

This command initiates a power sensor measurement and queries the results.

Suffix:
<p> Power sensor index

Usage: Query only

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

This command turns the duty cycle correction on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:DCYC:STAT ON`

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

This command defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:
<p> Power sensor

Parameters:
<Percentage> Range: 0.001 to 99.999
*RST: 99.999
Default unit: %

Example: `PMET2:DCYC:STAT ON`
Activates the duty cycle correction.
`PMET2:DCYC:VAL 0.5`
Sets the correction value to 0.5%.

[SENSe:]PMETer<p>:FREQuency <Frequency>

This command defines the frequency of the power sensor.

Suffix:
<p> Power sensor index

Parameters:
<Frequency> The available value range is specified in the data sheet of the power sensor in use.
*RST: 50 MHz
Default unit: HZ

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

This command selects the frequency coupling for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Coupling>
CENTer
Couples the frequency to the center frequency of the analyzer
MARKer1
Couples the frequency to the position of marker 1
OFF
Switches the frequency coupling off
*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

[SENSe:]PMETer<p>:MTIMe <Duration>

This command selects the duration of power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Duration> SHORt | NORMal | LONG
*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

This command sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:
<p> Power sensor index

Parameters:
<NumberReadings> An average count of 0 or 1 performs one power reading.

Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

This command turns averaging for power sensor measurements on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

This command includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:ROFF OFF`
Takes no offset into account for the measured power.

[SENSe:]PMETer<p>:SOFFset <SensorOffset>

Takes the specified offset into account for the measured power. Only available if `[SENSe:]PMETer<p>:ROFFset[:STATe]` is disabled.

Suffix:
<p> Power sensor index

Parameters:
<SensorOffset> Default unit: DB

Example: `PMET2:TRIG:SOFF 0.001`

[SENSe:]PMETer<p>[:STATe] <State>

This command turns a power sensor on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1 ON`
Switches the power sensor measurements on.

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

This command turns continuous update of power sensor measurements on and off.

If on, the results are update even if a single sweep is complete.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

UNIT<n>:PMETer<p>:POWer <Unit>

This command selects the unit for absolute power sensor measurements.

Suffix:

<n>	irrelevant
<p>	Power sensor index

Parameters:

<Unit>	DBM | WATT | W | DB | PCT *RST: DBM

Example: `UNIT:PMET:POW DBM`

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

This command selects the unit for relative power sensor measurements.

Suffix:

<n>	irrelevant
<p>	Power sensor index

Parameters:

<Unit>	DB | PCT *RST: DB

Example: `UNIT:PMET:POW:RAT DB`

Triggering with Power Sensors

[SENSe:]PMETer<p>:TRIGger:DTIMe <Time>

This command defines the time period that the input signal has to stay below the IF power trigger level before the measurement starts.

Suffix:

<p>	Power sensor index

Parameters:

<Time>

Range: 0 s to 1 s
Increment: 100 ns
*RST: 100 µs
Default unit: S

Example: `PMET2:TRIG:DTIMe 0.001`

[SENSe:]PMETer<p>:TRIGger:HOLDoff <Holdoff>

This command defines the trigger holdoff for external power triggers.

Suffix:

<p> Power sensor index

Parameters:

<Holdoff> Time period that has to pass between the trigger event and the start of the measurement, in case another trigger event occurs.

Range: 0 s to 1 s
Increment: 100 ns
*RST: 0 s
Default unit: S

Example: `PMET2:TRIG:HOLD 0.1`
Sets the holdoff time of the trigger to 100 ms

[SENSe:]PMETer<p>:TRIGger:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis for external power triggers.

The hysteresis in dB is the value the input signal must stay below the IF power trigger level in order to allow a trigger to start the measurement.

Suffix:

<p> Power sensor index

Parameters:

<Hysteresis>

Range: 3 dB to 50 dB
Increment: 1 dB
*RST: 0 dB
Default unit: DB

Example: `PMET2:TRIG:HYST 10`
Sets the hysteresis of the trigger to 10 dB.

[SENSe:]PMETer<p>:TRIGger:LEVel <Level>

This command defines the trigger level for external power triggers.

Suffix:

<p> Power sensor index

Parameters:
<Level> -20 to +20 dBm

Range: -20 dBm to 20 dBm
*RST: -10 dBm
Default unit: DBM

Example: `PMET2:TRIG:LEV -10 dBm`
Sets the level of the trigger

[SENSe:]PMETer<p>:TRIGger:SLOPe <Edge>

This command selects the trigger condition for external power triggers.

Suffix:
<p> Power sensor index

Parameters:
<Edge>
POSitive
The measurement starts in case the trigger signal shows a positive edge.
NEGative
The measurement starts in case the trigger signal shows a negative edge.
*RST: POSitive

Example: `PMET2:TRIG:SLOP NEG`

[SENSe:]PMETer<p>:TRIGger[:STATe] <State>

This command turns the external power trigger on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `PMET2:TRIG ON`
Switches the external power trigger on

10.4.1.10 Configuring the 2 GHz / 5 GHz Bandwidth Extension (R&S FSW-B2000/B5000)

The following commands are required to use the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

For details on prerequisites and restrictions see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85.

See also the command for configuring triggers while using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000):

- `TRIGger[:SEQuence]:OSCilloscope:COUPling` on page 351

Remote commands exclusive to configuring the 2 GHz / 5 GHz bandwidth extensions:

EXPort:WAVeform:DISPlayoff <FastExport>

Enables or disables the display update on the oscilloscope during data acquisition with the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

Note that this command is **only executable by the oscilloscope**, not by the R&S FSW.

As soon as the R&S FSW-B2000/B5000 is activated, the display on the oscilloscope is turned off to improve performance during data export. As soon as the R&S FSW closes the connection to the oscilloscope, the display is reactivated and the oscilloscope can be operated as usual. However, if the LAN connection is lost for any reason, the display of the oscilloscope remains deactivated. Use this command to re-activate it.

For details on the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000), see R&S FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:

<FastExport> ON | OFF | 1 | 0

ON | 1: Disables the display update for maximum export speed.
OFF | 0: Enables the display update. The export is slower.

*RST: 1

SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe] <State>

Activates the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S FSW, is not possible while the B2000/B5000 option is active.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC ON`

Manual operation: See "B2000/B5000 State" on page 151

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP<st>[:STATe] <State>

Performs the alignment of the oscilloscope itself and the oscilloscope ADC for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000). The correction data for the oscilloscope (including the connection cable between the R&S FSW and the oscilloscope) is recorded. As a result, the state of the alignment is returned.

Alignment is required only once after setup. If alignment was performed successfully, the alignment data is stored on the oscilloscope.

Thus, alignment need only be repeated if one of the following applies:

- A new oscilloscope is connected to the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW
- A new cable is used between the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW and the oscilloscope
- A power splitter is inserted between the "IF OUT 2 GHz/ IF OUT 5 GHz " connector of the R&S FSW and the oscilloscope
- New firmware is installed on the oscilloscope or the R&S FSW

Suffix:
<st> 1..n

Parameters:
<State> Returns the state of the second alignment step.

ON | 1
Alignment was successful.

OFF | 0
Alignment was not yet performed (successfully).

Example:
```
SYST:COMM:RDEV:OSC:ALIG:STEP?
//Result: 1
```

Manual operation: See "Alignment" on page 154

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE <Date>

Returns the date of alignment of the "IF OUT 2 GHz/ IF OUT 5 GHz " to the oscilloscope for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

The alignment data is stored separately for common B2000/B5000 mode and power splitter mode. The returned date refers to the alignment of the currently active mode.

Parameters:

<Date> Returns the date of alignment.

Example:
```
SYST:COMM:RDEV:OSC:DATE?
//Result: 2014-02-28
```

Manual operation: See "Alignment" on page 154

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:FALignment <State>

Performs a self-alignment on the oscilloscope before the B2000/B5000 alignment on the R&S FSW.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
SYST:COMM:RDEV:OSC:ALIG:FAL ON
```

Manual operation: See "Force Oscilloscope Alignment" on page 154

SYSTem:COMMunicate:RDEVice:OSCilloscope:IDN <IDString>

Returns the identification string of the oscilloscope connected to the R&S FSW.

Parameters:

<IDString>

Example:
```
SYST:COMM:RDEV:OSC:IDN?
//Result: Rohde&Schwarz,RTO,
1316.1000k14/200153,2.45.1.1
```

Manual operation: See " TCPIP Address / Computer Name " on page 152

SYSTem:COMMunicate:RDEVice:OSCilloscope:LEDState <Color>

Returns the state of the LAN connection to the oscilloscope for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

Parameters:

<Color> OFF | SUCCessful | ERRor

SUCCessful
Connection to the instrument has been established successfully.

OFF
No instrument configured.

ERRor
Connection to the instrument could not be established.
Check the connection between the R&S FSW and the oscilloscope, and make sure the IP address of the oscilloscope has been defined (see `SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip` on page 350).

Example:
```
SYST:COMM:RDEV:OSC:LEDS?
//Result: 'SUCC'
```

SYSTem:COMMunicate:RDEVice:OSCilloscope:PSMode[:STATe] <State>

Activates the use of the power splitter inserted between the "IF 2 GHZ OUT" connector of the R&S FSW and the "CH1" and "CH3" input connectors of the oscilloscope. Note that this mode requires an additional alignment with the power splitter.

For details see Chapter 5.9.8, "Power Splitter Mode", on page 93.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SYST:COMM:RDEV:OSC:PSM ON
```

Manual operation: See "Power Splitter Mode" on page 152

SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe <Rate>

Determines whether the 10 GHz mode (default) or 20 GHz mode of the connected oscilloscope is used. The 20 GHZ mode achieves a higher decimation gain, but reduces the record length by half.

Parameters:

<Rate> 10 GHz | 20 GHz

No other sample rate values are allowed.

*RST: 10 GHz
Default unit: HZ

Example:
```
TRAC:IQ:SRAT?
//Result: 100000000
TRAC:IQ:RLEN?
//Result: 3128
SYST:COMM:RDEV:OSC:SRAT 20GHZ
TRAC:IQ:SRAT?
//Result: 200000000
TRAC:IQ:RLEN?
//Result: 1564
```

Manual operation: See "Oscilloscope Sample Rate" on page 152

SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip <Address>

Defines the TCPIP address or computer name of the oscilloscope connected to the R&S FSW via LAN.

Note: The IP address is maintained after a [PRESET], and is transferred between applications.

Parameters:

<Address> computer name or IP address

Example: `SYST:COMM:RDEV:OSC:TCP '192.0.2.0'`

Example: `SYST:COMM:RDEV:OSC:TCP 'FSW43-12345'`

Manual operation: See " TCPIP Address / Computer Name " on page 152

SYSTem:COMMunicate:RDEVice:OSCilloscope:VDEVice?

Queries whether the connected instrument is supported by the 2 GHz / 5 GHz bandwidth extension option(B2000/B5000).

For details see Chapter 5.9.3, "Prerequisites and Measurement Setup", on page 88.

Return values:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC:VDEV?`

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:VFIRmware?

Queries whether the firmware on the connected oscilloscope is supported by the 2 GHz / 5 GHz bandwidth extension (B2000/B5000) option.

Return values:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC:VFIR?`

Usage: Query only

TRIGger[:SEQuence]:OSCilloscope:COUPling <CoupType>

Configures the coupling of the external trigger to the oscilloscope.

Parameters:

<CoupType> Coupling type

DC
Direct connection with 50 Ω termination, passes both DC and AC components of the trigger signal.

CDLimit
Direct connection with 1 MΩ termination, passes both DC and AC components of the trigger signal.

AC
Connection through capacitor, removes unwanted DC and very low-frequency components.

*RST: DC

Manual operation: See " Coupling " on page 180

10.4.1.11 Configuring the Outputs

The following commands are required to provide output from the R&S FSW.

Configuring trigger input/output is described in Chapter 10.4.4.2, "Configuring the Trigger Output", on page 375.

Configuring the Digital I/Q 40G Streaming Output option (R&S FSW-B517) is described in Chapter 10.4.1.12, "Digital I/Q 40G Streaming Output Commands", on page 355.

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.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source Control" on page 159

OUTPut<up>:IF:SBANd?

This command queries the sideband provided at the "IF OUT 2 GHz" connector compared to the sideband of the RF signal. The sideband depends on the current center frequency.

This command is available only if the output is configured for IF2 (see `OUTPut<up>:IF[:SOURce]` on page 352).

For more information and prerequisites see Chapter 5.11, "IF and Video Signal Output", on page 97.

Suffix:
<up>

Return values:

<SideBand>

NORMal
The sideband at the output is identical to the RF signal.

INVerted
The sideband at the output is the inverted RF signal sideband.

Example: `OUTP:IF IF2`
Activates output at the IF OUTPUT (2 GHZ) connector.
`OUTP:IF:SBAN?`
Queries the sideband provided at the connector.

Usage: Query only

OUTPut<up>:IF[:SOURce] <Source>

Defines the type of signal available at one of the output connectors of the R&S FSW.

For restrictions and more information see Chapter 5.11, "IF and Video Signal Output", on page 97.

Suffix:
<up>

Parameters:

<Source>

IF
The measured IF value is available at the IF/VIDEO/DEMOD output connector.
The frequency at which the IF value is provided is defined using the `OUTPut<up>:IF:IFFRequency` command.

IF2
The measured IF value is available at the "IF OUT 2 GHz/ IF OUT 5 GHz " output connector at a frequency of 2 GHz.
This setting is only available if the "IF OUT 2 GHz/ IF OUT 5 GHz " connector or the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is available.
It is automatically set if the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is installed and active.
For details see Chapter 5.9, "Basics on the 2 GHz / 5 GHz Bandwidth Extensions (R&S FSW-B2000/B5000 Options)", on page 85.

VIDeo
The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

*RST: IF

Example: `OUTP:IF VID`
Selects the video signal for the IF/VIDEO/DEMOD output connector.

Manual operation: See "Data Output" on page 158

OUTPut<up>:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output of the R&S FSW. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

If the [IF WIDE OUTPUT] connector is used (`TRACe:IQ:WBANd ON`, see `TRACe:IQ:WBANd[:STATe]` on page 388), this command is available as a query only. It returns the used IF output frequency which is defined automatically by the application according to the center frequency.

For more information see Chapter 5.11, "IF and Video Signal Output", on page 97.

Suffix:
<up>

Parameters:
<Frequency> *RST: 50.0 MHz
Default unit: HZ

Manual operation: See "Data Output" on page 158

OUTPut<up>:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSW.

Suffix:
<up> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
User port is switched to INPut

ON | 1
User port is switched to OUTPut

Example: `OUTP:UPOR:STAT ON`

OUTPut<up>:UPORt[:VALue] <Value>

This command sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern.

If the user port is programmed to input instead of output (see `INPut<ip>:UPORt:STATe` on page 280), the output value is temporarily stored.

Suffix:
<up> irrelevant

Parameters:
<Value> bit values in hexadecimal format

TTL type voltage levels (max. 5V)

Range: #B00000000 to #B00111111

Example: `OUTP:UPOR #B00100100`
Sets pins 5 and 7 to 5 V.

SYSTem:SPEaker:VOLume <Volume>

This command defines the volume of the built-in loudspeaker for demodulated signals. This setting is maintained for all applications.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

Parameters:

<Volume>	Percentage of the maximum possible volume. Range: 0 to 1 *RST: 0.5

Example: `SYST:SPE:VOL 0`
Switches the loudspeaker to mute.

10.4.1.12 Digital I/Q 40G Streaming Output Commands

The following commands are only available if the Digital I/Q 40G Streaming Output option (R&S FSW-B517) is installed.

For details see Chapter 5.10, "Digital I/Q 40G Streaming Output", on page 95.

OUTPut<up>:IQHS:CDEVice?

Returns a comma-separated list of information on the instrument connected to the QSFP+ connector, if available.

Suffix:

<up>	irrelevant

Example: `OUTP:IQHS:CDEV?`
Result:
`1,IQW,1525.7551k05,900987,DIG IQ 40G A,tcpip::computername::hislip0,1.9,1.1,1,1`

Usage: Query only

Manual operation: See " Connected Instrument " on page 162

OUTPut<up>:IQHS:SRATe?

Returns the currently used sample rate to transfer data via the Digital I/Q 40G Streaming Output interface.

Suffix:

<up>	irrelevant

Usage: Query only

Manual operation: See "Output Settings Information" on page 162

OUTPut<up>:IQHS[:STATe] <State>

Enables or disables a digital output stream to the optional QSFP+ connector, if available.

Suffix:

<up> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "Digital I/Q 40G Streaming Out" on page 161

10.4.2 Configuring the Vertical Axis (Amplitude, Scaling)

The following commands are required to configure the amplitude and vertical axis settings in a remote environment.

10.4.2.1 Amplitude Settings

Useful commands for amplitude configuration described elsewhere:

- `[SENSe:]ADJust:LEVel` on page 392

Remote commands exclusive to amplitude configuration:

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

This command matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:REF`
Sets the reference level to the level of marker 2.

Manual operation: See " Reference Level = Marker Level " on page 225

CALCulate<n>:UNIT:POWer <Unit>
UNIT<n>:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:
<n> irrelevant

Parameters:
<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DBUa_mhz | DBUV_mhz | DBmV_mhz | DBpW_mhz

(Units based on 1 MHz require installed R&S FSW-K54 (EMI measurements) option.)

*RST: dBm

Example: `UNIT:POW DBM`
Sets the power unit to dBm.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:
<n> irrelevant

<t> irrelevant

Parameters:
<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm
Default unit: DBM

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See " Reference Level " on page 164

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> irrelevant

<t> irrelevant

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See " Shifting the Display (Offset)" on page 164

10.4.2.2 Configuring the Attenuation

INPut<ip>:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If an electronic attenuator is available and active, the command defines a mechanical attenuation (see `INPut<ip>:EATT:STATe` on page 361).

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.

This function is not available if the optional Digital Baseband Interface is active.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)
Default unit: DB

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Manual operation: See " Attenuation Mode / Value " on page 165

INPut<ip>: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.

This function is not available if the optional Digital Baseband Interface is active.

Suffix:
<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<State>
ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Manual operation: See " Attenuation Mode / Value " on page 165

INPut<ip>:ATTenuation:AUTO:MODE <OptMode>

Selects the priority for signal processing *after* the RF attenuation has been applied.

Suffix:
<ip>
1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<OptMode>
LNOise | LDIStortion

LNOise
Optimized for high sensitivity and low noise levels

LDIStortion
Optimized for low distortion by avoiding intermodulation

*RST: LDIStortion (WLAN application: LNOise)

Example: `INP:ATT:AUTO:MODE LNO`

Manual operation: See " Optimization " on page 166

INPut<ip>:EATT <Attenuation>

This command defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut<ip>:EATT:AUTO` on page 360).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command requires the electronic attenuation hardware option.

It is not available if the optional Digital Baseband Interface is active.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Attenuation> attenuation in dB

Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)
Default unit: DB

Example:
```
INP:EATT:AUTO OFF
INP:EATT 10 dB
```

Manual operation: See " Using Electronic Attenuation " on page 166

INPut<ip>: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.

This command requires the electronic attenuation hardware option.

It is not available if the optional Digital Baseband Interface is active.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See " Using Electronic Attenuation " on page 166

INPut<ip>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command requires the electronic attenuation hardware option.

It is not available if the optional Digital Baseband Interface is active.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See " Using Electronic Attenuation " on page 166

10.4.2.3 Configuring a Preamplifier

INPut<ip>:EGAin[:STATe] <State>

Before this command can be used, the external preamplifier must be connected to the R&S FSW. See the preamplifier's documentation for details.

When activated, the R&S FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results.

Note that when an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For R&S FSW85 models with two RF inputs, you must enable correction from the external preamplifier for each input individually. Correction cannot be enabled for both inputs at the same time.

When deactivated, no compensation is performed even if an external preamplifier remains connected.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
No data correction is performed based on the external preamplifier

ON | 1
Performs data corrections based on the external preamplifier

*RST: 0

Example: `INP:EGA ON`

Manual operation: See "Ext. PA Correction" on page 167

INPut<ip>:GAIN:STATe <State>

This command turns the internal preamplifier on and off. It requires the optional preamplifier hardware.

Note that if an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

This function is not available for input from the optional Digital Baseband Interface.

If option R&S FSW-B22 is installed, the preamplifier is only active below 7 GHz.

If option R&S FSW-B24 is installed, the preamplifier is active for all frequencies.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```
Switches on 15 dB preamplification.

Manual operation: See " Preamplifier " on page 167

INPut<ip>:GAIN[:VALue] <Gain>

This command selects the gain if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut<ip>:GAIN:STATe` on page 362).

