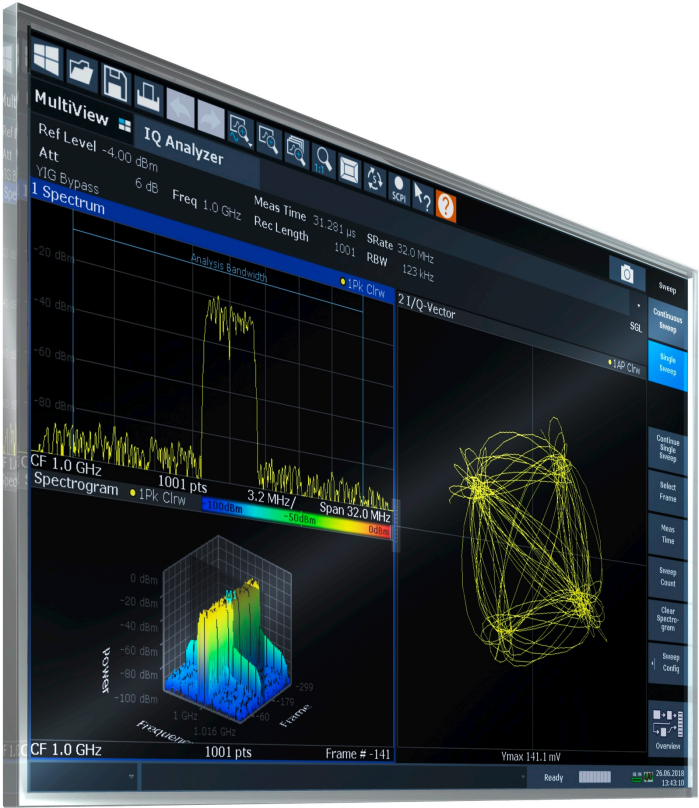


R&S®FSW I/Q Analyzer and I/Q Input Interfaces User Manual



1175644902
Version 43



This manual applies to the following FSW models with firmware version 6.10 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)

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1175.6449.02 | Version 43 | 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.

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1 Documentation overview

This section provides an overview of the FSW user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/FSW

Further documents are available at:

www.rohde-schwarz.com/product/FSW

1.1 Getting started manual

Introduces the 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.

1.2 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 FSW is not included.

The contents of the user manuals are available as help in the 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.

1.3 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>

1.4 Instrument security procedures

Deals with security issues when working with the FSW in secure areas. It is available for download on the internet.

1.5 Printed safety instructions

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

1.6 Specifications and brochures

The specifications document, also known as the data sheet, contains the technical specifications of the 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

1.7 Release notes and open-source acknowledgment (OSA)

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

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

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

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

1.9 Videos

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: <https://www.youtube.com/@RohdeundSchwarz>

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 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
- 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

Described options

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

Option	Description
R&S®FSW-B10 (1313.1622.02)	External generator control
R&S®FSW-B13 (1313.0761.02)	High-pass filter
R&S®FSW-B17 (1313.0784.02)	"Digital Baseband" interface
R&S®FSW-B21 (1313.1100.XX)	External mixer
R&S®FSW-B24 (1313.0832.XX)	Preamplifier
R&S®FSW-B25 (1313.0990.02)	Electronic attenuator
R&S®FSW-B71 (1313.1651.XX, 1313.6547.02) / R&S®FSW-B2071 (1331.8302.XX)	"Analog Baseband" interface
R&S®FSW-B106 (1331.6451.02) /	I/Q memory extension 6 GHz
R&S®FSW-B108 (1331.6751.02) /	I/Q memory extension 8 GHz
R&S®FSW-B124 (1338.5273.02)	I/Q memory extension 24 GHz
R&S®FSW-B517 (1331.6980.02) / R&S®FSW-B1017 (1350.7008.02)	Digital I/Q 40G streaming output
R&S®FSW-B40 (1313.0861.02) / R&S®FSW-U40 (1313.52505.02)	Bandwidth extension 40 MHz
R&S®FSW-B80 (1313.0878.02) / R&S®FSW-U80 (1313.5211.02)	Bandwidth extension 80 MHz
R&S®FSW-B160 (1313.1668.02 / 1325.4850.04) / R&S®FSW-U160 (1313.3754.02 / 1325.5357.04)	Bandwidth extension 160 MHz

Option	Description
R&S®FSW-B320 (1313.7172.02 / 1325.4867.04) / R&S®FSW-U320 (1313.7189.02)	Bandwidth extension 320 MHz
R&S®FSW-B512 (1313.4296.xx) / R&S®FSW-U512 (1321.6320.xx)	Bandwidth extension 512 MHz
R&S®FSW-B1200 (1331.6400.xx)	Bandwidth extension 1.2 GHz
R&S®FSW-B2000 (1325.4750.xx) / R&S®FSW-U2000 (1325.5405.xx)	Bandwidth extension 2 GHz (external)
R&S®FSW-B2001 (1331.6916.xx) / R&S®FSW-U2001 (1331.7070.xx)	Bandwidth extension 2 GHz
R&S®FSW-B4001 (1338.5215.xx) / R&S®FSW-U4001 (1338.5244.xx)	Bandwidth extension 4 GHz
R&S®FSW-B5000 (1331.6997.xx) / R&S®FSW-U5000 (1331.7629.xx)	Bandwidth extension 5 GHz (external)
R&S®FSW-B6001 (1338.5221.xx) / R&S®FSW-U6001 (1338.5250.xx)	Bandwidth extension 6 GHz
R&S®FSW-B8001 (1338.5238.xx) / R&S®FSW-U8001 (1338.5267.xx)	Bandwidth extension 8 GHz
R&S®FSW-K575 (1353.2894.xx)	I/Q Noise Cancellation

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 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 FSW.

To activate the I/Q Analyzer application

1. Select [MODE].
A dialog box opens that contains all applications currently available on your FSW.
2. Select the "I/Q Analyzer" item.



The 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 "Overview" from any menu (see [Chapter 6.1, "Configuration overview"](#), on page 91).

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 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 FSW MSRA User Manual. For details on the MSRT operating mode see the FSW Realtime Spectrum Application and MSRT Operating Mode User Manual.

Channel bar information

In the I/Q Analyzer application, the 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
"SAN: Att"	Attenuation at the analyzer when using an optional external frontend
"ExtFE: Att"	External frontend attenuation when measuring external frontend input.

"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 54)
"200 MHz"	The 200 MHz filter for wideband processing is active (see "200 MHz Filter" on page 161)
"Low Noise"	Signal processing is optimized for low noise (rather than low distortion, see "Optimization" on page 139)

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 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 10.1, "Error messages"](#), on page 239.

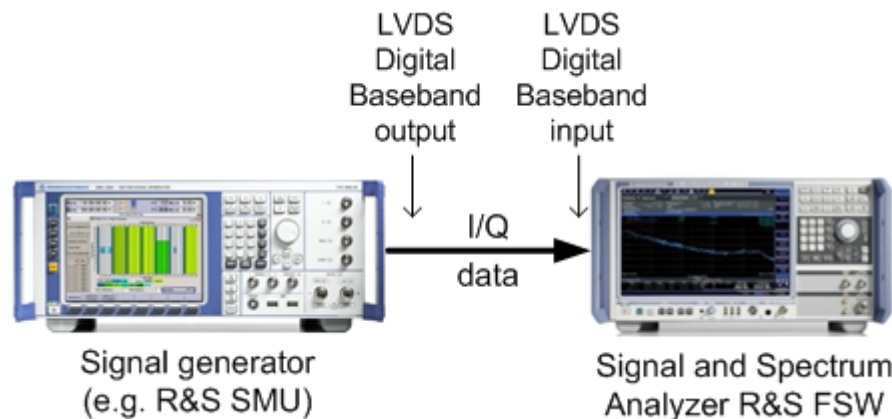
3 Typical applications for the I/Q analyzer and I/Q input

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.

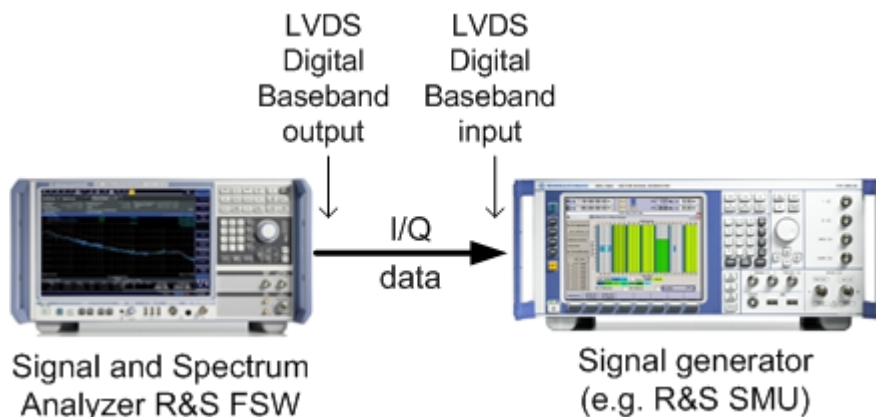
The optional "Digital Baseband" interface can be used to capture or output the I/Q data.