The command requires the additional preamplifier hardware option.

Suffix:

<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:

<Gain> 15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSW.
R&S FSW8/13/26: 15 dB and 30 dB
R&S FSW43 or higher: 30 dB
All other values are rounded to the nearest of these two.

Default unit: DB

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```
Switches on 30 dB preamplification.

Manual operation: See " Preamplifier " on page 167

10.4.2.4 Scaling the Y-Axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing`.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Range> Range: 1 dB to 200 dB
*RST: 100 dB
Default unit: HZ

Example: `DISP:TRAC:Y 110dB`

Manual operation: See " Range " on page 171
See " Y-Axis Max " on page 172

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:

<n> Window

<t> irrelevant

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis (for all traces).

When the display update during remote control is off, this command has no immediate effect.

Suffix:

<n> Window

<w> subwindow

<t> irrelevant

Parameters:

<Mode> **ABSolute**
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

Example: `DISP:TRAC:Y:MODE REL`

Manual operation: See " Scaling " on page 171

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.

In spectrum displays, for example, this command is not available.

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
Default unit: DBM

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

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.

For measurements with the optional external generator control, the command defines the position of the reference value.

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
  Default unit: PCT

Example: `DISP:TRAC:Y:RPOS 50PCT`

Manual operation: See " Reference Position " on page 150
See " Ref Level Position " on page 171

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis (for all traces, <t> is irrelevant).

Suffix:

<n>
: Window

<w>
: subwindow

<t>
: Trace

Parameters:

<ScalingType>
: **LOGarithmic**
  Logarithmic scaling.
  LINear
  Linear scaling in %.
  LDB
  Linear scaling in the specified unit.
  PERCent
  Linear scaling in %.
  *RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Manual operation: See " Scaling " on page 171

10.4.3 Frequency

CALCulate<n>:MARKer<m>:FUNCtion:CENTer

This command matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Manual operation: See " Center Frequency = Marker Frequency " on page 225

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:
<Frequency> The allowed range and f_{max} is specified in the data sheet.

*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.

Manual operation: See " Center Frequency " on page 136
See " Center Frequency " on page 173

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer` on page 367.

Parameters:
<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example: //Set the center frequency to 110 MHz.
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See " Center Frequency Stepsize " on page 173

[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.

See also " Frequency Offset " on page 173.

Note: In MSRA/MSRT mode, the setting command is only available for the MSRA/MSRT Master. For MSRA/MSRT client applications, only the query command is available.

Parameters:

<Offset> Range: -1 THz to 1 THz

*RST: 0 Hz

Default unit: HZ

Example: `FREQ:OFFS 1GHZ`

Manual operation: See " Frequency Offset " on page 173

10.4.4 Triggering

The following remote commands are required to configure a triggered measurement in a remote environment. More details are described for manual operation in Chapter 6.6, "Trigger Settings", on page 174.

*OPC should be used after requesting data. This will hold off any subsequent changes to the selected trigger source, until after the sweep is completed and the data is returned.

10.4.4.1 Configuring the Triggering Conditions

The following commands are required to configure a triggered measurement.

Useful commands for configuring triggers described elsewhere:

- `TRIGger[:SEQuence]:OSCilloscope:COUPling` on page 351

Remote commands exclusive to configuring triggers:

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 370 command for new remote control programs.

Parameters:

<Period> Range: 150 ns to 1000 s
*RST: 150 ns
Default unit: S

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.

For input from the Analog Baseband Interface (R&S FSW-B71) using the baseband power trigger (BBP), the default drop out time is set to 100 ns to avoid unintentional trigger events (as no hysteresis can be configured in this case).

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See " Drop-Out Time " on page 180

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the sweep.

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative sweep time to 30 s.

*RST: 0 s
Default unit: S

Example: `TRIG:HOLD 500us`

Manual operation: See " Trigger Offset " on page 180

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).

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: 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 181

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
Default unit: 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 181

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
Default unit: DBM

Example: `TRIG:LEV:BBP -30DBM`

Manual operation: See " Trigger Level " on page 179

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

In the I/Q Analyzer application, only `EXTernal1` is supported.

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)
(Not available for R&S FSW85 models with two RF input connectors.)
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
Default unit: V

Example: `TRIG:LEV 2V`

Manual operation: See " Trigger Level " on page 179

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.

For compatibility reasons, this command is also available for the "baseband power" trigger source when using the Analog Baseband Interface (R&S FSW-B71).

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -10 dBm
Default unit: DBM

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See " Trigger Level " on page 179

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. If defined, a reference level offset is also considered.

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See " Trigger Level " on page 179

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
Default unit: DBM

Example: `TRIG:LEV:RFP -30dBm`

Manual operation: See " Trigger Level " on page 179

TRIGger[:SEQuence]:SLOPe <Type>

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.

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 181

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

For details on trigger sources see " Trigger Source " on page 175.

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.

If the 1.2 GHz bandwidth extension option (B1200) or the internal 2 GHz option (B2001) is active, only an external trigger, IF power trigger, or no trigger is available.

If a B4001/B6001/B8001 bandwidth extension option is active, only an external trigger, power trigger, or no trigger is available.

Parameters:

<Source> **IMMediate**
Free Run

EXTernal
Trigger signal from the "Trigger Input" connector.
If the optional 2 GHz bandwidth extension (B2000/B5000) is installed and active, this parameter activates the "Ch3" input connector on the oscilloscope. Then the R&S FSW triggers when the signal fed into the "Ch3" input connector on the oscilloscope meets or exceeds the specified trigger level.
Note: In previous firmware versions, the external trigger was connected to the "Ch2" input on the oscilloscope. As of firmware version R&S FSW 2.30, the **"Ch3"** input on the oscilloscope must be used!
If power splitter mode is active, this parameter activates the "EXT TRIGGER INPUT" connector on the oscilloscope. Then the R&S FSW triggers when the signal fed into the "EXT TRIGGER INPUT" connector on the oscilloscope meets or exceeds the specified trigger level.

EXT2
Trigger signal from the "Trigger Input/Output" connector.
For R&S FSW85 models, Trigger 2 is not available due to the second RF input connector on the front panel. The trigger signal is taken from the "Trigger Input/Output" connector on the rear panel.
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
(Frequency and time domain measurements only.)
Not available for input from the optional Digital Baseband Interface or the optional Analog Baseband Interface.

IFPower
Second intermediate frequency
Not available for input from the optional Digital Baseband Interface. For input from the optional Analog Baseband Interface, this parameter is interpreted as `BBPower` for compatibility reasons.

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.
Not available for input from the optional Digital Baseband Interface or the optional Analog Baseband Interface.

TIME
Time interval

VIDeo
Video mode is available in the time domain and only in the Spectrum application.

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

PSEN
External power sensor

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See " Trigger Source " on page 175
See " Free Run " on page 176
See "External Trigger 1/2/3" on page 176
See " External Channel 3 " on page 176
See "External Analog" on page 177
See " IF Power " on page 177
See " Baseband Power " on page 178
See " I/Q Power " on page 178
See " Digital I/Q " on page 178
See " RF Power " on page 179
See " Time " on page 179

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

This command defines the repetition interval for the time trigger.

Parameters:

<Interval> 2.0 ms to 5000

Range: 2 ns to 5000 s
*RST: 1.0 s
Default unit: S

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 50`
The sweep starts every 50 s.

Manual operation: See " Repetition Interval " on page 180

10.4.4.2 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<up>:TRIGger<tp>:DIRection <Direction>

This command selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:

<up>	irrelevant
<tp>	Selects the used trigger port. 2 = trigger port 2 (front) (Not available for R&S FSW85 models with two RF input connectors.) 3 = trigger port 3 (rear panel)

Parameters:

<Direction> INPut | OUTPut

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 2/3" on page 182

OUTPut<up>:TRIGger<tp>: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<up>:TRIGger<tp>:OTYPe`.

Suffix:

<up>	1..n
<tp>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (front) (Not available for R&S FSW85 models with two RF input connectors.) 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 183

OUTPut<up>:TRIGger<tp>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Suffix:

<up>	1..n
<tp>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (front) (Not available for R&S FSW85 models with two RF input connectors.) 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<up>:TRIGger<tp>:LEVel`.

*RST: DEVice

Manual operation: See " Output Type " on page 182

OUTPut<up>:TRIGger<tp>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<up>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (front) (Not available for R&S FSW85 models with two RF input connectors.) 3 = trigger port 3 (rear)
<tp>	1..n

Manual operation: See " Send Trigger " on page 183

OUTPut<up>:TRIGger<tp>:PULSe:LENGth <Length>

This command defines the length of the pulse generated at the trigger output.

Suffix:

<up> 1..n

<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for R&S FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:

<Length> Pulse length in seconds.
Default unit: S

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See " Pulse Length " on page 183

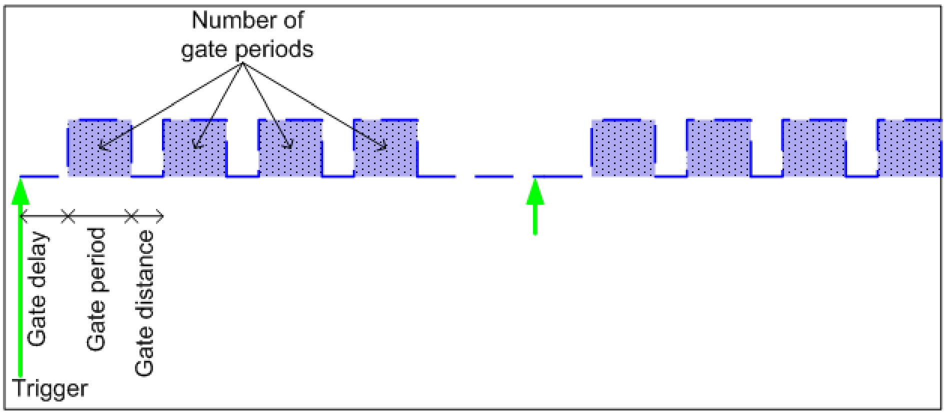
10.4.4.3 Configuring I/Q Gating

Usually in spectrum analysis, measurements are based on a certain length of time called the gate area. With I/Q gating, you can define the gate area using the gate length, the distance between the capture periods and the number of periods. The gate length and the distance between the capture periods are specified in samples.

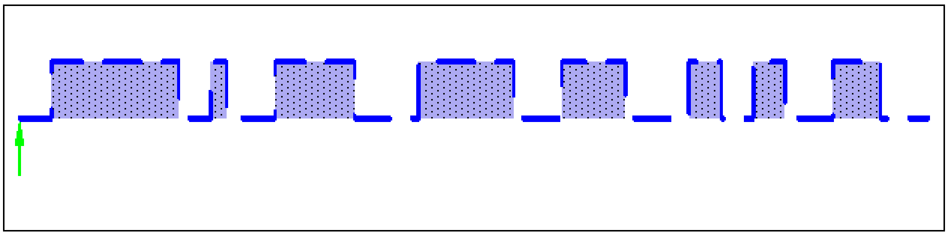
I/Q gating is only available using remote commands; manual configuration is not possible.
It is only possible up to a bandwidth of 10 MHz.

Using I/Q gating, the gate area can be defined using the following methods:

- Edge triggered capturing
  After a trigger signal, the gate period is defined by a gate length and a gate distance. All data in the gate period is captured until the required number of samples has been captured.



- Level triggered capturing
  After a trigger signal, all data is captured in which the gate signal is set to 1, which means it has exceeded a level. In this case, the gate signal can be generated by the IFP trigger, for example: each time the IFP level is exceeded, the IFP trigger signal is set to 1 and the samples in this area are captured as gate samples.



The number of complex samples to be captured prior to the trigger event can be selected (see `TRACe:IQ:SET` on page 385) for all available trigger sources, except for "Free Run".

TRACe:IQ:EGATe[:STATe] <State>

This command turns gated measurements with the I/Q analyzer on and off.

Before you can use the command you have to turn on the I/Q analyzer and select an external or IF power trigger source.

Parameters:

<State> ON | OFF

Example: TRAC:IQ:EGAT ON

TRACe:IQ:EGATe:GAP <Samples>

This command defines the interval between several gate periods for gated measurements with the I/Q analyzer.

Parameters:

<Samples> <numeric value>

Max = (440 MS * sample rate/200MHz) -1
pretrigger samples defined by `TRACe:IQ:SET`;
sample rate defined by `TRACe:IQ:SRATe`)

Range: 1…Max (samples)
*RST: 1

Example: `TRAC:IQ:EGAT:GAP 2`

TRACe:IQ:EGATe:LENGth <GateLength>

This command defines the gate length for gated measurements with the I/Q analyzer.

Defines the gate length in samples in edge mode. For details see Chapter 10.4.4.3, "Configuring I/Q Gating", on page 378.

Parameters:
<GateLength> <numeric value>

Max = (440 MS * sample rate/200MHz) -1
pretrigger samples defined by TRACe:IQ:SET;
sample rate defined by TRACe:IQ:SRATe)

Range: 1…Max (samples)
*RST: 100

Example: `TRAC:IQ:EGAT:LENG 2000`

TRACe:IQ:EGATe:NOF <Number>

This command defines the number of gate periods after the trigger signal for gated measurements with the I/Q analyzer.

Parameters:
<Number> Range: 1 to 1023
*RST: 1

Example: `TRAC:IQ:EGAT:NOF 2`

TRACe:IQ:EGATe:TYPE <Type>

This command selects the gate mode for gated measurements with the I/Q analyzer.

Note: The IF power trigger holdoff time is ignored if you are using the "Level" gate mode in combination with an IF Power trigger.

Parameters:
<Type> **LEVel**

EDGE

*RST: EDGE

Example: `TRAC:IQ:EGAT:TYPE LEV`

10.4.5 Configuring Data Acquisition

The following commands are required to capture data in the I/Q Analyzer.

MSRA/MSRT operating mode

Note that in MSRA/MSRT operating mode, configuring data acquisition is only possible for the MSRA/MSRT Master channel. In I/Q Analyzer application channels, these commands define the **analysis interval**. Be sure to select the correct channel before using these commands.

For more commands related to the MSRA operating mode see Chapter 10.7.4, "Configuring an Analysis Interval and Line (MSRA mode only)", on page 465.

For more commands related to the MSRT operating mode see Chapter 10.7.5, "Configuring an Analysis Interval and Line (MSRT mode only)", on page 467.

Useful commands for I/Q data acquisition described elsewhere

- [SENSe:]SWEep:COUNt on page 406
- [SENSe:]SWEep[:WINDow<n>]:POINts on page 406
- [SENSe:]SWEep:TIME on page 407

Remote commands exclusive to I/Q data acquisition

[SENSe:]IQ:BANDwidth:MODE <Mode>
[SENSe:]IQ:BWIDth:MODE <Mode>

This command defines how the resolution bandwidth is determined.

Parameters:

<Mode> AUTO | MANual | FFT

AUTO
(Default) The RBW is determined automatically depending on the sample rate and record length.

MANual
The user-defined RBW is used and the (FFT) window length (and possibly the sample rate) are adapted accordingly. The RBW is defined using the [SENSe:]IQ:BWIDth:RESolution command.

FFT
The RBW is determined by the FFT parameters.

*RST: AUTO

Example: `IQ:BAND:MODE MAN`
Switches to manual RBW mode.
`IQ:BAND:RES 120000`
Sets the RBW to 120 kHz.

Manual operation: See " RBW " on page 188

[SENSe:]IQ:BANDwidth:RESolution <Bandwidth>
[SENSe:]IQ:BWIDth:RESolution <Bandwidth>

This command defines the resolution bandwidth manually if `[SENSe:]IQ:BWIDth:MODE` is set to `MAN`.

Defines the resolution bandwidth. The available RBW values depend on the sample rate and record length.

For details see Chapter 5.14.4, "Frequency Resolution of FFT Results - RBW", on page 105.

Parameters:
<Bandwidth> refer to data sheet
*RST: RBW: AUTO mode is used
Default unit: HZ

Example: `IQ:BAND:MODE MAN`
Switches to manual RBW mode.
`IQ:BAND:RES 120000`
Sets the RBW to 120 kHz.

Manual operation: See " RBW " on page 188

[SENSe:]IQ:FFT:ALGorithm <Method>

Defines the FFT calculation method.

Parameters:
<Method>

SINGle
One FFT is calculated for the entire record length; if the FFT length is larger than the record length (see `[SENSe:]IQ:FFT:LENGth` and `TRACe:IQ:RLENgth`), zeros are appended to the captured data.

AVERage
Several overlapping FFTs are calculated for each record; the results are averaged to determine the final FFT result for the record.
The user-defined window length and window overlap are used (see `[SENSe:]IQ:FFT:WINDow:LENGth` and `[SENSe:]IQ:FFT:WINDow:OVERlap`).
*RST: AVER

Example: `IQ:FFT:ALG SING`

Manual operation: See " Transformation Algorithm " on page 189

[SENSe:]IQ:FFT:LENGth <NoOfBins>

Defines 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.

Parameters:

<NoOfBins> integer value

Range: 3 to 524288
*RST: 4096

Example: `IQ:FFT:LENG 2048`

Manual operation: See " FFT Length " on page 189

[SENSe:]IQ:FFT:WINDow:LENGth <NoOfFFT>

Defines the number of samples to be included in a single FFT window when multiple FFT windows are used.

Parameters:

<NoOfFFT> integer value

Range: 3 to 1001
*RST: 1001

Example: `IQ:FFT:WIND:LENG 500`

Manual operation: See " Window Length " on page 190

[SENSe:]IQ:FFT:WINDow:OVERlap <Rate>

Defines the part of a single FFT window that is re-calculated by the next FFT calculation.

Parameters:

<Rate> double value

Percentage rate

Range: 0 to 1
*RST: 0.75

Example: `IQ:FFT:WIND:OVER 0.5`
Half of each window overlaps the previous window in FFT calculation.

Manual operation: See " Window Overlap " on page 189

[SENSe:]IQ:FFT:WINDow:TYPE <Function>

In the I/Q Analyzer you can select one of several FFT window types.

Parameters:

<Function> **BLACkharris**
Blackman-Harris

FLATtop
Flattop

GAUSsian
Gauss

RECTangular
Rectangular

P5
5-Term

*RST: FLAT

Example: `IQ:FFT:WIND:TYPE GAUS`

Manual operation: See " Window Function " on page 189

[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.

Parameters:
<State>

ON | 1
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF | 0
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: 0

Manual operation: See " Swap I/Q " on page 188

TRACe:IQ:BWIDth

This command defines or queries the bandwidth of the resampling filter.

The bandwidth of the resampling filter depends on the sample rate.

Parameters:
<Bandwidth> For details on the maximum bandwidth see Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.

Default unit: HZ

Manual operation: See " Analysis Bandwidth " on page 185

TRACe:IQ:DIQFilter <State>

This command is only available when using the optional Digital Baseband Interface.

By default, a decimation filter is used during data acquisition to reduce the sample rate to the value defined using `TRACe:IQ:SRATe`.

If the filter is bypassed, the sample rate is identical to the input sample rate configured for the Digital I/Q input source (see `INPut<ip>:DIQ:SRATe` on page 286).

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See "Omitting the Digital Decimation Filter (No Filter)" on page 186

TRACe:IQ:RLENgth <NoOfSamples>

This command sets the record length for the acquired I/Q data.

Increasing the record length also increases the measurement time.

Note: Alternatively, you can define the measurement time using the `SENS:SWE:TIME` command.

Parameters:

<NoOfSamples> Number of samples to record.
See Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.
For digital input via the Digital Baseband Interface (R&S FSW-B17) the valid number of samples is described in Chapter 5.2.3, "Sample Rates and Bandwidths for Digital I/Q Data", on page 45.

*RST: 1001

Example: `TRAC:IQ:RLEN 256`

Manual operation: See " Record Length " on page 187

TRACe:IQ:SET <NORM>, <0>, <SampleRate>, <TriggerMode>, <TriggerSlope>, <PretriggerSamp>, <NumberSamples>

This command sets up the R&S FSW for I/Q measurements.

If you do not use this command to set up I/Q measurements, the R&S FSW will use its current settings for I/Q measurements.

If the I/Q Analyzer has not been turned on previously, the command also switches to the I/Q Analyzer.

For more information on triggering measurements see Chapter 6.6, "Trigger Settings", on page 174. You can set the trigger level with `TRIGger[:SEQuence]:LEVel:IFPower`. For details on trigger parameters see Chapter 10.4.4, "Triggering", on page 368.

Note: If you use the default settings with `TRACe:IQ:DATA?`, the following minimum buffer sizes for the response data are recommended:

ASCII format: 10 kBytes

Binary format: 2 kBytes

Parameters:

Norm — This value is always `NORM`.