The following typical applications use the "Digital Baseband" interface:

- Capturing and evaluating digital I/Q data in the I/Q Analyzer application of the 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 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 FSW Getting Started manual.

Measurements in the time and frequency domain

The I/Q Analyzer secondary application (*not primary*) in **MSRA mode** can also perform measurements on the captured I/Q data in the time and frequency domain (see also [Chapter 5.14, "Measurements in the time and frequency domain"](#), on page 89). 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.

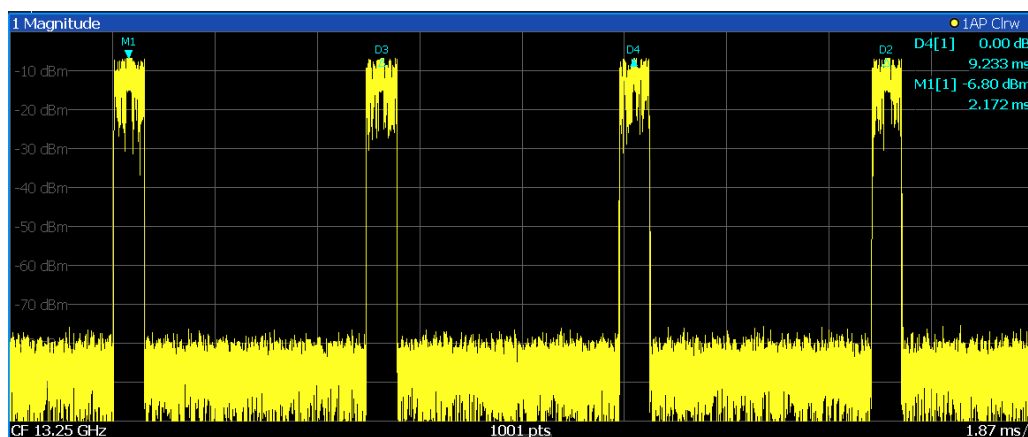
The time and frequency domain measurements and the available results are described in detail in the FSW User Manual.

Result displays for I/Q data:

Magnitude.....	17
Spectrum.....	18
I/Q-Vector.....	18
Real/Imag (I/Q).....	19
Phase vs. Time.....	20
Marker Table.....	20
Marker Peak List.....	21
I/Q 40G Recording.....	21

Magnitude

Shows the level values in time domain.



Remote command:

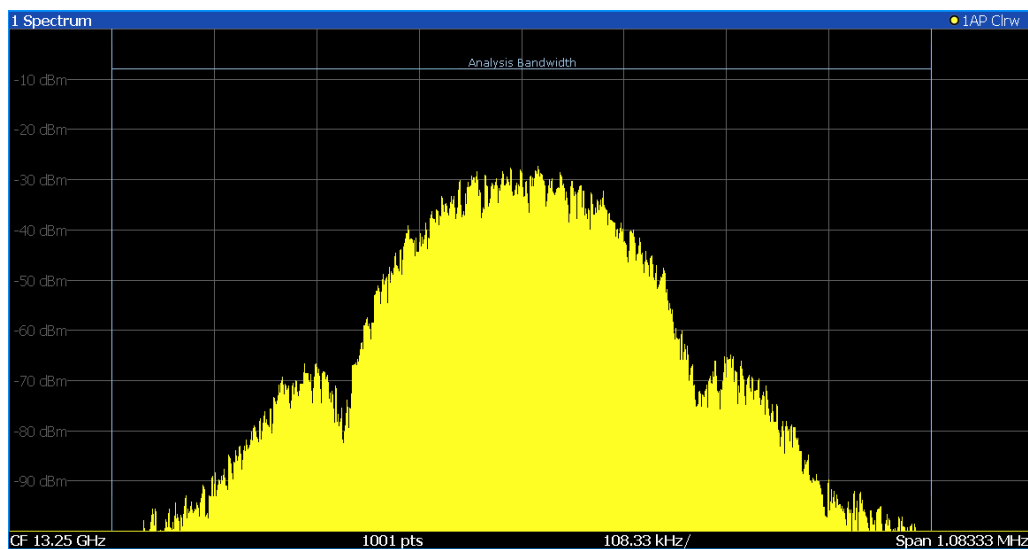
LAY:ADD:WIND? '1', RIGH, MAGN, see [LAYout:ADD\[:WINDow\]?](#) on page 393

Results:

[TRACe<n>\[:DATA\]?](#) on page 477

Spectrum

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



The specified [Analysis Bandwidth](#) is indicated by vertical blue lines.