0 — Default unit: HZ
This value is always `0`.

<SampleRate> — Sample rate for the data acquisition.
Range: 100 Hz to 20 GHz, continuously adjustable
*RST: 32000000
Default unit: HZ

<TriggerMode> — Selection of the trigger source used for the measurement.
IMMediate | EXTernal | EXT2 | EXT3 | IFPower
For IMM mode, gating is automatically deactivated.
*RST: IMM

<TriggerSlope> — Used trigger slope.
POSitive | NEGative
*RST: POS

<PretriggerSamp> — Defines the trigger offset in terms of pretrigger samples. Negative values correspond to a trigger delay.
This value also defines the interval between the trigger signal and the gate edge in samples.
Range: -1399999999 to 1399999999
*RST: 0

<NumberSamples> — Number of measurement values to record (including the pretrigger samples).
See Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.
For digital input via the Digital Baseband Interface (R&S FSW-B17) the valid number of samples is described in Chapter 5.2.3, "Sample Rates and Bandwidths for Digital I/Q Data", on page 45.
*RST: 1001

Example: `TRAC:IQ:SET NORM,0,32MHz,EXT,POS,0,2048`
Reads 2048 I/Q-values starting at the trigger point.
sample rate = 32 MHz
trigger = External
slope = Positive
`TRAC:IQ:SET NORM,0,4 MHz,EXT,POS,1024,512`
Reads 512 I/Q-values from 1024 measurement points before the trigger point.
filter type = NORMAL
sample rate = 4 MHz
trigger = External
slope = Positive

Manual operation: See " Record Length " on page 187

TRACe:IQ:SRATe <SampleRate>

This command sets the final user sample rate for the acquired I/Q data. Thus, the user sample rate can be modified without affecting the actual data capturing settings on the R&S FSW.

Note: The smaller the user sample rate, the smaller the usable I/Q bandwidth, see Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.

In order to ensure a minimum usable I/Q bandwidth use the `TRACe:IQ:WBANd:MBWidth` on page 388 command.

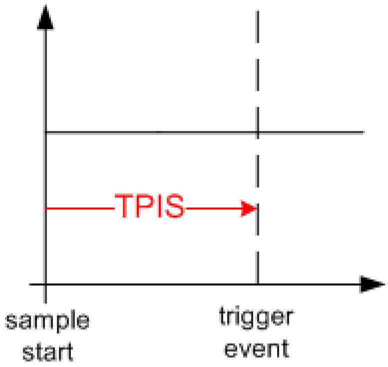
Parameters:

<SampleRate> The valid sample rates are described in Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24.
*RST: 32 MHz
Default unit: HZ

Manual operation: See " Sample Rate " on page 185

TRACe:IQ:TPISample?

This command queries the time offset between the sample start and the trigger event (trigger point in sample = TPIS). Since the R&S FSW usually samples with a much higher sample rate than the specific application actually requires, the trigger point determined internally is much more precise than the one determined from the (down-sampled) data in the application. Thus, the TPIS indicates the offset between the sample start and the actual trigger event.



This value can only be determined in triggered measurements using external or IFPower triggers, otherwise the value is 0.

This command is not available if the Digital Baseband Interface (R&S FSW-B17) is active and not for bandwidths > 80 MHz.

Return values:

<TPIS> numeric value
Default unit: s

Example: `TRAC:IQ:TPIS?`
Result for a sample rate of 1 MHz: between 0 and 1/1 MHz, i.e. between 0 and 1 µs (the duration of 1 sample).

Usage: Query only

Manual operation: See " Trigger Offset " on page 180

TRACe:IQ:WBANd[:STATe] <State>

This command determines whether the wideband provided by bandwidth extension options is used or not (if installed).

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See " Maximum Bandwidth " on page 186

TRACe:IQ:WBANd:MBWidth <Limit>

Defines the maximum analysis bandwidth. Any value can be specified; the next higher fixed bandwidth is used.

Defining a value other than "MAX" is useful if you want to specify the sample rate directly and at the same time, ensure a minimum bandwidth is available.

(See Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24).

Parameters:

<Limit>

80 MHz
Restricts the analysis bandwidth to a maximum of 80 MHz.
The bandwidth extension options greater than 160 MHz are disabled.
`TRACe:IQ:WBANd[:STATe]` is set to OFF.

160 MHz
Restricts the analysis bandwidth to a maximum of 160 MHz. The bandwidth extension option R&S FSW-B320 is deactivated.
(Not available or required if other bandwidth extension options larger than 320 MHz are installed.)
`TRACe:IQ:WBANd[:STATe]` is set to ON.

1200 MHz | 500 MHz | 320 MHz | MAX
All installed bandwidth extension options are activated. The currently available maximum bandwidth is allowed.
(See Chapter 5.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 24).
`TRACe:IQ:WBANd[:STATe]` is set to ON.

*RST: maximum available
Default unit: Hz

Example:

```
TRAC:IQ:WBAN:MBW 82 MHZ
TRAC:IQ:WBAN:MBW?
```
Result if R&S FSW-B160/-B320 is active:
```
160000000
```

Example:

```
TRAC:IQ:WBAN:MBW 82 MHZ
TRAC:IQ:WBAN:MBW?
```
Result if R&S FSW-B512 is active:
```
512000000
```

Manual operation: See " Maximum Bandwidth " on page 186

TRACe:IQ:WFILter <State>

Activates a 200 MHz filter before the A/D converter, thus restricting the processed bandwidth to 200 MHz while using the wideband processing path in the R&S FSW. For prerequisites see manual operation.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "200 MHz Filter" on page 187

10.4.6 Adjusting Settings Automatically

The commands required to adjust settings automatically in a remote environment are described here.

The tasks for manual operation are described in Chapter 6.9, "Adjusting Settings Automatically", on page 194.

MSRA operating mode

In MSRA operating mode, settings related to data acquisition (measurement time, hysteresis) can only be adjusted automatically in the MSRA Master, not in the MSRA applications.

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Reference level

Example: `ADJ:ALL`

Manual operation: See " Adjusting all Determinable Settings Automatically (Auto All)" on page 195

[SENSe:]ADJust:CONFigure:LEVel:DURation <Duration>

In order to determine the ideal reference level, the R&S FSW performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See " Changing the Automatic Measurement Time (Meastime Manual)" on page 196

[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S FSW performs a measurement on the current input data. This command selects the way the R&S FSW determines the length of the measurement .

Parameters:

<Mode>

AUTO
The R&S FSW determines the measurement length automatically according to the current input data.

MANual
The R&S FSW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:LEVel:DURation` on page 390.

*RST: AUTO

Manual operation: See " Resetting the Automatic Measurement Time (Meastime Auto)" on page 196
See " Changing the Automatic Measurement Time (Meastime Manual)" on page 196

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 392 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example:

```
SENS:ADJ:CONF:HYST:LOW 2
```

For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See " Lower Level Hysteresis " on page 197

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 392 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See " Upper Level Hysteresis " on page 196

[SENSe:]ADJust:CONFigure:TRIGger <State>

Defines the behavior of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

See "Adjusting settings automatically during triggered measurements" on page 195.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Manual operation: See " Adjusting the Center Frequency Automatically (Auto Frequency)" on page 195

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Manual operation: See " Setting the Reference Level Automatically (Auto Level)" on page 165

10.5 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

10.5.1 General Window Commands

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected channel* (see `INSTrument[:SELect]` on page 271).

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 398).

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`

10.5.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a 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 channel.

Note that the suffix <n> always refers to the window *in the currently selected channel*.

(See `INSTrument[:SELect]` on page 271).

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active 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.

Query 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? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See " Magnitude " on page 17
See " Spectrum " on page 18
See " I/Q-Vector " on page 18
See " Real/Imag (I/Q) " on page 19
See " Marker Table " on page 19
See " Marker Peak List " on page 20

Table 10-4: <WindowType> parameter values for IQ Analyzer application

Parameter value	Window type
Basic I/Q measurement:	
FREQ	Spectrum
MAGN	Magnitude
MTABle	Marker table
PEAKlist	Marker peak list
RIMAG	Real/Imag (I/Q)
VECT	I/Q Vector
Frequency and time domain measurements:	
DIAGram	Diagram
MTABle	Marker table

Parameter value	Window type
PEAKlist	Marker peak list
RSUMmary	Result summary

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active 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 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:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:

<WindowName> String containing the name of an existing window that is to be moved.
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 channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
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 channel, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace
Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active channel.

Setting 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: Setting only

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 channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting 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 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 394 for a list of available window types.

Example: LAY:REPL:WIND '1',MTAB
Replaces the result display in window 1 with a marker table.

Usage: Setting only

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 393 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.

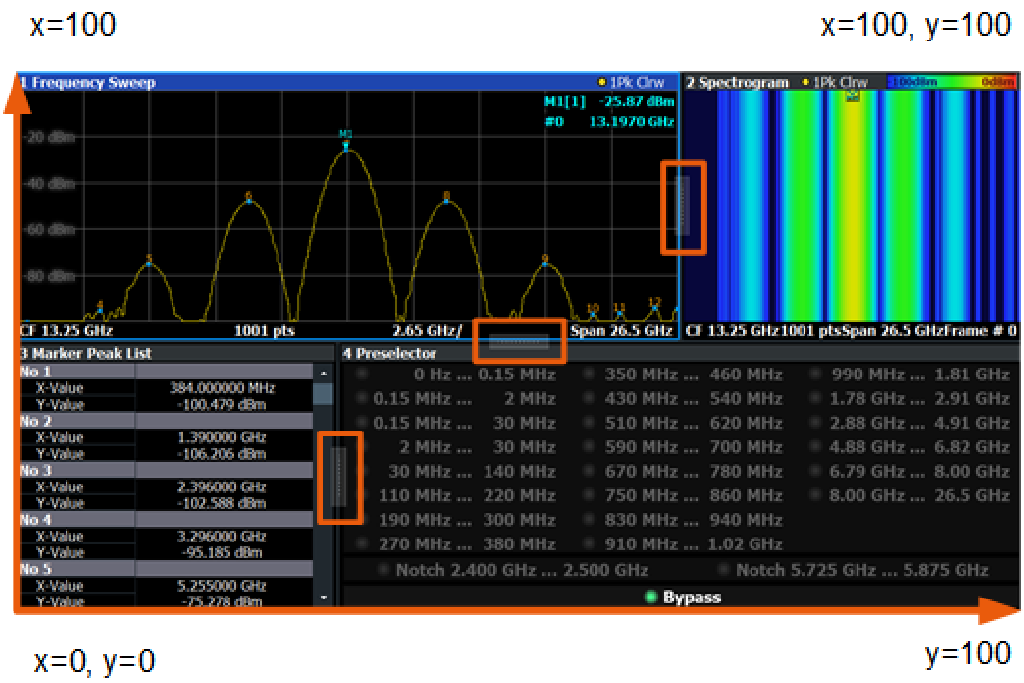


Figure 10-1: SmartGrid coordinates for remote control of the splitters

Setting 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 10-1.)
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
```

Usage: Setting only

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

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 394 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 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 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 channel.

The effect 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

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 394 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

10.6 Capturing Data and Performing Sweeps

Different measurement procedures

Two different procedures to capture I/Q data remotely are available:

- Measurement and result query with one command (see `TRACe:IQ:DATA` on page 470)
  This method causes the least delay between measurement and output of the result data, but it requires the control computer to wait actively for the response data.
- Setting up the instrument, starting the measurement via `INIT` and querying the result list at the end of the measurement (see `TRACe:IQ:DATA:MEMory?` on page 472)
  With this method, the control computer can be used for other activities during the measurement. However, the additional time needed for synchronization via service request must be taken into account.

MSRA/MSRT operating mode

Note that in MSRA/MSRT operating mode, capturing data is only possible for the MSRA Master channel. In I/Q Analyzer application channels, the sweep configuration commands define the **analysis interval**. Be sure to select the correct channel before using these commands.

ABORt

This command aborts the measurement in the current 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: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

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single sweep 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

Example:
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Setting the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.
`INIT:CONM;*WAI`
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual operation: See " Continue Single Sweep " on page 192

INITiate<n>:CONTinuous <State>

This command controls the sweep mode for an individual channel.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the sweep mode is changed for a channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 404) 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 sweep

OFF | 0
Single sweep

*RST: 1

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep.
`INIT:CONT ON`
Switches the sweep mode to continuous sweep.

Manual operation: See " Continuous Sweep / Run Cont " on page 191

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the 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

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

Manual operation: See " Single Sweep / Run Single " on page 192

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 404.

Usage: Event

INITiate: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 407).

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.

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and channels it contains.

Note: In order to synchronize to the end of a measurement sequence using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

Parameters:

<Mode>

SINGle
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitly.

*RST: CONTinuous

INITiate:SEQuencer:REFResh[:ALL]

This function is only available if the Sequencer is deactivated (`SYSTem:SEQuencer` `SYST:SEQ:OFF`) and only in MSRA/MSRT mode.

The data in the capture buffer is re-evaluated by all active MSRA/MSRT client applications.

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.
`INIT:SEQ:REFR`
Refreshes the display for all channels.

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of sweeps that the application uses to average traces.

In continuous sweep mode, the application calculates the moving average over the average count.

In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Example:
`SWE:COUN 64`
Sets the number of sweeps to 64.
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.

Manual operation: See " Sweep/Average Count " on page 191

[SENSe:]SWEep:COUNt:CURRent?

This query returns the current number of started sweeps or measurements. This command is only available if a sweep count value is defined and the instrument is in single sweep mode.

Return values:
<CurrentCount>

Example:
`SWE:COUNt 64`
Sets sweep count to 64
`INIT:CONT OFF`
Switches to single sweep mode
`INIT`
Starts a sweep (without waiting for the sweep end!)
`SWE:COUN:CURR?`
Queries the number of started sweeps

Usage: Query only

[SENSe:]SWEep[:WINDow<n>]:POINts <SweepPoints>

This command defines the number of sweep points to analyze after a sweep.

Suffix:
<n>

Parameters:
<SweepPoints> Range: 101 to 100001
*RST: 1001

Example: `SWE:POIN 251`

Manual operation: See "Sweep Points" on page 191

[SENSe:]SWEep:TIME <Time>

This command defines the sweep time. It automatically decouples the time from any other settings.

Parameters:

<Time> refer to data sheet

*RST: depends on current settings (determined automatically)

Default unit: S

Manual operation: See " Meas Time " on page 187

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`

10.7 I/Q Analysis

General result analysis settings concerning the trace, markers, etc. can be configured using the following commands. They are identical to the analysis functions in the Spectrum application except for the special marker functions.

10.7.1 Configuring Standard Traces

Useful commands for trace configuration described elsewhere

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 366
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 364

Remote commands exclusive to trace configuration

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode. If necessary, the selected trace is also activated.

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.

Suffix:

<n>	Window
<t>	Trace

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
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.

MINHold
The minimum value is determined from several measurements 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.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:
`INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual operation: See " Trace Mode " on page 200

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous <State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:

<n>	Window
<w>	subwindow
<t>	Trace

Parameters:

<State>	ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual operation: See " Hold " on page 201

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PRESet <ResultType>

Applies predefined, commonly required trace settings to the selected window.

Suffix:

<n> 1..n
Window

<w> 1..n
subwindow

<t> 1..n
Trace

Parameters:

<ResultType>

ALL
Preset All Traces

MAM
Max | Avg | Min

MCM
Max | ClrWrite | Min

Example: `DISP:WIND3:TRAC:PRES MCM`
In window 3, the traces are set to the following modes:
Trace 1: Max Hold
Trace 2: Clear Write
Trace 3: Min Hold

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:TRAC3 ON`

Manual operation: See " Trace 1 / Trace 2 / Trace 3 / Trace 4 / Trace 5 / Trace 6 " on page 200
See " Trace 1 / Trace 2 / Trace 3 / Trace 4 (Softkeys)" on page 203

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture <Aperture>

This command defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]` `TRUE`.

Suffix:

<n>	Window
<w>	subwindow
<t>	Trace

Parameters:

<Aperture>
Range: 1 to 50
*RST: 2
Default unit: PCT

Example: `DISP3:TRAC2:SMO:APER 5`
Defines an aperture of 5% for trace 2 in window 3

Manual operation: See " Smoothing " on page 201

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe] <State>

This command turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture` on page 411.

For more information see the R&S FSW User Manual.

Suffix:

<n>	Window
<w>	subwindow
<t>	Trace

Parameters:

<State>
ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP3:TRAC2:SMO ON`
Turns on trace smoothing for trace 2 in window 3

Manual operation: See " Smoothing " on page 201

[SENSe:]AVERage<n>:TYPE <Mode>

This command selects the trace averaging mode.

Suffix:
<n> 1..n
Window

Parameters:
<Mode>
LOGarithmic
The logarithmic power values are averaged.
LINear
The power values are averaged before they are converted to logarithmic values.
POWer
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.

Example: `AVER:TYPE LIN`
Switches to linear average calculation.

Manual operation: See " Average Mode " on page 202

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

Suffix:
<n> Window
<t> Trace

Parameters:
<Detector>
APEak
Autopeak
NEGative
Negative peak
POSitive
Positive peak
SAMPle
First value detected per trace point
RMS
RMS value

AVERage
Average
*RST: APEak

Example: `DET POS`
Sets the detector to "positive peak".

Manual operation: See " Detector " on page 201

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Suffix:
<n> Window

<t> Trace

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `DET:AUTO OFF`
The selection of the detector is not coupled to the trace mode.

Manual operation: See " Detector " on page 201

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Suffix:
<n> Window

Parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example: `TRAC:COPY TRACE1,TRACE2`
Copies the data from trace 2 to trace 1.

Manual operation: See " Copy Trace " on page 203

[SENSe:]AVERage<n>:COUNt <AverageCount>
TRACe:IQ:AVERage:COUNt <NumberSets>

This command defines the number of I/Q data sets that the averaging is based on.

Parameters:
<NumberSets> Range: 0 to 32767
*RST: 0

Example:

`TRAC:IQ ON`
Switches on acquisition of I/Q data.
`TRAC:IQ:AVER ON`
Enables averaging of the I/Q measurement data
`TRAC:IQ:AVER:COUN 10`
Selects averaging over 10 data sets
`TRAC:IQ:DATA?`
Starts the measurement and reads out the averaged data.

[SENSe:]AVERage<n>[:STATe<t>] <State>
TRACe:IQ:AVERage[:STATe] <State>

This command turns averaging of the I/Q data on and off.

Before you can use the command you have to turn the I/Q data acquisition on with `TRACe:IQ[:STATe]`.

If averaging is on, the maximum amount of I/Q data that can be recorded is 512kS (524288 samples).

Parameters:

<State>

ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:

`TRAC:IQ ON`
Switches on acquisition of I/Q data.
`TRAC:IQ:AVER ON`
Enables averaging of the I/Q measurement data.
`TRAC:IQ:AVER:COUN 10`
Selects averaging over 10 data sets.
`TRAC:IQ:DATA?`
Starts the measurement and reads out the averaged data.

10.7.2 Configuring Spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the R&S FSW also provides a spectrogram display of the measured data. A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. The commands required to configure spectrograms in a remote environment are described here. For details and manual operation see Chapter 7.2, "Spectrogram Settings", on page 203.

When configuring spectrograms, the window suffix is irrelevant. The settings are always applied to the spectrogram window, or to all spectrogram windows, if several are active for the same channel.

For commands to set markers in spectrograms, see Chapter 10.7.3.4, "Marker Search (Spectrograms)", on page 434.

10.7.2.1 Configuring a Spectrogram Measurement

CALCulate<n>:SGRam:CLEar[:IMMediate]
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]

This command resets the spectrogram and clears the history buffer.

Suffix:

<n> Window

Example: //Reset the result display and clear the memory
`CALC:SGR:CLE`

Manual operation: See " Clear Spectrogram " on page 193

CALCulate<n>:SGRam:CONTinuous <State>
CALCulate<n>:SPECtrogram:CONTinuous <State>

This command determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

This setting applies to all spectrograms in the channel.

Suffix:
<n> Window

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
`INIT:CONT OFF`
Selects single sweep mode.
`INIT;*WAI`
Starts the sweep and waits for the end of the sweep.
`CALC:SGR:CONT ON`
Repeats the single sweep measurement without deleting the results of the last measurement.

Manual operation: See " Continue Frame " on page 193

CALCulate<n>:SGRam:FRAMe:COUNt <Frames>
CALCulate<n>:SPECtrogram:FRAMe:COUNt <Frames>

This command defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the channel.

Suffix:
<n> Window

Parameters:
<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1
*RST: 1

Example:
//Select single sweep mode
`INIT:CONT OFF`
//Set the number of frames to 200
`CALC:SGR:FRAM:COUN 200`

Manual operation: See " Frame Count " on page 193

CALCulate<n>:SGRam:FRAMe:SELect <Frame> | <Time>
CALCulate<n>:SPECtrogram:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:
<n> Window

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:
`INIT:CONT OFF`
Stop the continuous sweep.
`CALC:SGR:FRAM:SEL -25`
Selects frame number -25.

Manual operation: See "Select Frame" on page 193

CALCulate<n>:SGRam:HDEPth <History>
CALCulate<n>:SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S FSW memory.

Suffix:

<n> Window

Parameters:

<History> The maximum number of frames depends on the number of sweep points.

Range: 781 to 20000
Increment: 1
*RST: 3000

Example:
//Set the history depth to 1500
`CALC:SGR:SPEC 1500`

Manual operation: See " History Depth " on page 205

CALCulate<n>:SGRam:LAYout <State>
CALCulate<n>:SPECtrogram:LAYout <State>

This command selects the state and size of spectrograms.

The command is available for result displays that support spectrograms.

Suffix:

<n> Window

Parameters:

<State> **FULL**
Only the spectrogram is displayed, the trace diagram is not.
SPLIT
Spectrogram and trace diagram share a window.

OFF
Only the trace diagram is displayed, the spectrogram is not.

*RST: OFF

Example: `CALC4:SPEC:LAY FULL`
Shows the spectrogram in window 4. The corresponding trace diagram is hidden.

Manual operation: See "State" on page 204

CALCulate<n>:SGRam[:STATe] <State>
CALCulate<n>:SPECtrogram[:STATe] <State>

This command turns the spectrogram on and off.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:SGR ON`
Activates the Spectrogram result display.

CALCulate<n>:SGRam:THReedim[:STATe] <State>
CALCulate<n>:SPECtrogram:THReedim[:STATe] <State>

Activates or deactivates a 3-dimensional spectrogram for the selected result display.

Suffix:
<n> Window

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CALC:SPEC:THR:STAT ON`

Manual operation: See "3D Spectrogram State" on page 205

CALCulate<n>:SGRam:TRACe <Trace>
CALCulate<n>:SPECtrogram:TRACe <Trace>

This command determines the trace in the result display the Spectrogram is based on.

Suffix:
<n> Window

Parameters:
<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6
How many traces are available depends on the selected result display.

Example: `CALC2:SPEC:TRAC TRACE3`

CALCulate<n>:SGRam:TSTamp:DATA? <Frames>
CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

This command queries the starting time of the frames.

The return values consist of four values for each frame. If the Spectrogram is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

Suffix:
<n> Window

Query parameters:
<Frames>
CURRent
Returns the starting time of the current frame.
ALL
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:
<Seconds> Number of seconds that have passed since 01.01.1970 till the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 till the frame start.

<Reserved> The third value is reserved for future uses.

<Reserved> The fourth value is reserved for future uses.

Example: `CALC:SGR:TST ON`
Activates the time stamp.
`CALC:SGR:TST:DATA? ALL`
Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See " Time Stamp " on page 205

CALCulate<n>:SGRam:TSTamp[:STATe] <State>
CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe` on page 439
- `CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 435
- `CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 416

Suffix:

<n>	1..n Window

Parameters:

<State>	ON | OFF | 0 | 1 **OFF | 0** Switches the function off **ON | 1** Switches the function on
Example:	//Activates the time stamp `CALC:SGR:TST ON`
Manual operation:	See " Time Stamp " on page 205

10.7.2.2 Configuring the Color Map

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Suffix:

<n>	Window
Manual operation:	See " Set to Default " on page 208

DISPlay[:WINDow<n>]:SGRam:COLor:LOWer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Suffix:

<n> Window

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:LOW 10`
Sets the start of the color map to 10%.

Manual operation: See " Start / Stop " on page 208

DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe <Shape>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Suffix:

<n> Window

Parameters:

<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Manual operation: See " Shape " on page 208

DISPlay[:WINDow<n>]:SGRam:COLor:UPPer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Suffix:

<n> Window

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual operation: See " Start / Stop " on page 208

DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe] <ColorScheme>
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:

<ColorScheme>

HOT
Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example:
`DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual operation: See " Hot / Cold / Radar / Grayscale " on page 208

10.7.3 Using Markers

The following commands are available for marker settings and functions in the I/Q Analyzer application.

For "I/Q Vector" displays markers are not available.

10.7.3.1 Setting Up Individual Markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker<m>:AOFF

This command turns off *all* delta markers.

Suffix:

<n>	Window
<m>	irrelevant

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>` or `CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>` commands.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK ON`

Manual operation: See " Linking to Another Marker " on page 215

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

Suffix:

<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See " Linking to Another Marker " on page 215

CALCulate<n>:DELTamarker<m>:MODE <Mode>

This command defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker.

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 426)!

Suffix:

<n> Window

<m> irrelevant

Parameters:

<Mode> **ABSolute**
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

This command selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Suffix:

<n> Window

<m>	Marker

Parameters:

<Reference>

1 to 16
Selects markers 1 to 16 as the reference.

FIXed
Selects the fixed reference as the reference.

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See " Reference Marker " on page 214

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 | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See " Marker State " on page 214
See " Marker Type " on page 214
See " Select Marker " on page 215

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>: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:

<n> — Window

<m> — Marker

Parameters:

<Position> — Numeric value that defines the marker position on the x-axis.
Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker Position X-value " on page 214

CALCulate<n>:MARKer<m>:AOFF

This command turns off all markers.

Suffix:

<n> — Window

<m> — Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Manual operation: See " All Markers Off " on page 216

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Suffix:

<n> — Window

<ms> — source marker, see Marker

<md> — destination marker, see Marker

Parameters:

<State> — ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See " Linking to Another Marker " on page 215

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See " Marker State " on page 214
See " Marker Type " on page 214
See " Select Marker " on page 215

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>

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See " Assigning the Marker to a Trace " on page 215

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a specific 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:

<n> Window

<m> Marker

Parameters:

<Position> Numeric value that defines the marker position on the x-axis. The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See " Marker Table " on page 19
See " Marker Peak List " on page 20
See "Marker Position X-value " on page 214

10.7.3.2 General Marker Settings

The following commands control general marker functionality.

Remote commands exclusive to general marker functionality

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

This command turns the marker table on and off.

Suffix:

<n> irrelevant

Parameters:

<DisplayMode>

ON | 1
Turns on the marker table.

OFF | 0
Turns off the marker table.

AUTO
Turns on the marker table if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See " Marker Table Display " on page 216

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

This command turns the marker information in all diagrams on and off.

Suffix:
<n> irrelevant

Parameters:
<State>
ON | 1
Displays the marker information in the diagrams.
OFF | 0
Hides the marker information in the diagrams.
*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See " Marker Info " on page 217

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

This command selects the marker step size mode for *all* markers in *all* windows.

The step size defines the distance the marker moves when you move it with the rotary knob.

It therefore takes effect in manual operation only.

Suffix:
<n> irrelevant
<m> irrelevant

Parameters:
<StepSize>
STANdard
the marker moves from one pixel to the next
POINts
the marker moves from one sweep point to the next
*RST: POINts

Example: `CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual operation: See " Marker Stepsize " on page 217

10.7.3.3 Configuring and Performing a Marker Search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `CALC:MARK:LOEX ON`

Manual operation: See " Exclude LO " on page 219

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized

*RST: 6 dB in the Spectrum application and RF displays

Default unit: DB

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual operation: See " Peak Excursion " on page 219

CALCulate<n>:MARKer<m>:SEARch <MarkRealImag>

This command selects the trace type a marker search is performed on.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<MarkRealImag>

REAL
Marker search functions are performed on the real trace of the "I/Q" measurement.

IMAG
Marker search functions are performed on the imaginary trace of the "I/Q" measurement.

MAGN
Marker search functions are performed on the magnitude of the I and Q data.

*RST: REAL

Example: `CALC4:MARK:SEAR IMAG`

Manual operation: See " Branch for Peaksearch " on page 220

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual operation: See " Search Limits (Left / Right)" on page 219
See " Deactivating All Search Limits " on page 220
See " Limit State " on page 234

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchLimit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border
Default unit: HZ

Example:
```
CALC:MARK:X:SLIM ON
```
Switches the search limit function on.
```
CALC:MARK:X:SLIM:LEFT 10MHz
```
Sets the left limit of the search range to 10 MHz.

Manual operation: See " Search Limits (Left / Right)" on page 219
See " Left Limit / Right Limit " on page 234

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt <SearchLimit>

This command defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Limit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border
Default unit: HZ

Example:
`CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation:
See " Search Limits (Left / Right)" on page 219
See " Left Limit / Right Limit " on page 234

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
`CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation:
See " Use Zoom Limits " on page 220

CALCulate<n>:THReshold <Level>

This command defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

Parameters:

<Level> Numeric value. The value range and unit are variable.

*RST: -120 dBm
Default unit: DBM

Example:
`CALC:THR -82DBM`
Sets the threshold value to -82 dBm.

Manual operation:
See " Search Threshold " on page 220

CALCulate<n>:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual operation: See " Deactivating All Search Limits " on page 220

10.7.3.4 Marker Search (Spectrograms)

The following commands automatically define the marker and delta marker position in the spectrogram.

Using Markers

The following commands control spectrogram markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the markers.

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 444
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 444
- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 445
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 445
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 446
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 446
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 446
- `CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 446

Remote commands exclusive to spectrogram markers

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example:
`CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual operation: See " Frame (Spectrogram only)" on page 214

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for all spectrogram markers in the channel.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:
<SearchArea> **VISible**
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See " Marker Search Area " on page 222

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Suffix:
<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Suffix:
<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:
<n> Window

<m> Marker

Using Delta Markers

The following commands control spectrogram delta markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the delta markers.

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 447
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 447
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 448
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 448
- `CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 448
- `CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 448
- `CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 449
- `CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 449

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame>
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame either by its frame number or time stamp.
The frame number is available if the time stamp is off. The range depends on the history depth.
The time stamp is available if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Default unit: S

Example: `CALC:DELT4:SGR:FRAM -20`
Sets fourth deltamarker 20 frames below marker 1.
`CALC:DELT4:SGR:FRAM 2 s`
Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See " Frame (Spectrogram only)" on page 214

CALCulate<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the channel.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchArea> **VISible**
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See " Marker Search Area " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n>	Window
<m>	Marker

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Mode for Next Peak in Y-Direction " on page 222

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:

<n>	Window
<m>	Marker

10.7.3.5 Positioning the Marker

This chapter contains remote commands necessary to position the marker on a trace.

Positioning Normal Markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S FSW performs the peak search after each sweep.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:MAX:AUTO ON`
Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See " Auto Max Peak Search / Auto Min Peak Search " on page 219

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Peak Search " on page 224

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window

<m> Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S FSW performs the peak search after each sweep.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
CALC:MARK:MIN:AUTO ON
```
Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See " Auto Max Peak Search / Auto Min Peak Search " on page 219

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Minimum " on page 224

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Minimum " on page 224

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Minimum " on page 224

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Minimum " on page 224

Positioning Delta Markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	1..n Window
<m>	1..n Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Peak Search " on page 224

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Peak " on page 224

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n>	Window
<m>	Marker

Manual operation: See " Search Next Minimum " on page 224

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Next Minimum " on page 224

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Minimum " on page 224

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See " Search Next Minimum " on page 224

10.7.3.6 Band Power Marker

The following commands control the marker for band power measurements.

Using Markers

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF

Removes all band power markers in the specified window.

Suffix:

<n> Window

<m> irrelevant

Example: `CALC:MARK:FUNC:BPOW:AOFF`

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power marker are displayed.

(Note: relative power results are only availabe for delta markers,
see .`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 451

Suffix:

<n> Window

<m> Marker

Parameters:

<Mode>

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

*RST: POWer

Example: `CALC:MARK4:FUNC:BPOW:MODE DENS`
Configures marker 4 to show the measurement results in dBm/Hz.

Manual operation: See " Power Mode " on page 231

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Suffix:

<n> Window

<m> Marker

Return values:

<Power> Signal power over the marker bandwidth.

Example: Activate the band power marker:
`CALC:MARK:FUNC:BPOW:STAT ON`
Select the density mode for the result:
`CALC:MARK:FUNC:BPOW:MODE DENS`
Query the result:
`CALC:MARK:FUNC:BPOW:RES?`
Response:
`20dBm/Hz`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the marker position.

Suffix:

<n> Window

<m> Marker

Parameters:

<Span> Frequency. The maximum span depends on the marker position and R&S FSW model.

*RST: 5% of current span
Default unit: Hz

Example: `CALC:MARK:FUNC:BPOW:SPAN 2MHz`
Measures the band power over 2 MHz around the marker.

Manual operation: See " Span " on page 230

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns markers for band power measurements on and off.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:FUNC:BPOW:STAT ON`
Activates or turns marker 4 into a band power marker.

Manual operation: See " Band Power Measurement State " on page 230
See " Switching All Band Power Measurements Off " on page 231

Using Delta Markers

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power delta marker are displayed.

Suffix:

<n> Window

<m> Marker

Parameters:

<Mode>

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

RPOWer
This setting is only available for a delta band power marker.
The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]
For details see "Relative band power markers" on page 229.

*RST: POWer

Manual operation: See " Power Mode " on page 231

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Suffix:

<n> Window

<m> Marker

Return values:

<Power> Signal power over the delta marker bandwidth.

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the delta marker position.

Suffix:

<n> Window

<m> Marker

Parameters:

<Span> Frequency. The maximum span depends on the marker position and R&S FSW model.

*RST: 5% of current span
Default unit: Hz

Manual operation: See " Span " on page 230

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns delta markers for band power measurements on and off.

If neccessary, the command also turns on a reference marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See " Band Power Measurement State " on page 230
See " Switching All Band Power Measurements Off " on page 231

10.7.3.7 Marker Peak Lists

Useful commands for peak lists described elsewhere

- `CALCulate<n>:MARKer<m>:PEXCursion` on page 430
- `MMEMory:STORe<n>:PEAK` on page 456

Remote commands exclusive to peak lists

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] <State>

This command turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Example: `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`
Removes the peak labels from the diagram

Manual operation: See " Display Marker Numbers " on page 238

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt?

This command queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

Suffix:
<n> irrelevant

<m> irrelevant

Return values:
<NumberOfPeaks>

Example: `CALC:MARK:FUNC:FPE:COUN?`
Queries the number of peaks.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] <Peaks>

This command initiates a peak search.

Suffix:
<n> Window

<m> Marker

Parameters:
<Peaks> This parameter defines the number of peaks to find during the search.
Note that the actual number of peaks found during the search also depends on the peak excursion you have set with `CALCulate<n>:MARKer<m>:PEXCursion`.

Range: 1 to 200

Example: `CALC:MARK:PEXC 5`
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
`CALC:MARK:FUNC:FPE 10`
Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE <MaxNoPeaks>

This command defines the maximum number of peaks that the R&S FSW looks for during a peak search.

Suffix:
<n> Window

<m> Marker

Parameters:
<MaxNoPeaks> Maximum number of peaks to be determined.
Range: 1 to 500
*RST: 50

Example: `CALC:MARK:FUNC:FPE:LIST:SIZE 10`
The marker peak list will contain a maximum of 10 peaks.

Manual operation: See " Maximum Number of Peaks " on page 238

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>

This command selects the order in which the results of a peak search are returned.

Suffix:
<n> Window

<m> Marker

Parameters:
<SortMode>
X
Sorts the peaks according to increasing position on the x-axis.
Y
Sorts the peaks according to decreasing position on the y-axis.
*RST: X

Example: `CALC:MARK:FUNC:FPE:SORT Y`
Sets the sort mode to decreasing y values

Manual operation: See " Sort Mode " on page 238

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe <State>

This command turns a peak search on and off.

Suffix:
<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:FUNC:FPE:STAT ON`
Activates marker peak search

Manual operation: See " Peak List State " on page 238

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X?

This command queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y?

This command queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

MMEMory:STORe<n>:PEAK <FileName>

This command exports the marker peak list to a file.

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 limit reached" 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 base unit user manual.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path,name and extension of the target file.

Example: `MMEM:STOR:PEAK 'test.dat'`
Saves the current marker peak list in the file `test.dat`.

Manual operation: See " Export Peak List " on page 238

10.7.3.8 Measuring the Time Domain Power

All remote control commands specific to time domain power measurements are described here.

Configuring the Measurement

The following remote commands measure the time domain power.

Useful commands for time domain power measurements described elsewhere

- `CALCulate<n>:MARKer<m>:X:SLIMits:LEFT`
- `CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt`
- `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]`

Remote commands exclusive to time domain power measurements

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF

This command turns all time domain power evaluation modes off.

Suffix:

<n>	Window
<m>	Marker

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage <State>

This command switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with `[SENSe:]AVERage<n>:COUNt`.

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0 *RST: 0

Example:

`INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:SUMM:AVER ON`
Switches on the calculation of average.
`AVER:COUN 200`
Sets the measurement counter to 200.
`INIT;*WAI`
Starts a sweep and waits for the end.

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd <State>

This command switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0 *RST: 0

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] <State>

This command turns time domain power measurements on and off. This measurement is only available in zero span.

When you turn the measurement on, the R&S FSW activates a marker and positions it on the peak power level in the marker search range.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0 *RST: 0

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] <State>

This command turns the evaluation to determine the mean time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0 *RST: 0

Manual operation: See " Results " on page 234

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] <State>

This command turns the evaluation to determine the positive peak time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0 *RST: 0

Manual operation: See " Results " on page 234

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] <State>

This command turns the evaluation to determine the RMS time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0
	*RST: 0

Manual operation: See " Results " on page 234

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] <State>

This command turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON | OFF | 1 | 0
	*RST: 0

Performing a Time Domain Power Measurement

The following commands are required to perform a Time Domain Power measurement:

`INITiate<n>[:IMMediate]` on page 404

Retrieving Measurement Results

The following commands query the results for time domain measurements.

Measuring the Mean Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

This command queries the average mean time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 458.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<MeanPower>	Mean power of the signal during the measurement time.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

This command queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<MeanPower>	Mean power of the signal during the measurement time.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?

This command queries the mean time domain power.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window

<m> Marker

Return values:
<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

Manual operation: See " Results " on page 234

Measuring the Peak Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

This command queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 458.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:
<n> Window

<m> Marker

Return values:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

This command queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:
<n> Window

<m> Marker

Return values:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?

This command queries the positive peak time domain power.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<PeakPower>	Peak power of the signal during the measurement time.
Usage:	Query only
Manual operation:	See " Results " on page 234

Measuring the RMS Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult?

This command queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 458.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<RMSPower>	RMS power of the signal during the measurement time.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

This command queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<RMSPower>	RMS power of the signal during the measurement time.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?

This command queries the RMS of the time domain power.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<RMSPower>	RMS power of the signal during the measurement time.
Usage:	Query only
Manual operation:	See " Results " on page 234

Measuring the Standard Deviation

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

This command queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 458.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<StandardDeviation>	Standard deviation of the signal during the measurement time.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

This command queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<StandardDeviation>	Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult?

This command queries the standard deviation of the time domain power.

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 403.

Suffix:

<n>	Window
<m>	Marker

Return values:

<StandardDeviation>	Standard deviation of the signal during the measurement time.

Usage: Query only

10.7.4 Configuring an Analysis Interval and Line (MSRA mode only)

In MSRA operating mode, only the MSRA Master actually captures data; the MSRA client 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 client applications.

For the I/Q Analyzer client application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see Chapter 10.4.5, "Configuring Data Acquisition", on page 380. Be sure to select the correct measurement channel before executing these commands.

Useful commands for configuring the analysis interval described elsewhere:

- `TRACe:IQ:SRATe` on page 387
- `TRACe:IQ:BWIDth` on page 384
- `TRACe:IQ:RLENgth` on page 385
- `[SENSe:]SWEep:TIME` on page 407

Remote commands exclusive to MSRA client applications

The following commands are only available for MSRA client 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 client 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 client application remains in the window title bars.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See " Show Line " on page 240

CALCulate<n>:MSRA:ALINe[:VALue] <Position>

This command defines the position of the analysis line for all time-based windows in all MSRA client 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

Manual operation: See " Position " on page 239

CALCulate<n>:MSRA:WINDow<n>:IVAL

Returns the current analysis interval for applications in MSRA operating mode.

Suffix:

<n>	irrelevant
<n>	1..n Window

Return values:

<IntStart>	Analysis start = Capture offset time Default unit: s
<IntStop>	Analysis end = capture offset + capture time Default unit: s

INITiate<n>:REFResh

Refreshes the displays.