Remote command:

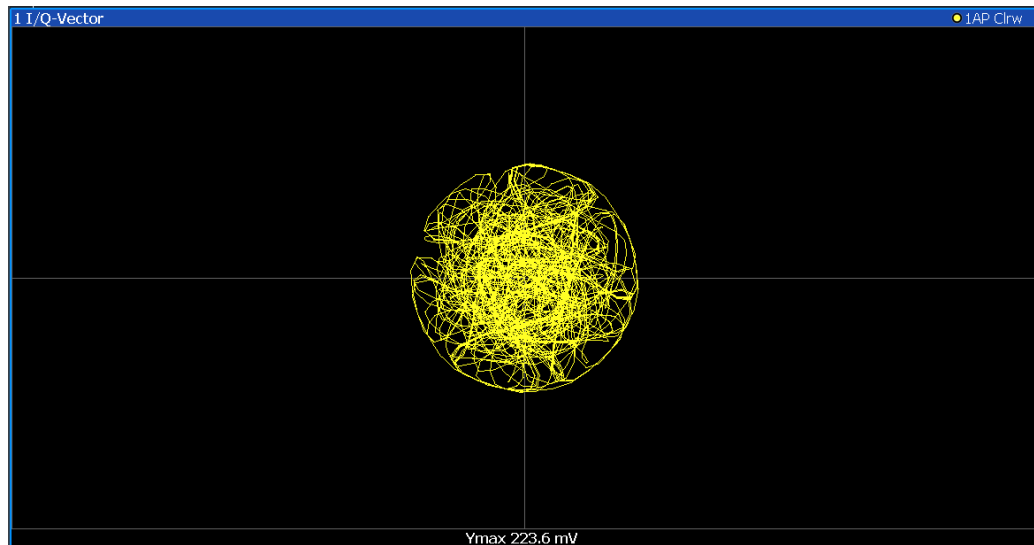
LAY:ADD:WIND? '1', RIGH, FREQ, see [LAYout:ADD\[:WINDow\]?](#) on page 393

Results:

[TRACe<n>\[:DATA\]?](#) on page 477

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 54.

Remote command:

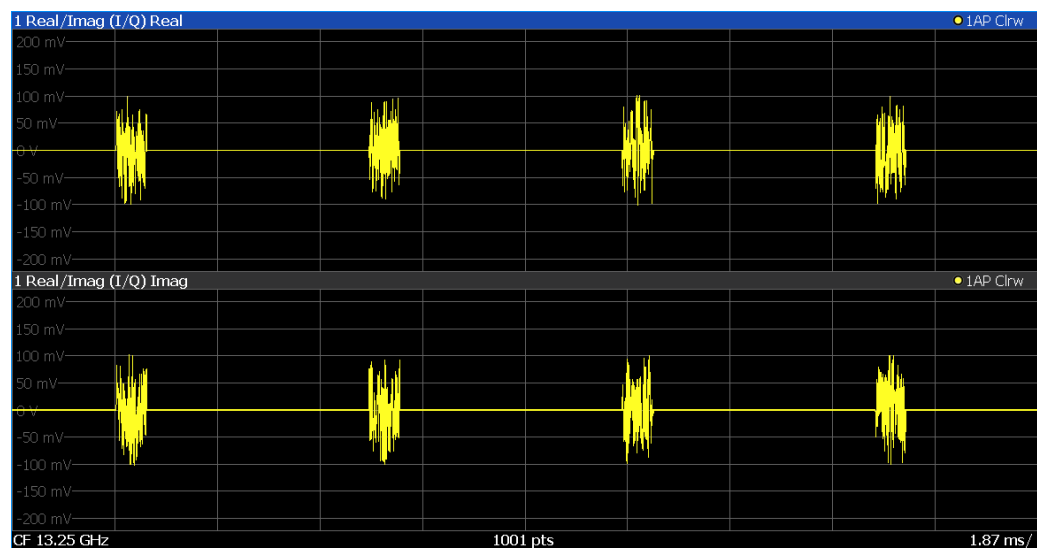
LAY:ADD:WIND? '1', RIGH, VECT, see [LAYout:ADD\[:WINDOW\]?](#) on page 393

Results:

[TRACe<n>\[:DATA\]?](#) on page 477

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 56.