Suffix:

<n>	1..n

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for client 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 client application data. The offset must be a positive value, as the client application can only analyze data that is contained in the capture buffer. Range: 0 to <Record length> *RST: 0 Default unit: S
Manual operation:	See " Capture Offset " on page 190

10.7.5 Configuring an Analysis Interval and Line (MSRT mode only)

In MSRT operating mode, only the MSRT Master actually captures data; the MSRT client 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 MSRT client applications.

For the I/Q Analyzer client application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see Chapter 10.4.5, "Configuring Data Acquisition", on page 380. Be sure to select the correct 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 I/Q Analyzer.

Useful commands related to MSRT mode described elsewhere:

- `INITiate<n>:REFResh` on page 467
- `INITiate:SEQuencer:REFResh[:ALL]` on page 405

Remote commands exclusive to MSRT client applications

The following commands are only available for MSRT client application channels:

CALCulate<n>:RTMS:ALINe:SHOW

This command defines whether or not the analysis line is displayed in all time-based windows in all MSRT client applications and the MSRT 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 client application remains in the window title bars.

Suffix:

<n>	irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See " Show Line " on page 240

CALCulate<n>:RTMS:ALINe[:VALue] <Position>

This command defines the position of the analysis line for all time-based windows in all MSRT client applications and the MSRT Master.

Suffix:

<n>	irrelevant

Parameters:

<Position> Position of the analysis line in seconds. The position must lie within the measurement time (pretrigger + posttrigger) of the MSRT measurement.

Default unit: s

Manual operation: See " Position " on page 239

CALCulate<n>:RTMS:WINDow<n>:IVAL

Returns the current analysis interval for applications in MSRT operating mode.

Suffix:

<n>	irrelevant
<n>	1..n Window

Return values:

<IntStart>	Analysis start = Capture offset time Default unit: s
<IntStop>	Analysis end = capture offset + capture time Default unit: s

[SENSe:]RTMS:CAPTure:OFFSet <Offset>

This setting is only available for client applications in MSRT mode, not for the MSRT 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 client application data. The offset must be a positive value, as the client application can only analyze data that is contained in the capture buffer.

Range: - [pretrigger time] to min (posttrigger time; sweep time)
*RST: 0
Default unit: S

Manual operation: See " Capture Offset " on page 190

10.8 Retrieving Results

The following commands can be used to retrieve the results of the I/Q Analyzer measurement.

Storing large amounts of I/Q data

When storing large amounts of I/Q data to a file, consider the following tips to improve performance:

- If capturing and storing the I/Q data is the main goal of the measurement and evaluation functions are not required, use the basic I/Q data acquisition mode (see `TRACe:IQ[:STATe]` on page 273).
- Use a HiSlip or raw socket connection to export the data from the R&S FSW to a PC.
- Export the data in binary format rather than ASCII format (see Chapter B, "Formats for Returned Values: ASCII Format and Binary Format", on page 501).
- Use the "Compatible" or "IQPair" data mode (see Chapter C, "Reference: Format Description for I/Q Data Files", on page 502).
- If only an extract of the available data is relevant, use the `TRACe<n>[:DATA]:MEMory?` command to store only the required section of data.

10.8.1 Retrieving Captured I/Q Data

The raw captured I/Q data is output in the form of a list.

Outputting I/Q data via the Digital I/Q 40G Streaming Output option (R&S FSW-B517) is described in Chapter 10.4.1.12, "Digital I/Q 40G Streaming Output Commands", on page 355.

TRACe:IQ:DATA

This command initiates a measurement with the current settings and returns the captured data from I/Q measurements.

This command corresponds to:

`INIT:IMM;*WAI;:TRACe:IQ:DATA:MEMory?`

However, the `TRACe:IQ:DATA?` command is quicker in comparison.

Note: Using the command with the *RST values for the `TRACe:IQ:SET` command, the following minimum buffer sizes for the response data are recommended: ASCII format 10 kBytes, binary format: 2 kBytes

Return values:

<Results>	Measured voltage for I and Q component for each sample that has been captured during the measurement.

For analog baseband input in real baseband mode, the results for the irrelevant component are all 0.
For more information see Chapter 5.3.3, "I/Q Processing Modes", on page 51.
The number of samples depends on `TRACe:IQ:SET`. In ASCII format, the number of results is 2* the number of samples.
The data format depends on `TRACe:IQ:DATA:FORMat` on page 471.

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

TRACe:IQ:DATA:FORMat <Format>

This command selects the order of the I/Q data.

For details see Chapter C, "Reference: Format Description for I/Q Data Files", on page 502.

For traces captured using the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000), only "IQPair" format is available.

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)
This option is not available for input from SnP files (see the R&S FSW I/Q Analyzer and I/Q Input User Manual)

IQPair
One pair of I/Q values after the other is listed (I,Q,I,Q,I,Q...).
This option is the default for input from SnP files (see the R&S FSW I/Q Analyzer and I/Q Input User Manual)

*RST: IQBL

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

This command queries the I/Q data currently stored in the capture buffer 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.)

This command is not available for traces captured with the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

The command returns a comma-separated list of the measured values in floating point format (comma-separated values = CSV). The number of values returned is 2 * the number of complex samples.

The total number of complex samples is displayed in the channel bar in manual operation and can be calculated as:

<SampleRate> * <CaptureTime>

(See `TRACe:IQ:SET`, `TRACe:IQ:SRATe` on page 387 and `[SENSe:]SWEep:TIME` on page 407)

Query 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.
By default, the first half of the list contains the I values, the second half the Q values. The order can be configured using `TRACe:IQ:DATA:FORMat`.
The data format of the individual values depends on `FORMat[:DATA]` on page 474.

Default unit: V

Example:

`TRAC:IQ:STAT ON`
Enables acquisition of I/Q data
`TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,100,4096`
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 100
Number of Samples = 4096
`INIT;*WAI`
Starts measurement and wait for sync
`FORMat REAL,32`
Determines output format
To read the results:
`TRAC:IQ:DATA:MEM?`
Reads all 4096 I/Q data
`TRAC:IQ:DATA:MEM? 0,2048`
Reads 2048 I/Q data starting at the beginning of data acquisition
`TRAC:IQ:DATA:MEM? 2048,1024`
Reads 1024 I/Q data from half of the recorded data
`TRAC:IQ:DATA:MEM? 100,512`
Reads 512 I/Q data starting at the trigger point (<Pretrigger Samples> was 100)

Example:

// Perform a single I/Q capture.
`INIT;*WAI`
// Determine output format (binary float32)
`FORMat REAL,32`
// Read 1024 I/Q samples starting at sample 2048.
`TRAC:IQ:DATA:MEM? 2048,1024`

Usage:
Query only

10.8.2 Retrieving I/Q Trace Data

In addition to the raw captured I/Q data, the results from I/Q analysis as shown in the result displays can also be retrieved.

FORMat[:DATA] <Format>[, <BitLength>]

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
Floating-point numbers (according to IEEE 754) in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

<BitLength>

Length in bits for floating-point results

16
16-bit floating-point numbers.
Compared to `REAL,32` format, half as many numbers are returned.

32
32-bit floating-point numbers
For I/Q data, 8 bytes per sample are returned for this format setting.

64
64-bit floating-point numbers
Compared to `REAL,32` format, twice as many numbers are returned.

Example: `FORM REAL,32`

TRACe<n>[:DATA]? <ResultType>

This command queries current trace data and measurement results.

If you use it as a setting command, it transfers trace data from an external source to the R&S FSW.

The data format depends on `FORMat[:DATA]` on page 474.

Suffix:
<n> Window

Query parameters:
<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the trace data for the corresponding trace.
For details see Table 10-5.

LIST
Returns the results of the peak list evaluation for Spurious Emission and Spectrum Emission Mask measurements.
For SEM measurements, one peak per range is returned.
For details see Table 10-6.

SPURious
Returns the peak list of Spurious Emission measurements.

SPECtrogram | SGRam
Returns the results of the spectrogram result display.
For details see Table 10-7.

Return values:
<TraceData> Returns the sweep point values as shown in the result display.
If you are measuring with the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.)
For the Magnitude and Spectrum result displays in the I/Q Analyzer application, this command returns the magnitude of the I and Q values (I+jQ) for each sweep point (=1001 values).
For the Real/Imag (I/Q) result display, the command returns first the real parts for each trace point, then the imaginary parts (I_1,...,I_{1001}, Q_1,...,Q_{1001}).
For the I/Q Vector result display, the I and Q values for each trace point are returned (1001 pairs of I and Q values).
For analog baseband input in real baseband processing mode (I or Q only), only the positive spectrum is returned. The values for the missing component in the Real/Imag (I/Q) and the I/Q vector result displays are all 0.

Example:
```
TRAC? TRACE3
```
Queries the data of trace 3.

Manual operation:
See " Magnitude " on page 17
See " Spectrum " on page 18
See " I/Q-Vector " on page 18
See " Real/Imag (I/Q) " on page 19

Table 10-5: Return values for TRACE1 to TRACE6 parameter

The trace data consists of a list of power levels that have been measured. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the unit you have currently set. If you are measuring with the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.)

Table 10-6: Return values for LIST parameter

For each peak, the command returns 11 values in the following order: <No>,<StartFreq>,<StopFreq>,<RBW>,<PeakFreq>,<PowerAbs>,<PowerRel>,<PowerDelta>,<Limit-Check>,<Unused1>,<Unused2> ● <No>: range number ● <StartFreq>,<StopFreq>: start and stop frequency of the range ● <RBW>: resolution bandwidth ● <PeakFreq>: frequency of the peak in a range ● <PowerAbs>: absolute power of the peak in dBm ● <PowerRel>: power of the peak in relation to the channel power in dBc ● <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check ● <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) ● <Unused1>,<Unused2>: reserved (0.0)

Table 10-7: Return values for SPECtrogram parameter

For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRAC:DATA? TRACE1`.

Suffix:
<n> — Window

Query parameters:
<Trace> — TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

<OffsSwPoint> — The offset in sweep points related to the start of the measurement at which data retrieval is to start.

<NoOfSwPoints> — Number of sweep points to be retrieved from the trace.

Return values:
<SweepPointValues>

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

TRACe<n>[:DATA]:X? <TraceNumber>

This command queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

This is especially useful for traces with non-equidistant x-values.

Suffix:

<n> Window

Query parameters:

<TraceNumber> Trace number.

TRACE1 | ... | TRACE6

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

10.8.3 Exporting Traces and Data

The following commands are required to export traces and spectrograms.

FORMat:DEXPort:CSEParator <Separator>

This command selects the column separator for exported trace data.

The selected value is not affected by a preset. The command therefore has no reset value.

Parameters:

<Separator>

COMMa
Selects a comma as a separator.

SEMicolon
Selects a semicolon as a separator.

TAB
Selects a tabulator as a separator.

*RST: n/a

Example: //Select column separator
`FORM:DEXP:CSEP TAB`

Manual operation: See "Column Separator" on page 115

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:
<Separator> POINt | COMMa

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.

Manual operation: See " Decimal Separator " on page 115
See " Export Peak List " on page 238

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program in which the data file was created or will be evaluated, a comma-separated list (CSV) or a plain data format (DAT) file may be required.

Parameters:
<FileFormat> CSV | DAT

*RST: DAT

Example: `FORM:DEXP:FORM CSV`

Manual operation: See " File Type " on page 115

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Manual operation: See " Include Instrument & Measurement Settings " on page 209

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 479).

Parameters:
<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Manual operation: See " Export all Traces and all Table Results " on page 209

MMEMory:STORe<n>:SPECtrogram <FileName>

This command exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

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 limit reached" 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 base unit user manual.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SGR 'Spectrogram'`
Copies the spectrogram data to a file.

Manual operation: See " Export Spectrogram to ASCII File " on page 211

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

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 limit reached" 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 base unit user manual.

Suffix:
<n> Window

Parameters:
<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See " Export Trace to ASCII File " on page 114

10.8.4 Retrieving Marker Results

The following commands are required to retrieve the results of markers.

Useful commands for retrieving marker results described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 426
- `CALCulate<n>:MARKer<m>:X` on page 428
- `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X?` on page 456
- `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y?` on page 456

Remote commands exclusive to retrieving marker results:

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?

Queries the result at the position of the specified delta marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.
Default unit: DBM

Usage: Query only

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Default unit: DBM

Usage: Query only

Manual operation: See " Marker Table " on page 19
See " Marker Peak List " on page 20

MMEMory:STORe<n>:LIST <FileName>

This command exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

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 limit reached" 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 base unit user manual.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:LIST 'test'`
Stores the current list evaluation results in the `test.dat` file.

10.9 Importing and Exporting I/Q Data and Results

Alternatively to capturing I/Q data by the I/Q Analyzer itself, stored I/Q data from previous measurements or other applications can be imported to the I/Q Analyzer. Furthermore, I/Q data processed in the I/Q Analyzer can be stored to a file for further evaluation in other applications.

I/Q data can only be exported in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

For details see Chapter 5.13, "I/Q Data Import and Export", on page 100.

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

This command restores I/Q data from a file.

The file extension is *.iq.tar.

Setting parameters:
<FileName> string
String containing the path and name of the source file.

Example: `MMEM:LOAD:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Loads IQ data from the specified file.

Usage: Setting only

Manual operation: See " I/Q Import " on page 113

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.

Manual operation: See " I/Q Export " on page 115

MMEMory:STORe<n>:IQ:FORMat <Format>,<DataFormat>

This command sets or queries the format of the I/Q data to be stored.

Suffix:
<n> irrelevant

Parameters:
<Format>
FLOat32
32-bit floating point format.
INT32
32-bit integer format.
*RST: FLOat32

<DataFormat>
COMPlex
Exports complex data.
REAL
Exports real data.
*RST: COMPlex

Example:
`MMEM:STOR:IQ:FORM INT32,REAL`

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.

Suffix:
<n> 1..n

Parameters:
<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.

Manual operation: See " I/Q Export " on page 115

10.10 Querying the Status Registers

The R&S FSW-I/Q Analyzer uses the standard status registers of the R&S FSW.

The following status registers of the R&S FSW status reporting system are used by the Digital Baseband Interface (R&S FSW-B17). The commands required to query the status registers specific to the Digital Baseband Interface (R&S FSW-B17) are described with the registers.

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.

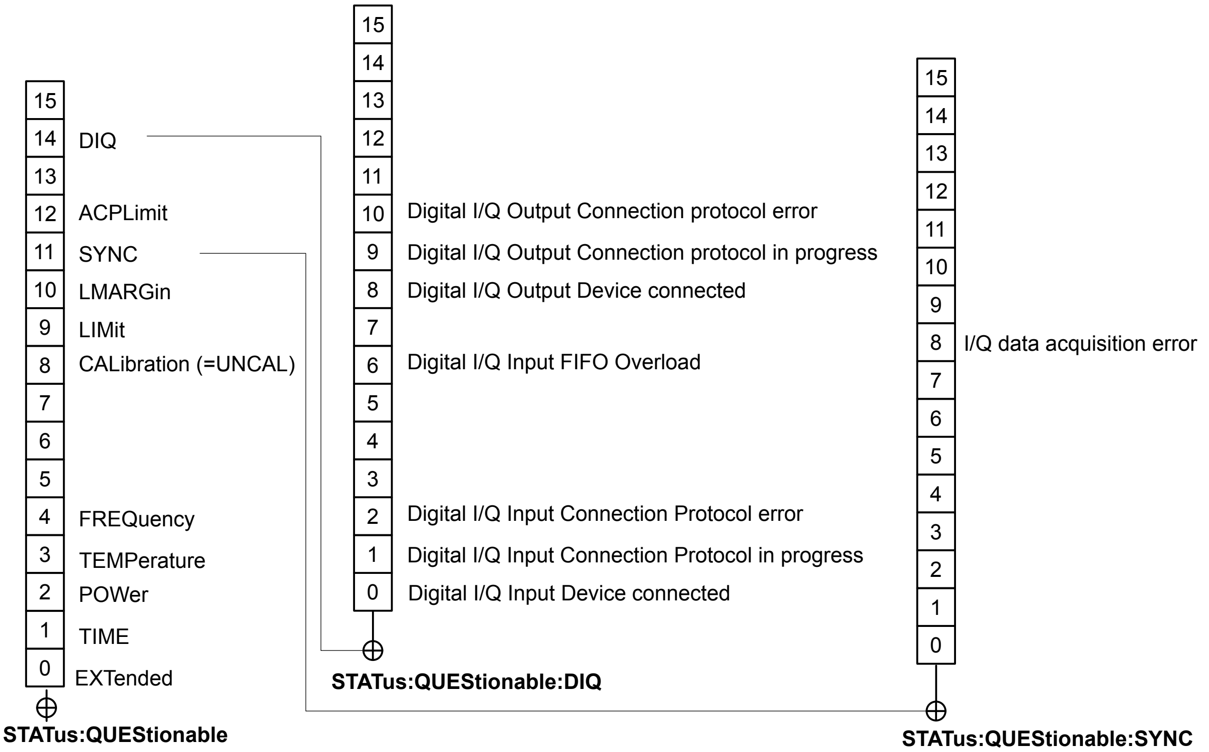


Figure 10-2: Status registers used by the Digital Baseband Interface (R&S FSW-B17)

10.10.1 STATus:QUEStionable:SYNC Register

This register contains information about the state of the I/Q data acquisition.

This register is used by the optional Digital Baseband Interface.

The status of the `STATus:QUEStionable:SYNC` register is indicated in bit 11 of the `STATus:QUEStionable` register.

You can read out the state of the register with `STATus:QUEStionable:SYNC:CONDition?` on page 485 and `STATus:QUEStionable:SYNC[:EVENt]?` on page 486.

Bit No.	Meaning
0-7	not used
8	**I/Q data acquisition error** This bit is set if an error occurs during I/Q data acquisition because the input sample rates or number of samples between the signal source and the R&S FSW do not match. See also Chapter 9.1, "Error Messages", on page 257
9-14	not used
15	This bit is always set to 0.

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.

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

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.

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.

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.

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.

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.

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.

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.

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

10.10.2 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 488 and STATus:QUEStionable:DIQ[:EVENt]? on page 489.

For more information on the optional Digital Baseband Interface see Chapter 5.2, "Processing Data from the Digital Baseband Interface ", on page 42.

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.
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.

Bit No.	Meaning
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

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

10.11 Programming Examples

The following programming examples demonstrate how to capture I/Q data and perform I/Q data analysis using the I/Q Analyzer in a remote environment.

Optional interfaces for I/Q data input are also demonstrated in the I/Q Analyzer.

10.11.1 I/Q Analysis with Graphical Evaluation

This example demonstrates how to configure and perform a basic I/Q data acquisition and analyze the data using the I/Q Analyzer in a remote environment.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument
INST:CRE IQ,'IQANALYZER'
//Creates a new measurement channel named 'IQANALYZER'.
INIT:CONT OFF
//Switches to single sweep mode

//--------------Configuring Data Acquisition-------------
TRAC:IQ:SRAT 32MHZ
//Defines the sample rate.
TRAC:IQ:RLEN 1000
//Sets the record length (number of samples to capture) to 1000 samples.
TRAC:IQ:BWID?
//Queries the bandwidth of the resampling filter, determined by the sample rate
FORM:DATA REAL,32
//Formats the data as 32-byte real values.
TRAC:IQ:DATA:FORM IQBL
//Lists all I values first, then all Q values in the trace results.

//--------------Configuring the Trace--------------------
TRAC:IQ:AVER ON
//Defines averaging for the I/Q trace.
TRAC:IQ:AVER:COUN 10
//Defines an average over 10 sweeps.

DISP:TRAC1:MODE WRIT
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Changes the trace modes.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results---------------------------
```

```
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
//Returns the magnitude for each sweep point

LAY:REPL:WIND '1',RIMAG
//Changes the result display to Real/Imag (I/Q)

CALC:MARK:SEAR MAGN
//Configures searches to search both I and Q branches.
CALC:MARK:Y?
//Queries the result of the peak search on both branches.

TRAC:IQ:DATA:MEM? 0,500
//Returns the first 500 samples of the stored I/Q data for the measurement.
//For each sample, first the I-value, then the Q-value is listed.

TRAC:IQ:DATA:MEM? 500,500
//Returns the second half of the 1000 captured sample values.
```

10.11.2 Basic I/Q Analysis with Improved Performance

This example demonstrates how to configure and perform a basic I/Q data acquisition and analyze the data using the I/Q Analyzer in a remote environment.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument

INIT:CONT OFF
//Switches to single sweep mode
TRACE:IQ ON
//Switches the operating mode of the current measurement channel to I/Q Analyzer
//while retaining the relevant parameters from the Spectrum mode.

//--------------Configuring Data Acquisition-------------
TRACE:IQ:SET NORM,0,32000000,IQP,POS,0,1000
//Configures the sample rate as 32 MHz, IQP trigger, positive trigger slope,
//no pretrigger samples, 1000 samples to capture
FORM REAL,32
//The data is formatted as real values.

//--------------Configuring I/Q Gating--------------------------
TRAC:IQ:EGAT ON
//Turns on gated measurement.
TRAC:IQ:EGAT:TYPE LEV
//Select the level gate type.
```

```
TRAC:IQ:EGAT:LENG 20
//Sets the gate length to 20 samples.
TRAC:IQ:EGAT:GAP 20
//Sets the interval between gate periods to 20 samples.
TRAC:IQ:EGAT:NOF 2
//Sets the number of gate periods after the trigger signal to 2.
TRIG:SOUR IQP
//Defines the magnitude of the sampled I/Q data to be used as a trigger.
TRIG:LEV:IQP -30dbm
//Sets the trigger level.

//---------------Performing the Measurement and Retrieving Results--------------
TRAC:IQ:DATA?; *WAI;
//Performs a measurement and returns the RF input voltage at each sample point
//(first 1000 I-values, then 1000 Q-values).

TRAC:IQ:DATA:MEM? 0,500
//Returns the first 500 samples of the stored trace data for the measurement.
//For each sample, first the I-value, then the Q-value is listed.

TRAC:IQ:DATA:MEM? 500,500
//Returns the second half of the 1000 captured sample values.
```

10.11.3 Data Acquisition via the Optional Digital Baseband Interface

This example demonstrates how to capture I/Q data via the optional Digital Baseband Interface using the I/Q Analyzer in a remote environment.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument
INST:CRE IQ,'IQANALYZER'
//Creates a new measurement channel named 'IQANALYZER'.
INIT:CONT OFF
//Switches to single sweep mode

//--------------Activating the Digital Baseband Interface-------------
INP:SEL DIQ
//Selects the digital baseband interface as the input source
INP:DIQ:CDEV?
//Queries the detected information for the connected instrument
INP:DIQ:SRAT:AUTO ON
//Sets the input sample rate to the rate of the connected instrument automatically
INP:DIQ:RANG:UPP 2 V
//Sets the level for value "1" to 2 V.
INP:DIQ:RANG:COUP ON
//Adjusts the reference level to the full scale level automatically (after every change)
```

```
//--------------Configuring Data Acquisition-------------
TRIG:SOUR BBP
TRIG:SEQ:LEV:BBP -20
//Trigger on baseband power of -20 dBm.
TRAC:IQ:SRAT 32MHZ
//Defines the sample rate.
TRAC:IQ:RLEN 1000
//Sets the record length (number of samples to capture) to 1000 samples.
TRAC:IQ:BWID?
//Queries the bandwidth of the resampling filter, determined by the sample rate.
FORM:DATA REAL,32
//Formats the data as 32-byte real values.
TRAC:IQ:DATA:FORM IQBL
//Lists all I values first, then all Q values in the trace results.

//--------------Configuring the Trace--------------------
TRAC:IQ:AVER ON
//Defines averaging for the I/Q trace.
TRAC:IQ:AVER:COUN 10
//Defines an average over 10 sweeps.

DISP:TRAC1:MODE WRIT
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Changes the trace modes.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results----------------------------

TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
//Returns the magnitude for each sweep point
```

10.11.4 Converting an RF Signal to a Digital I/Q Signal via the Optional Digital Baseband Interface

In the following example, an RF signal is measured at the RF input and then output as digital I/Q data via the Digital Baseband Interface, which requires an additional hardware option.

The following signal is to be measured:

Table 10-8: Signal parameters for programming example

carrier frequency	5 GHz
peak power	-10 dBm
bandwidth	22 MHz

Note: For a bandwidth of 22 MHz, a sample rate of 27.5 MHz is required.

Table 10-9: Required I/Q data acquisition parameters for TRAC:IQ:SET command

Filter type	Normal
Sample Rate	27.5 MHz
Trigger Source	External
Trigger Slope	Positive
Pretrigger Samples	0
Number of Samples	1000

```
//----------Preparing the instrument------------------------
*RST
//Sets the instrument to a defined default status

//------------Configuring the measurement-----------------------------

FREQ:CENT 5GHz
//Sets the center frequency to 5 GHz
DISP:TRAC1:Y:RLEV -10dBm
//Sets the reference level to -10 dBm
TRACE:IQ:STATE ON
//Enables acquisition of I/Q data
TRAC:IQ:SET NORM,50MHz,27.5MHz,EXT,POS,0,1000
//Configures the measurement. Only the sample rate and trigger source settings
//are relevant to the digital baseband interface. The other parameters can be set
//to their default values as listed above.
OUTPUT:DIQ ON
//Enables digital I/Q data output interface

//------------Performing the measurement----------------------------

INIT:IMM
//    Starts data acquisition and transmission to the output connector
```

10.11.5 Output via the Optional Digital Baseband Interface

This example demonstrates how to output I/Q data to a connected instrument via the optional Digital Baseband Interface using the I/Q Analyzer in a remote environment. The data to output is taken from the measurement described in Chapter 10.11.1, "I/Q Analysis with Graphical Evaluation", on page 490.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument
INST:CRE IQ,'IQANALYZER'
//Creates a new measurement channel named 'IQANALYZER'.
INIT:CONT OFF
//Switches to single sweep mode

//--------------Configuring Data Acquisition-------------
TRAC:IQ:SRAT 32MHZ
//Defines the sample rate.
TRAC:IQ:RLEN 1000
//Sets the record length (number of samples to capture) to 1000 samples.
TRAC:IQ:BWID?
//Queries the bandwidth of the resampling filter, determined by the sample rate.
FORM:DATA REAL,32
//Formats the data as 32-byte real values.
TRAC:IQ:DATA:FORM IQBL
//Lists all I values first, then all Q values in the trace results.

//--------------Configuring the Traces--------------------
TRAC:IQ:AVER ON
//Defines averaging for the I/Q trace.
TRAC:IQ:AVER:COUN 10
//Defines an average over 10 sweeps.

DISP:TRAC1:MODE WRIT
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Changes the trace modes.

//--------------Configuring output--------------------
OUTP:DIQ ON
OUTP:DIQ:CDEV?
//Activates the digital baseband interface for output and queries the
//detected information of the connected instrument

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
//The results are simultaneously sent to the output connector.
```

10.11.6 Data Acquisition via the Optional Analog Baseband Interface

This example demonstrates how to capture I/Q data via the optional Analog Baseband Interface using the I/Q Analyzer in a remote environment. As an input signal, a differential probe is assumed to be connected to the R&S FSW.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument
INST:CRE IQ,'IQANALYZER'
//Creates a new measurement channel named 'IQANALYZER'.
INIT:CONT OFF
//Switches to single sweep mode

//--------------Activating the Analog Baseband Interface-------------
INP:SEL AIQ
//Selects the analog baseband interface as the input source
INP:IQ:TYPE I
//Only the signal on I input is analyzed (I only mode)
INP:IQ:BAL ON
//Differential input signal
INP:IQ:FULL:AUTO OFF
INP:IQ:FULL:LEV 2V
//Peak voltage at connector is set manually to the maximum of 2V
FREQ:CENT 1MHz
//Shift center frequency to 1 MHz (Low IF I)


//--------------Configuring Data Acquisition-------------
TRIG:SOUR BBP
TRIG:SEQ:LEV:BBP -20
//Trigger on baseband power of -20 dBm.
TRAC:IQ:SRAT 32MHZ
//Defines the sample rate.
TRAC:IQ:RLEN 1000
//Sets the record length (number of samples to capture) to 1000 samples.
TRAC:IQ:BWID?
//Queries the bandwidth of the resampling filter, determined by the sample rate.

//--------------Adding result displays--------------------
LAY:ADD? '1',RIGH,FREQ
//Spectrum display in window 2, to the right of Magnitude results
LAY:ADD? '1',BEL,RIMAG
//Real I display in window 3, below Magnitude results

//--------------Configuring the Trace--------------------
TRAC:IQ:AVER ON
//Defines averaging for the magnitude trace of I component.
TRAC:IQ:AVER:COUN 10
//Defines an average over 10 sweeps.

DISP:TRAC1:MODE WRIT
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Changes the trace modes.
```

```
//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results----------------------------
TRAC:IQ:DATA:FORM IQBL
TRAC:IQ:DATA?
//Retrieves the captured I samples (1000 values), followed by the captured
//Q samples (1000 values); Q samples are all 0 because of I/Q mode: Low IF
TRAC2:DATA? TRACE1
//Returns the power levels for each sample (y-values from Spectrum display)
TRAC2:DATA:X? TRACE1
//Returns the frequency for each sample (x-values from Spectrum display)
```

10.12 Deprecated Commands

The following commands are provided for compatibility to other signal analyzers only. For new remote control programs use the specified alternative commands.

CALCulate<n>:FORMat <Evaluation>

This command selects the evaluation method of the measured data that is to be displayed in the specified window.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see Chapter 10.5.2, "Working with Windows in the Display", on page 394).

Suffix:
<n> 1..n

Parameters:
<Evaluation> Type of evaluation you want to display.
See the table below for available parameter values.

Example:
`INST:SEL IQ`
Activates I/Q Analyzer.
`CALC:FORM FREQ`
Selects the display of the I/Q data spectrum.

Table 10-10: <Evaluation> parameter values for the I/Q Analyzer application

Parameter value	Window type
FREQ	Spectrum
MAGN	Magnitude
MTABle	Marker table
PEAKlist	Marker peak list

Parameter value	Window type
RIMAG	Real/Imag (I/Q)
VECT	I/Q Vector

Annex

A Description of the LVDS Connector

The R&S Digital Baseband Interface is a proprietary LVDS serial interface. For adaptation to industrial standard interfaces use the R&S EX-IQ-BOX (see the "R&S EX-IQ-BOX - External Signal Interface Module Manual").

The LVDS Connector is a 26 pin female 0.050" Mini D Ribbon connector (e.g.: 3M 102XX-1210VE series).

For the connection, use the cables provided with the R&S EX-IQ-BOX or an R&S®SMU-Z6 cable (order no.: 1415.0201.02).

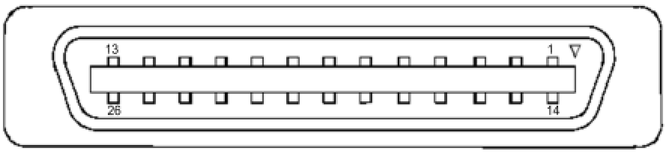


Figure A-1: LVDS connector on the R&S FSW rear panel, connector front view

The Table A-1 shows the multiplexed data at the output of the LVDS transmitter.

Table A-1: LVDS connector pin description

Pin	Signal	Level	Description
1			reserved for future use
2	GND	0V	Ground, shield of pair 1-14, for future use
3	SDAT0_P	LVDS	Serial data channel 0 positive pin; carries the bits VALID, ENABLE, MARKER_1 (GP4), Reserve_1 (GP2), RE_0, RE_1
4	SDAT1_P	LVDS	Serial data channel 1 positive pin; carries the bits RE_2, RE_3, RE_4, RE_5, RE_6, RE_7
5	SDAT2_P	LVDS	Serial data channel 2 positive pin; carries the bits RE_8, RE_9, RE_10, RE_11, RE_12, RE_13
6	CLK1_P	LVDS	Clock 1 positive pin; clock for transmission on LVDS link
7	S_CLK	TTL	(for future use)
8	+5VD	+5.0V	Supply voltage (for future use)
9	SDAT3_P	LVDS	Serial data channel 3 positive pin; carries the bits RE_14, RE_15, RE_16, RE_17, RE_18, RE_19
10	SDAT4_P	LVDS	Serial data channel 4 positive pin; carries the bits TRIGGER_1 (GP0), TRIGGER_2 (GP1), MARKER_2 (GP5), Reserve_2 (GP3), IM_0, IM_1
11	SDAT5_P	LVDS	Serial data channel 5 positive pin; carries the bits IM_2, IM_3, IM_4, IM_5, IM_6, IM_7

Pin	Signal	Level	Description
12	SDAT6_P	LVDS	Serial data channel 6 positive pin; carries the bits IM_8, IM_9, IM_10, IM_11, IM_12, IM_13
13	SDAT7_P	LVDS	Serial data channel 7 positive pin; carries the bits IM_14, IM_15, IM_16, IM_17, IM_18, IM_19
14			reserved for future use
15	SDAT0_M	LVDS	Serial data channel 0 negative pin
16	SDAT1_M	LVDS	Serial data channel 1 negative pin
17	SDAT2_M	LVDS	Serial data channel 2 negative pin
18	CLK1_M	LVDS	Clock 1 negative pin
19	DGND	0V	Power ground; ground return for 5V supply voltage (for future use)
20	S_DATA	TTL	(for future use)
21	SDAT3_M	LVDS	Serial data channel 3 negative pin
22	SDAT4_M	LVDS	Serial data channel 4 negative pin
23	SDAT5_M	LVDS	Serial data channel 5 negative pin
24	SDAT6_M	LVDS	Serial data channel 6 negative pin
25	SDAT7_M	LVDS	Serial data channel 7 negative pin
26	GND	0V	LVDS ground; shielding of transmission lines and shielding of cable

B Formats for Returned Values: ASCII Format and Binary Format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]` on page 474. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,32):
  The data is stored as binary data (Definite Length Block Data according to IEEE 488.2), each measurement value being formatted in 32-Bit IEEE 754 Floating-Point-Format.
  The schema of the result string is as follows:
  `#41024<value1><value2>…<value n>` with

#4	Number of digits (= 4 in the example) of the following number of data bytes
1024	Number of following data bytes (= 1024 in the example)
<Value>	4-byte floating point value

Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

C Reference: Format Description for I/Q Data Files

This section describes how I/Q data is transferred to the memory during remote control (see `TRACe:IQ:DATA:FORMat` command).

For details on the format of the individual values, see Chapter B, "Formats for Returned Values: ASCII Format and Binary Format", on page 501.

For details on the format of I/Q export files (using the "I/Q Export" function), see the R&S FSW User Manual.

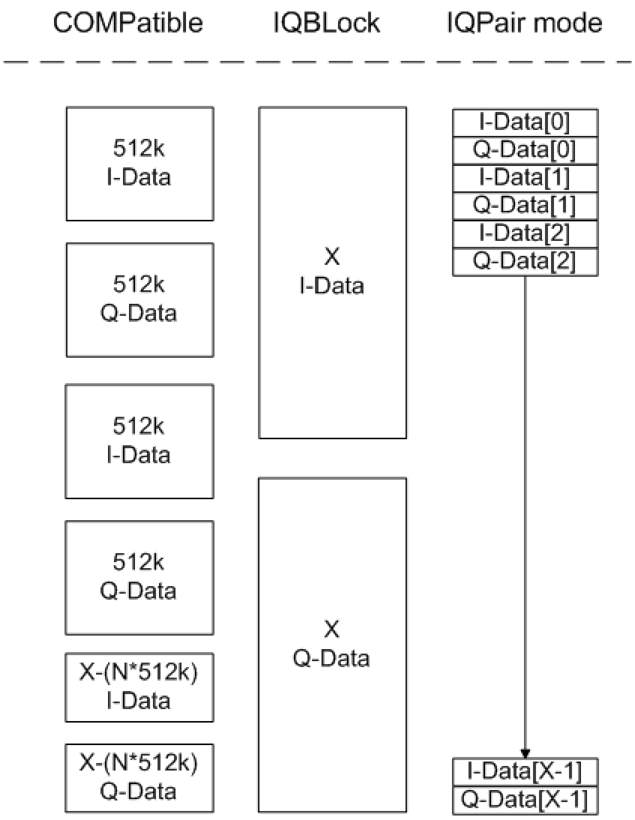


Figure C-1: I/Q data formats

Note: 512k corresponds to 524288 samples

For maximum performance, the formats "Compatible" or "IQPair" should be used. Furthermore, for large amounts of data, the data should be in binary format to improve performance.

In binary format, the number of I- and Q-data can be calculated as follows:

$$\#\,of\ I-Data \;=\; \#\,of\ Q-Data \;=\; \frac{\#\,of\ DataBytes}{8}$$

For the format "QBLock", the offset of Q-data in the output buffer can be calculated as follows:

$$Q - Data - Offset = \frac{(\# \, of \;\; DataBytes)}{2} + LengthIndicatorDigits$$

with "LengthIndicatorDigits" being the number of digits of the length indicator including the #. In the example above (#41024…), this results in a value of 6 for "LengthIndicatorDigits" and the offset for the Q-data results in 512 + 6 = 518.

D Reference: Supported I/Q File Formats

Various file types are supported for I/Q data import and export. The most important characteristics for each format are described here.

See " I/Q Import " on page 113.

For best performance and to ensure comprehensive meta data is available, use the iq.tar format. This is a widely used file format for Rohde & Schwarz products.

Table D-1: Characteristics of data file formats

File format	File extension	Comment
IQ.tar	`.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 a preview of the I/Q data in a web browser, and inclusion of user-specific data. Several streams of data can be provided in one file.
IQW	`.iqw`	(Import only) A binary file format containing one channel of complex IQ data. The file contains float32 data in a binary format (interleaved IQIQ or in blocks, IIIQQQ). The file does not contain any additional information as a header. This format requires setting the sample rate and measurement time or record length manually.
CSV	`.csv`	(Import only) A file containing I/Q data as comma-separated values (CSV). Additional metadata can be included.
Simple CSV	`.csv`	Simple CSV contains I/Q data only, without any header or meta data. That is, the file contains only (I,Q) data pairs, separated by commas. Several streams of data can be provided in one file. This format requires setting the sample rate and measurement time or record length manually.
Matlab® v4	`.mat`	(Import only) A file containing I/Q data in Matlab® file format v4. Channel-related information is stored in matlab variables with names starting with '`ChX_`'. '`X`' represents the number of the channel with a lower bound of 1, e.g. the variable `Ch1_ChannelName` contains the name of the first channel. The corresponding data is contained in `ChX_Data`. Optional user data can be saved to variables named `UserDataX`, where '`X`' starts at 0. The variable `UserData_Count` contains the number of `UserData` variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces. Variables can be written to the `*.mat` files in arbitrary order. **Limitations**: In general, the file format is limited to a maximum of 2 GB. A maximum of 100000000 values can be stored in a single variable, e.g. 50000000 complex data samples.
Matlab® v7.3	`.mat`	(Import only) A file containing I/Q data in Matlab® file format v7.3.

File format	File extension	Comment
Simple Matlab®	`.mat`	(Import only) Simple Matlab® format contains I/Q data only, without any meta data. That is, the file contains only variables (double, double) for the corresponding channel data. This format requires setting the sample rate and measurement time or record length manually.
AMMOS intermediate frequency data format	`.aid`	(Import only) Format used to transmit real or complex baseband signals. The IF signal is sent along with information that characterizes the datastream and datastream source. All datastreams have a frame-based structure, consisting of a global frame header coupled with a data-type specific frame body (i.e. the frame payload).
wv	`.wv`	(Import only) Proprietary file format used by Rohde & Schwarz signal generators to store waveform data. A waveform file contains a header and raw I/Q samples.

D.1 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 include user-specific data and to preview the I/Q data in a web browser (not supported by all web browsers).

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.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

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 (not supported by all web browsers).
  A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

D.1.1 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>
```

D.1.1.1 Minimum Data Elements

The following information is always provided by an `.iq.tar` file export from the R&S FSW. If not specified otherwise, it must be available in all `.iq.tar` files used to import data to the R&S FSW.

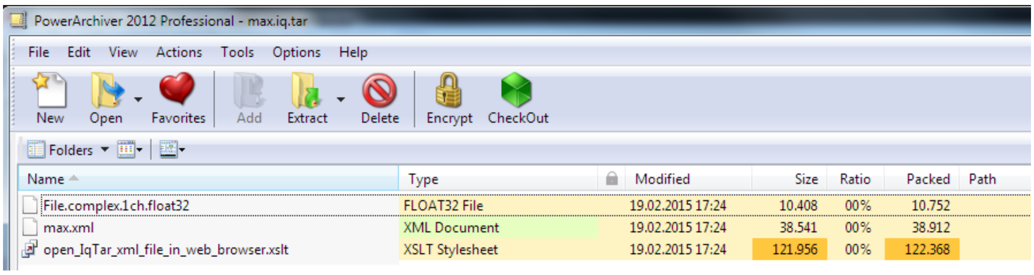
Element	Possible Values	Description
RS_IQ_TAR_FileFormat	-	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition.
Name	string	Optional: describes the device or application that created the file.
Comment	string	Optional: contains text that further describes the contents of the file.
DateTime	yyyy-mm-ddThh:mm:ss	Contains the date and time of the creation of the file. Its type is `xs:dateTime` (see `RsIqTar.xsd`).
Ch<n>_Samples	integer	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.
Ch<n>_Clock[Hz]	double	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".

Element	Possible Values	Description
Format	complex | real | polar	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	int8 | int16 | int32 | float32 | float64	Specifies the binary format used for samples in the I/Q data binary file (see `DataFilename` element and Chapter D.1.2, "I/Q Data Binary File", on page 511). 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	double	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	integer	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 D.1.2, "I/Q Data Binary File", on page 511). If the `NumberOfChannels` element is not defined, one channel is assumed.

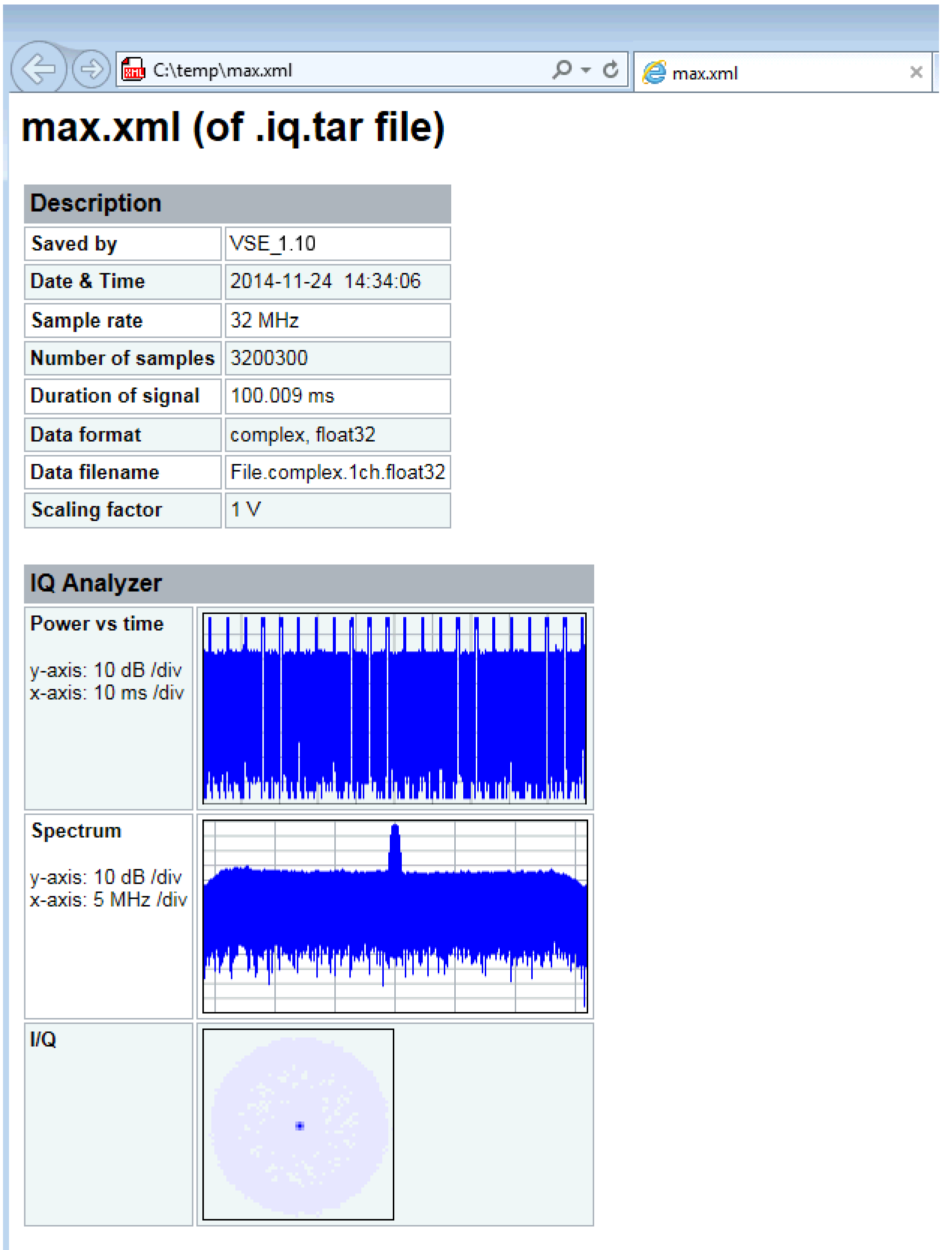
Element	Possible Values	Description
DataFilename	It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> ● <xyz> = a valid Windows file name ● <Format> = complex, polar or real (see `Format` element) ● <Channels> = Number of channels (see `NumberOfChannels` element) ● <Type> = float32, float64, int8, int16, int32 or int64 (see `DataType` element)	Contains the filename of the I/Q data binary file that is part of the `.iq.tar` file. Examples: ● xyz.complex.1ch.float32 ● xyz.polar.1ch.float64 ● xyz.real.1ch.int16 ● xyz.complex.16ch.int8
UserData	xml	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	xml	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.

D.1.1.2 Example

The following example demonstrates the XML description inside the `.iq.tar` file. Note that this preview is not supported by all web browsers.



Open the xml file in a web browser, e.g. Microsoft Internet Explorer. If the stylesheet `open_IqTar_xml_file_in_web_browser.xslt` is in the same directory, the web browser displays the xml file in a readable format.



Description	
Saved by	VSE_1.10
Date & Time	2014-11-24 14:34:06
Sample rate	32 MHz
Number of samples	3200300
Duration of signal	100.009 ms
Data format	complex, float32
Data filename	File.complex.1ch.float32
Scaling factor	1 V

IQ Analyzer	
Power vs time y-axis: 10 dB /div x-axis: 10 ms /div	
Spectrum y-axis: 10 dB /div x-axis: 5 MHz /div	
I/Q	

```
<?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=
"http://www.rohde-schwarz.com/file/RsIqTar.xsd" xmlns:xsi=
"http://www.w3.org/2001/XMLSchema-instance">
  <Name>VSE_1.10a 29 Beta</Name>
  <Comment></Comment>
  <DateTime>2015-02-19T15:24:58</DateTime>
  <Samples>1301</Samples>
  <Clock unit="Hz">32000000</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
```

```
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
  <DataFilename>File.complex.1ch.float32</DataFilename>

<UserData>
    <RohdeSchwarz>
      <DataImportExport_MandatoryData>
        <ChannelNames>
          <ChannelName>IQ Analyzer</ChannelName>
        </ChannelNames>
        <CenterFrequency unit="Hz">0</CenterFrequency>
      </DataImportExport_MandatoryData>
      <DataImportExport_OptionalData>
        <Key name="Ch1_NumberOfPostSamples">150</Key>
        <Key name="Ch1_NumberOfPreSamples">150</Key>
      </DataImportExport_OptionalData>
    </RohdeSchwarz>
  </UserData>

</RS_IQ_TAR_FileFormat>
```

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

D.1.2 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)
```

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>
```

D.2 CSV File Format

CSV files contain I/Q data as comma-separated values. Additional metadata can be saved.

D.2.1 Mandatory Data Elements

Parameter Name	Possible Values
Name	String
Comment	String
DateTime	Year-Month-DayTHour:Min:Sec
Format	complex
DataType	float32
NumberOfChannels	Integer
Ch<n>_ChannelName	String
Ch<n>_Samples	Integer
Ch<n>_Clock[Hz]	double
Ch<n>_CenterFrequency[Hz]	Double
IQ Data Header	<Channel Name>_I; <Channel Name>_Q (IQ data value)
-----	Double ; Double (IQ data I/Q pairs)

D.2.2 Optional Data Elements

Parameter name	Possible Values
Ch<n>_AttenuElecState	ON | OFF
Ch<n>_AttenuElecValue[dB]	Integer
Ch<n>_AttenuMech[dB]	Integer
Ch<n>_CalibrationState	ON | OFF
Ch<n>_DeviceHwInfo	String
Ch<n>_DeviceId	String
Ch<n>_DeviceOptions	String
Ch<n>_DeviceVersions	String
Ch<n>_FilterSettings	FLAT | GAUSS | OFF
Ch<n>_HighPassFilterState	ON | OFF

Parameter name	Possible Values
Ch<n>_Impedance[Ohm]	50 | 75
Ch<n>_InputCoupling	AC | DC
Ch<n>_InputPath	RF
Ch<n>_MeasBandwidth[Hz]	double
Ch<n>_NumberOfPostSamples	Integer
Ch<n>_NumberOfPreSamples	Integer
Ch<n>_PreampGain[dB]	Integer
Ch<n>_PreampState	ON | OFF
Ch<n>_RefLevelOffset[dB]	Double
Ch<n>_RefLevel[dBm]	Double
Ch<n>_RefOscillatorInput	OFF | ON
Ch<n>_RefOscillatorFreq[Hz]	Double
Ch<n>_TrgSource	Extern <1 ..4> | I/Q Power | IF Power | RF Power | Power Sensor | Time
Ch<n>_TrgLevel[dB]	Double
Ch<n>_TrgHysteresis[dB]	Double
Ch<n>_TrgTpis[s]	Double
Ch<n>_TrgOffset[s]	Double
Ch<n>_TrgSlope	Rising | Falling | Rising/Falling
Ch<n>_TrgHoldoff[s]	Double
Ch<n>_TrgDropOut[s]	Double
Ch<n>_YigPreSelectorState	ON | OFF

D.2.3 Example

```
DataImportExport_MandatoryData;
Name;ExampleFile
Comment;Example Comment
DateTime;2015-02-19T15:26:33
Format;complex
DataType;float32
NumberOfChannels;1
Ch1_ChannelName;Example_Channel
Ch1_Samples;10
Ch1_Clock[Hz];3,2000000E+007
Ch1_CenterFrequency[Hz];100,0000000E+007
DataImportExport_EndHeaderSection;
Example_Channel_I;Example_Channel_Q
```

```
-5,9390777E-006;-3,4644620E-006
9,8984629E-007;-8,4631858E-005
-5,9885701E-005;4,1078620E-005
2,0786772E-005;7,8692778E-005
-4,9492314E-006;-1,5095156E-004
1,6332464E-005;1,8312156E-005
-5,4936470E-005;4,5532928E-005
-4,8997390E-005;9,7004937E-005
-1,1383232E-005;4,5532928E-005
-8,2157239E-005;3,2170003E-005
```

D.2.4 Simple CSV Format

The simple `.CSV` format contains I/Q data only, without any header or meta data. That is, the file contains only (I,Q) data pairs, separated by commas. Several streams of data can be provided in one file.

Example:

```
7.0663854e-003,1.7059683e-005,
7.0817876e-003,7.5836733e-006,
7.0711789e-003,-1.2189972e-005,
```

This format requires setting the sample rate and measurement time or record length manually.

D.3 IQW File Format

IQW is a binary file format containing one channel of complex IQ data.

Format description details:

- IQDataFormat: Complex
- IQDataType: Float32
- Byte order: Intel
- Data order: IQIQIQ (I/Q paired or interleaved) or IIIQQQ (I/Q blocks, default)

This format requires setting the sample rate and measurement time or record length manually.

Mandatory Data Elements

Only the binary I/Q data.

Optional Data Elements

None.

D.4 Matlab® v. 4 / v. 7.3 File Format

In Matlab® files, channel-related information is stored in Matlab® variables with names starting with 'ChX_'. 'X' represents the number of the channel with a lower bound of 1, e.g. the variable Ch1_ChannelName contains the name of the first channel. The corresponding data is contained in ChX_Data.

Optional user data can be saved to variables named UserDataX, where 'X' starts at 0. The variable UserData_Count contains the number of UserData variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces.

Variables can be written to the *.mat files in arbitrary order.

The Matlab® v7.3. file format requires the Matlab® Compiler Runtime (MCR) to be installed on the system and registered in the PATH environment variable.

This format requires setting the sample rate and measurement time or record length manually.

D.4.1 Mandatory Data Elements

Variable name	Class	Format / possible values
Name	char	
Comment	char	
DateTime	char	Year-Month-DayTHour:Min:Sec
Format	char	complex
DataType	char	float32
NumberOfChannels	Double	
Ch<n>_ChannelName	char	
Ch<n>_Samples	double	
Ch<n>_Clock_Hz	double	
Ch<n>_CFrequency_Hz	Double	

Variable name	Class	Format / possible values
Ch<n>_Data	Double, Double	I,Q
UserData_Count	Double	(Number of optional user data variables)

D.4.2 Optional Data Elements

Optional user data can be saved to variables named `UserDataX`, where '`X`' starts at 0. The variable `UserData_Count` contains the number of `UserData` variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces.

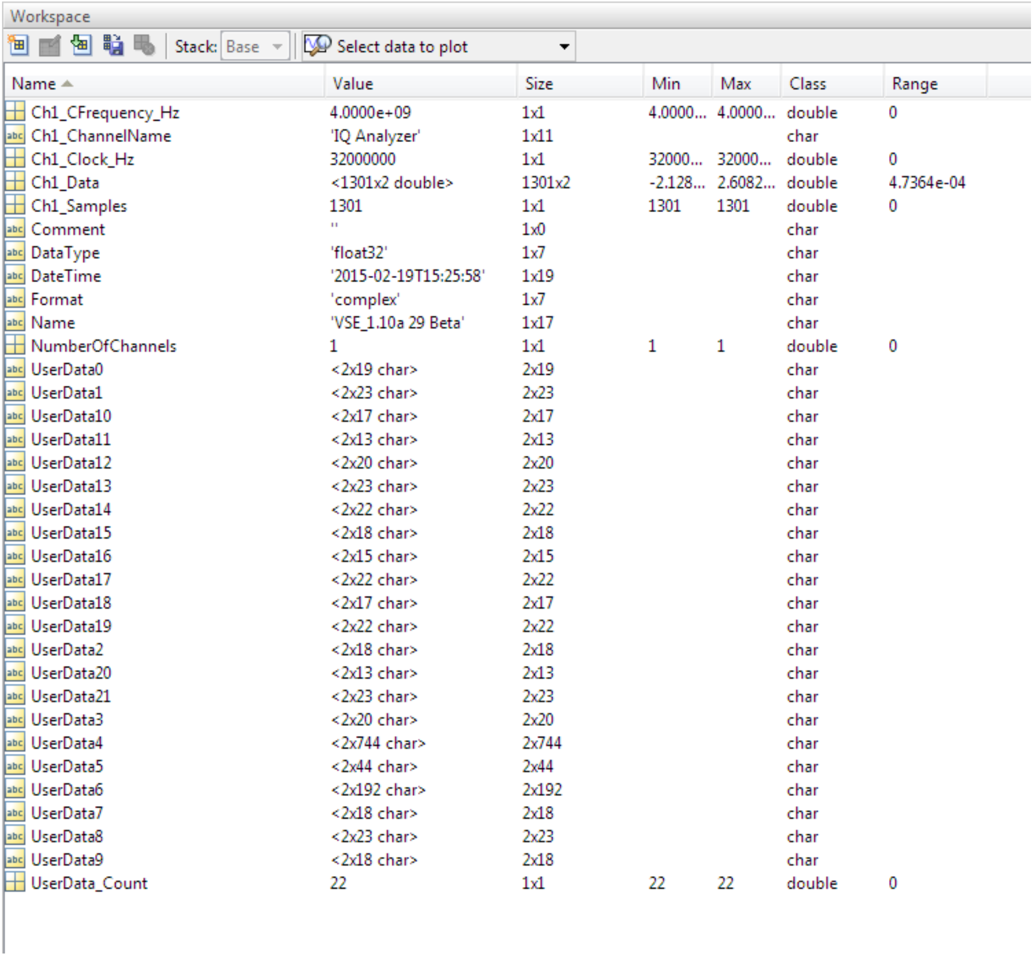
Variable name	Class	Format
UserData<n>	char	Optional Data Parameter name, Value

Table D-2: Optional parameter names to be defined in UserData<n> variables

Parameter name	Possible Values
Ch<n>_AttenuElecState	ON | OFF
Ch<n>_AttenuElecValue_dB	Integer
Ch<n>_AttenuMech_dB	Integer
Ch<n>_CalibrationState	ON | OFF
Ch<n>_DeviceHwInfo	String
Ch<n>_DeviceId	String
Ch<n>_DeviceOptions	String
Ch<n>_DeviceVersions	String
Ch<n>_FilterSettings	FLAT | GAUSS | OFF
Ch<n>_HighPassFilterState	ON | OFF
Ch<n>_Impedance_Ohm	50 | 75
Ch<n>_InputCoupling	AC | DC
Ch<n>_InputPath	RF
Ch<n>_MeasBandwidth_Hz	double
Ch<n>_NumberOfPostSamples	Integer
Ch<n>_NumberOfPreSamples	Integer
Ch<n>_PreampGain_dB	Integer
Ch<n>_PreampState	ON | OFF
Ch<n>_RefLevelOffset_dB	Double
Ch<n>_RefLevel_dBm	Double

Parameter name	Possible Values
Ch<n>_RefOscillatorInput	OFF | ON
Ch<n>_RefOscillatorFreq_Hz	Double
Ch<n>_TrgSource	Extern <1 ..4> | I/Q Power | IF Power | RF Power | Power Sensor | Time
Ch<n>_TrgLevel_dB	Double
Ch<n>_TrgHysteresis_dB	Double
Ch<n>_TrgTpis_s	Double
Ch<n>_TrgOffset_s	Double
Ch<n>_TrgSlope	Rising | Falling | Rising/Falling
Ch<n>_TrgHoldoff_s	Double
Ch<n>_TrgDropOut_s	Double
Ch<n>_YigPreSelectorState	ON | OFF

D.4.3 Example



Name	Value	Size	Min	Max	Class	Range
Ch1_CFrequency_Hz	4.0000e+09	1x1	4.0000...	4.0000...	double	0
Ch1_ChannelName	'IQ Analyzer'	1x11			char	
Ch1_Clock_Hz	32000000	1x1	32000...	32000...	double	0
Ch1_Data	<1301x2 double>	1301x2	-2.128...	2.6082...	double	4.7364e-04
Ch1_Samples	1301	1x1	1301	1301	double	0
Comment	''	1x0			char	
DataType	'float32'	1x7			char	
DateTime	'2015-02-19T15:25:58'	1x19			char	
Format	'complex'	1x7			char	
Name	'VSE_1.10a 29 Beta'	1x17			char	
NumberOfChannels	1	1x1	1	1	double	0
UserData0	<2x19 char>	2x19			char	
UserData1	<2x23 char>	2x23			char	
UserData10	<2x17 char>	2x17			char	
UserData11	<2x13 char>	2x13			char	
UserData12	<2x20 char>	2x20			char	
UserData13	<2x23 char>	2x23			char	
UserData14	<2x22 char>	2x22			char	
UserData15	<2x18 char>	2x18			char	
UserData16	<2x15 char>	2x15			char	
UserData17	<2x22 char>	2x22			char	
UserData18	<2x17 char>	2x17			char	
UserData19	<2x22 char>	2x22			char	
UserData2	<2x18 char>	2x18			char	
UserData20	<2x13 char>	2x13			char	
UserData21	<2x23 char>	2x23			char	
UserData3	<2x20 char>	2x20			char	
UserData4	<2x744 char>	2x744			char	
UserData5	<2x44 char>	2x44			char	
UserData6	<2x192 char>	2x192			char	
UserData7	<2x18 char>	2x18			char	
UserData8	<2x23 char>	2x23			char	
UserData9	<2x18 char>	2x18			char	
UserData_Count	22	1x1	22	22	double	0

D.4.4 Simple Matlab® Format

As of R&S FSW software version 1.50, a simple `.mat` format is supported. This format contains I/Q data only, without any meta data. That is, the file contains only variables (double, double) for the corresponding channel data.

When you load a simple Matlab® file, you must define the used sample rate (and optionally analysis bandwidth) manually.

D.5 AID Format

AID is a format used to transmit real or complex baseband signals. The IF signal is sent along with information that characterizes the datastream and datastream source.

All datastreams have a frame based structure using the same format, consisting of a global *Frame header* coupled with a data-type specific *Frame body* (i.e. the frame payload).

The header and the body of the frame consist of a number of 32-bit words. The *Frame header* has a predefined structure and size. The size and structure of the *Frame body* depends on the payload type. This is an important factor in the choice of the frame size.

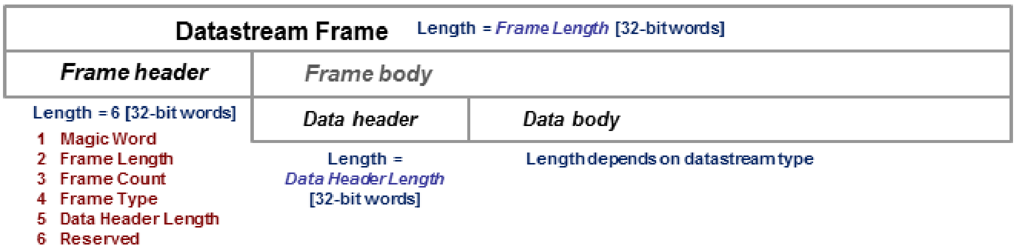


Figure D-1: Generic Datastream Frame structure

Global Frame header

The *Frame header* contains information used for frame synchronization, frame sequencing, payload identification and frame sizing. It consist of six 32-bit words as depicted in the following figure and is defined in **`rs_gx40x_global_frame_header_if_defs.h`**

Table D-3: Global Frame header (structure name: typFRH_FRAMEHEADER)

Word position in frame	Member name Member type	Description
1	**uintMagicWord** ptypUINT	**Magic Word** - 32-bit word, always identical (`0xFB746572`), defines the start of the *Frame header* and is used for frame synchronization. The *Magic Word* and the *Frame Length* are used to identify the beginning of each frame.
2	**uintFrameLength** ptypUINT	**Frame Length** - gives the length of the frame including both *Frame header* and *Frame body*. The length is expressed in 32-bit words. The minimum length is six in case the *Frame body* is empty and the maximum length is limited to the value: • `kFRH_FRAME_LENGTH_MAX = 0x100000` (`1048576 =` 2^{20}) in case of normal frames • `kFRH_FRAME_LENGTH_MAX_EX = 0x400000` (`64* 1048576 =` 2^{26}) in case of extended frames (an extended frame is marked by Bit#0 of the Reserved word of the frame header). Only some datastream types allow the extended frame size, see the definitions in the `rs_gx40x_global_frame_types_if_defs.h`. The next *Magic Word* which denotes the next frame in this data stream will occur `uintFrameLength` [32-bit words] after the *Magic Word* in this frame.
3	**uintFrameCount** ptypUINT	**Frame Count** - sequence counter modulo 2^{32}. Determines the position of this frame in the datastream and is used for sequencing and lost frame detection.

Word position in frame	Member name Member type	Description
4	**uintFrameType** ptypUINT	**Frame Type** - identifies the data type contained in this frame and gives the specific structure of the frame payload. The complete list of frame types (i.e. datastream types) can be found in the following header file: `rs_gx40x_global_frame_types_if_defs.h`
5	**uintDataHeaderLength** ptypUINT	**Data Header Length** - gives the length of the *data header* positioned at the beginning of the *Frame body*. The length is expressed in 32-bit words (`0` means no data header). This information can be used by the software to recognize the version of the datastream format and thus its compatibility to read and correctly interpret the datastream. It enables forward-compatibility with future datastream versions. This value will not vary for a continuous data stream.
6	**uintReserved** ptypUINT	• Bits `#31` to `#1` - Reserved (not yet used, must be `0`) • Bit `#0` - Marks the frame with extended size (up to kFRH_FRAME_LENGTH_MAX_EX 32-bit words).

The *Data Header Length* information is very important for the correct addressing of the data samples. This information gives the exact position in the frame where the *Data body* begins independent of the version of the *data header* (different versions consist of different number of parameters). From the frame beginning (indicated by the *Magic Word*), the first six 32-bit words represent the *Frame header* and the next *Data Header Length* 32-bit words represent the *data header*. After `6+uintDataHeaderLength` 32-bit words starts the *Data body*, i.e. the first data sample.

Frame body

The *Frame body* contains the payload of the frame and its structure depends on the datastream type, as defined by the *Frame Type* element in the *Frame header*.

The *Frame body* is structured into a *data header* followed by the *Data body*. The *data header* contains datastream specific information of the payload.

Bit numbering

Throughout this format description it is assumed that bit #0 is the bit of least numeric significance.

D.5.1 Data body

The IF Data format is valid for the following datastream types:

Table D-4: IF Datastream types

Datastream type ID	Description	Sample data type
ekFRH_DATASTREAM__IFDATA_32RE_32IM_FIX ekFRH_DATASTREAM__IFDATA_32RE_32IM_FIX_RESCALED	Complex IF Data samples, 32-bit real-part and 32-bit imaginary-part, fixed point	typIFD_SAMPLE_32RE_32IM_FIX
ekFRH_DATASTREAM__IFDATA_16RE_16IM_FIX	Complex IF Data samples, 16-bit real-part and 16-bit imaginary-part, fixed point	typIFD_SAMPLE_16RE_16IM_FIX
ekFRH_DATASTREAM__IFDATA_16RE_16RE_FIX	Real IF Data samples, 16-bit real-part, two samples in each 32-bit word, fixed point	typIFD_SAMPLE_16RE_16RE_FIX
ekFRH_DATASTREAM__IFDATA_32RE_32IM_FLOAT_RESCALED	Complex IF Data samples, 32-bit real-part und 32-bit imaginary-part, floating point	typIFD_SAMPLE_32RE_32IM_FLOAT

For the datastream types defined in Table D-4, the same frame body structure is used, the only difference is the carried sample data type.

IF Data Frame Structure

The structure of the IF Datastream is defined in the `rs_gx40x_global_ifdata_header_if_defs.h` header file.

The Data Frame consists of the global *frame header* of type `typFRH_FRAMEHEADER`, as described in "Global Frame header" on page 521, followed by the datastream-specific *Frame body*.

The corresponding "Frame Type" value from the *frame header* for this datastream type can be found in the global frame types header file: `rs_gx40x_global_frame_types_if_defs.h`.

The *frame body* consists of: the *data header* which describes the datastream payload and the *data body* which contains the actual datastream payload.

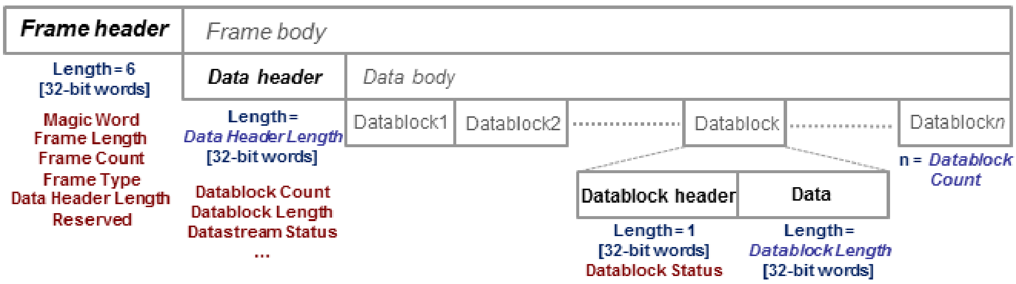


Figure D-2: IF Data frame format

IF data header

The data header describes the datastream payload (such as number of data samples contained in this frame), and contains common properties of the data samples.

The **basic** data header contains several fields that are always sent.

The **extended** data header contains extra information fields sent after the fields of the basic structure.

The length of the data header, as specified by the `uintDataHeaderLength` parameter from the frame header. This parameter provides information about which data header type is used - i.e. the basic header or the extended header.

The IF data header structure, of type `typIFD_IFDATAHEADER`, is described in the following table (data header length = 14 [32-bit words]).

Table D-5: IF DATA header (typIFD_IFDATAHEADER)

Word position in frame	Member name Member type	Description
7	**uintDatablockCount** ptypUINT	**Datablock Count** - represents the number of IF signal data blocks in the IF data frame.
8	**uintDatablockLength** ptypUINT	**Datablock Length** - The number 32-bit words in each IF signal data block excluding the data block header (has to be of the form 2^N with N≥2). This may not be the same as the number of IF signal data samples, as the size of a sample may be 16, 32 or 64 bits.
9 10	**bigtimeTimeStamp** ptypBIGTIME	64-bit **Timestamp** [µs] - Absolute time of the first IF signal data sample, in the first data block of IF signal data in this frame.
11	**uintStatusword** ptypUINT	**Status Word** - extra information that help the receiver react by parameter changes. • Bit `#31` - Reserved • Bit `#30` - **dBFS flag** – `1` indicates that all samples in this frame are considered to be dBFS (dB full scale). – `0` indicates that the values *Antenna Voltage Reference* and *Reciprocal gain correction* (see the *Status Word* description of the datablock header) can be used to calculate the corresponding level for each sample. • Bits `#29` to `#8` - Reserved (not yet used, must be `0`) • Bits `#7` to `#0` - User flags for special signaling between IF Data processing components.
12	**uintSignalSourceID** ptypUINT	**Signal Source Identifier** or antenna identifier (value 0x0 if not used)

Word position in frame	Member name Member type	Description
13	**uintSignalSourceState** ptypUINT	Current **Signal Source State** (value `0x0` if not used) • gives the *Configuration Set Identifier* of the Task Data Set (in GX400) currently being applied by the IF signal source OR • the current *Scan Step Number* in the case of scan operation In the case of memory scanning, the scan step number starts at `0` for the scan channel (memory location) configured with the lowest frequency, and increments (`+1`) for every channel configured for scanning in the memory scan list. In the case of frequency scanning, the scan step number starts at `0` for the scan step at the lowest frequency, and increments (`+1`) for every step taken within the configured frequency scan range.
14 15	**uintTunerFrequency_Low** **uintTunerFrequency_High** ptypUINT	64-bit **Tuner Center Frequency** [Hz] - least significant 32 bits (uintTunerFrequency_Low) followed by most significant 32 bits (uintTunerFrequency_High)
16	**uintBandwidth** ptypUINT	IF signal 3dB **Bandwidth** [Hz]
17	**uintSamplerate** ptypUINT	**Sample Rate** of the AD Converter [samples / second] - due to digital filtering within the source, the resulting sample rate of the samples within this frame is: Sample Rate × Interpolation / Decimation
18	**uintInterpolation** ptypUINT	**Interpolation Factor** referred to the ADC signal sample rate. The value `0x1` indicates no interpolation

Word position in frame	Member name Member type	Description
19	**uintDecimation** ptypUINT	**Decimation Factor** referred to the ADC signal sample rate. The value `0x1` indicates no decimation
20	**intAntennaVoltageRef** ptypINT	**Antenna Voltage Reference (AntVoltRef)** is the device specific correction value for the tuner front-end Rx attenuation (expresses anything from antenna input connector to ADC) and is expressed in `[0.1 dBµV]`. This is the level which, while the AGC amplification is at maximum attenuation, is required at the antenna input to produce the full scale value at the ADC. Using this value together with the RecipGain (Reciprocal Gain) value, one can calculate the true signal level at the antenna input connector (see "Data samples" on page 528). The RecipGain value is given in the Status Word of the IF Datablock header Table D-4

The extended IF data header structure, of type `typIFD_IFDATAHEADER_EX`, is described in the following table (total data header length = 19 [32-bit words]).

Table D-6: Extended IF data header (typIFD_IFDATAHEADER_EX) - extra fields only

Word position in frame	Member name Member type	Description
21 22	**bigtimeStartTimeStamp** ptypBIGTIME_NS	64-bit **Timestamp** [ns] - Absolute time of the first sample of the datastream since starting the datastream ("Sample Counter" == 0). This value remains constant until the datastream is stopped and started again or until the tuner performs an internal synchronization.
23 24	**uintSampleCounter_Low** **uintSampleCounter_High** ptypUINT	**Sample Count** - 64-bit counter from the first sample of the first datablock in this frame. Note that this value can be reset when the datastream is stopped and started again or when the tuner performs an internal synchronization. The Sample Count of the next IF frame can be deduced from Datablock Count, Datablock Length and the number of 32-bit words per sample. In this way the number of sample Dropouts can be estimated (that can be replaced with Null values). The exact time is given by *t = Start Time + Sample Count * Decimation / (Sample rate * Interpolation)*.
25	**intKFactor** ptypINT	**kFactor** - Correction factor of the current antenna, given in `0.1dB/m`. Used to determine the field strength (in [dBµV/m]) at the antenna from the voltage level at the antenna input of the receiver. Contains antenna gain, cable attenuation, antenna switch matrix attenuation and anything else from air to antenna input. (the value `0x80000000` is used if no kFactor is defined).

The values contained in the data header fields represent the status at the beginning of the frame. A modification happening during the transmission of a frame will only be noted in the data header of the next frame.

IF Data Body

The IF data body contains zero or more IF Data samples arranged as an array of `typIFD_DATABLOCK` data blocks (the actual IF signal datastream payload). The number of datablocks is specified by the `Datablock Count` parameter from the data header.

Each datablock (`typIFD_DATABLOCK`) has its own datablock header: `datablockheaderDatablockHeader` (of type `typIFD_DATABLOCKHEADER`) and a datablock body that contains the actual data sample.

Table D-7: IF Datablock header (typIFD_DATABLOCKHEADER)

Member name **Member type**	**Description**
uintStatusword ptypUINT	Status of the Datablock • Bits `#31` to `#16` - **RecipGain** - Automatic Gain Control (AGC) **Reciprocal Gain Correction** value that was applied when generating the following IF Data samples. The RecipGain is represented as 16-bit unsigned decimal value (the 16-bit unsigned decimal has to be divided by 2^{16} = 65535 to obtain the unsigned fractional between 0 and 1). For example a correction value of `-17.5dB` gives a value for RecipGain of `0.1333` which will be represented as `0x2220`. Using this value together with the value for the antenna voltage reference, one can calculate the true signal level at the antenna input connector (see "Data samples" on page 528). • Bits `#15` to `#8` - Reserved (must be `0`). • Bits `#7` to `#2` - User flags for special signaling between IF Data processing components. Set to `0` if not used. • Bit `#1` - **Blanking flag** - this flag is set (`1`) to indicate that the data in this block may have been falsified by some external event. • Bit `#0` - **Invalidity flag** - this flag is set (`1`) to indicate that the data within this block may be corrupt (e.g. the input signal exceeded the range of the AD converter, or the analog signal input from which the data was converted was overloaded), OR any one of the fields in the IF datastream header does not represent the data in this block correctly.

The datablock body is defined as an array of size `uintDatablockLength` with `uintData` elements interpreted using the corresponding sample type format ("typIFD_SAMPLE...." as described in the following table). The actual IF data samples have to be extracted from the array. Their structure and size is given by the IF datastream format (Table D-4). The possible IF data sample formats are described in the table below:

Table D-8: IF data sample format

Sample type	Sample format	Most significant bits	Least significant bits	Data type
typIFD_SAMPLE _32RE_32IM_FIX typIFD_SAMPLE _32RE_32IM_FLOAT	64-bit I/Q format	First 32-bit Real component		ptypINT or ptypFLOAT_SP
		Second 32-bit Imaginary component		ptypINT or ptypFLOAT_SP

Sample type	Sample format	Most significant bits	Least significant bits	Data type
typIFD_SAMPLE _16RE_16IM_FIX	32-bit I/Q format	16-bit Imaginary component	16-bit Real component	ptypINT
typIFD_SAMPLE _16RE_16RE_FIX	16-bit Real format	16-bit sample number `I+1`	16-bit sample number `I`	ptypINT

The term 'fix' ('fixed' point) indicates signed (2s-complement) fixed point fractional numbers.

Data samples

The absolute signal level in [dBµV] may be calculated as follows:

Level [dBµV] = 10*log(I_{rel}^2+Q_{rel}^2) [dB] + 20*log (RecipGain / 2^{16}) [dB] + 0.1*AntVoltRef [dBµV]

where I and Q are the real and imaginary parts of each signal sample.

The absolute signal level in [µV] may be calculated as follows:

I [µV] = I_{rel} * (RecipGain / 2^{16}) * AntVoltLin

Q [µV] = Q_{rel} * (RecipGain / 2^{16}) * AntVoltLin

where AntVoltLin [µV] = $10^{(0.1 \text{ * AntVoltRef) / 20}}$

Depending on the sample format, as presented in Table D-8, I and Q values can be represented as signed integers on 32-bits (I_{int32}) or 16-bits (I_{int16}) or as 32-bit float values (I_{float}). The relative values of I and Q can be calculated with the following formulas (same applies for Q_{rel}):

- I_{rel} = $I_{int32}/(2^{31}-1)$ where I_{int32} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- I_{rel} = $I_{int16}/(2^{15}-1)$ where I_{int16} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- I_{rel} = I_{float}

In the first two cases I_{rel} and Q_{rel} represent relative signal level values between -1 and 1. The absolute signal levels are retrieved through the parameter AntVoltRef as presented above. In the third case, I_{rel} and Q_{rel} can represent directly the absolute signal levels - in this case the RecipGain and AntVoltRef are not used (and are set to RecipGain=1, AntVoltRef=0).

Example

Word position in frame	Frame component name	Hex value	Description
1	**uintMagicWord**	FB746572	Frame synchronisation
2	**uintFrameLength**	0000001E	Entire frame length = 30 (in 32-bit units)

Word position in frame	Frame component name	Hex value	Description
3	**uintFrameCount**	000000FE	Running frame number = 254
4	**uintFrameType**	00000004	The type of data contained in this frame
5	**uintDataHeaderLength**	0000000E	data header length = 14 (in 32-bit units)
6	**uintReserved**	00000000	Reserved field
7	**uintDatablockCount**	00000002	Number of data blocks in this frame = 2
8	**uintDatablockLength**	00000004	The data block length (in 32-bit units) excluding the data block header = 4. Every data block in this frame will have the same length.
9 10	**bigtimeTimeStamp**	00035CED 1D63F4D0	Absolute time [µs] of the first IF signal data sample in this frame
11	**uintStatusword**	00000000	No status change indications.
12	**uintSignalSourceID**	00000003	Antenna ID = 3
13	**uintSignalSourceState**	00000A73	Tuner scan status = position 2675
14	**uintTunerFrequency_Low**	42Ef9EC0	Tuner center frequency = 1,123 GHz
15	**uintTunerFrequency_High**	00000000	
16	**uintBandwidth**	01312d00	The IF Data bandwidth = 20 MHz
17	**uintSamplerate**	0493E000	ADC sample rate = 76,8 Msample/s
18	**uintInterpolation**	00000001	Interpolation factor = none
19	**uintDecimation**	00000003	Decimation factor referred to the ADC sample rate = 3
20	**intAntennaVoltageRef**	0000001E	Antenna reference voltage = 3dBµV
21	**uintStatusword**	22200000	Beginning of the first Datablock. Statusword contains AGC correction factor = 0.1333 and no flags indications.
22	**uintData**	23873454	Real part of first sample
23	**uintData**	34234523	Imaginary part of first sample
24	**uintData**	56567543	Real part of second sample
25	**uintData**	34563456	Imaginary part of second sample
26	**uintStatusword**	41000004	Beginning of the second Datablock. Statusword contains AGC correction factor = 0.2539 and one user flag indication.
27	**uintData**	45345222	Real part of third sample
28	**uintData**	546672ab	Imaginary part of third sample
29	**uintData**	5BB25346	Real part of fourth sample
30	**uintData**	BBF7673e	Imaginary part of fourth sample

D.6 WV Format

WV is a format used by Rohde & Schwarz signal generators to store waveforms. A waveform file contains a header and raw I/Q samples.

D.6.1 Mandatory Elements

Each waveform file must begin with the TYPE tag. The sequence of the remaining tags is arbitrary.

Element	Description
`TYPE`	Designates the file type and source of creation (instrument type). Also includes an ASCII-coded checksum of the data part of the WAVEFORM tag, used to detect transmission errors.
`CLOCK`	The clock frequency (sample rate), in Hz
`EMPTYTAG-Length`	Length is an ASCII integer value that specifies the number of bytes in the EMPTYTAG, i.e. defines the number of bytes from the colon : to the end bracket }
`WAVEFORM-Length`	The actual waveform data (I/Q stream) Length specifies the number of bytes in a WAVEFORM tag and is calculated as follows: Length = Number of I/Q pairs * 4 (2 bytes per I and 2 bytes per Q value) + 1 byte (the length of the #) The binary data is represented by 16-bit signed integer in 2's complement notation. It contains the I and Q component alternately, starting with the I component. Each component consists of 2 bytes in Little endian format representation, i.e least significant byte (LSB) first. The values of the 2 bytes in an I component and a Q component are in the range 0x0 to 0xFFFF (-32767 to +32767).

D.6.2 Optional Elements

The following elements are optional in a `.wv` file.

Element	Description
`DATE`	Date and time at which the file was created Syntax: yyyy-mm-dd;hh:mm:ss
`LEVEL OFFS`	Offset of RMS and peak level relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.
`SAMPLES`	Number of I/Q samples in the waveform in ASCII format

List of Commands (I/Q Analyzer+I/Q Input Interfaces (B17+B71))

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