Remote command:

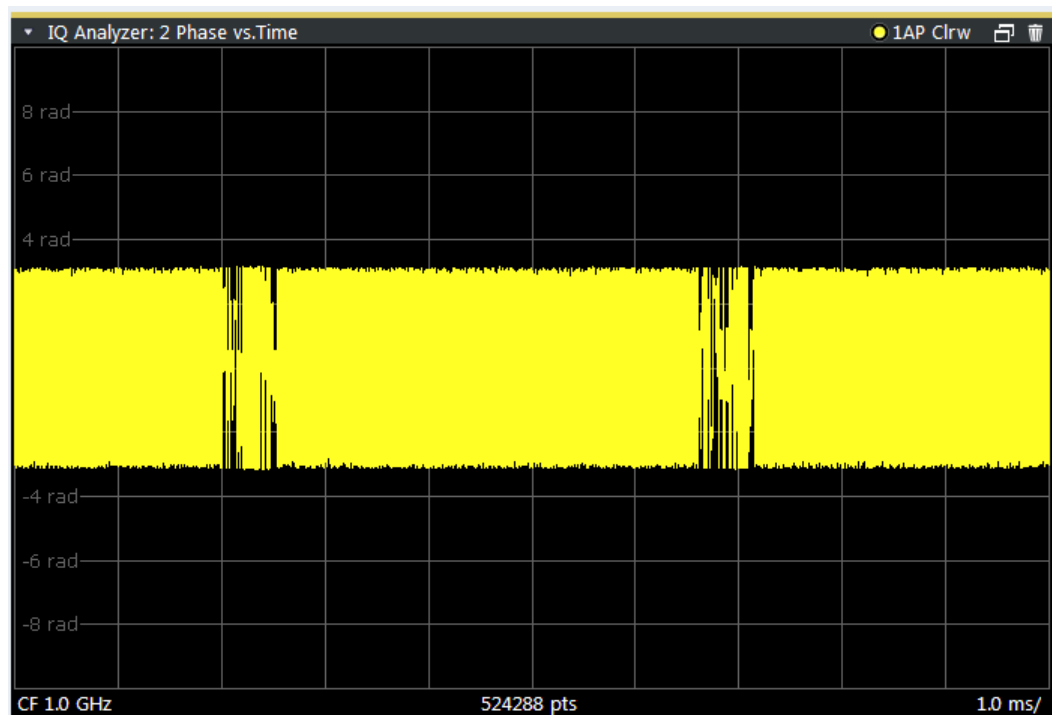
LAY:ADD:WIND? '1', RIGH, RIM, see [LAYout:ADD\[:WINDow\]?](#) on page 393

Results:

[TRACe<n>\[:DATA\]?](#) on page 477

Phase vs. Time

Shows the phase values in the time domain.



Remote command:

LAY:ADD? '1', RIGH, PHASe, see [LAYout:ADD\[:WINDow\]?](#) on page 393

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 192).

2 Marker						
Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.19705
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 393

Results:

[CALCulate<n>:MARKer<m>:X](#) on page 429

[CALCulate<n>:MARKer<m>:Y?](#) on page 484

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 393

Results:

[CALCulate<n>:MARKer<m>:X](#) on page 429

[CALCulate<n>:MARKer<m>:Y?](#) on page 484



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 5.7, "Digital I/Q 40G streaming output"](#), on page 73.

Remote command:

[OUTPut:IQHS:MARKer](#) on page 353

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 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 FSW via LAN
- Importing I/Q data from a file

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

• Processing analog I/Q data from RF input	22
• Processing data from the Digital Baseband interface	45
• Processing data from the Analog Baseband interface	51
• Processing Oscilloscope Baseband Input	58
• Basics on input from I/Q data files	63
• Basics on the R&S FSW bandwidth extensions (R&S FSW-B2000/B5000 options)	64
• Digital I/Q 40G streaming output	73
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• Concept of I/Q noise cancellation	86
• I/Q analyzer in MSRA/MSRT operating mode	88
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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 mod-

ern 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 FSW performs frequency sweeps on the input signal and measurements in the frequency and time domain. Other applications on the 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 FSW. By default, it assumes the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the 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 FSW for a maximum of 400 Msamples ($400 \times 1000 \times 1000$) 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 25).

The block diagram in [Figure 5-1](#) shows the analyzer hardware from the IF section to the processor.

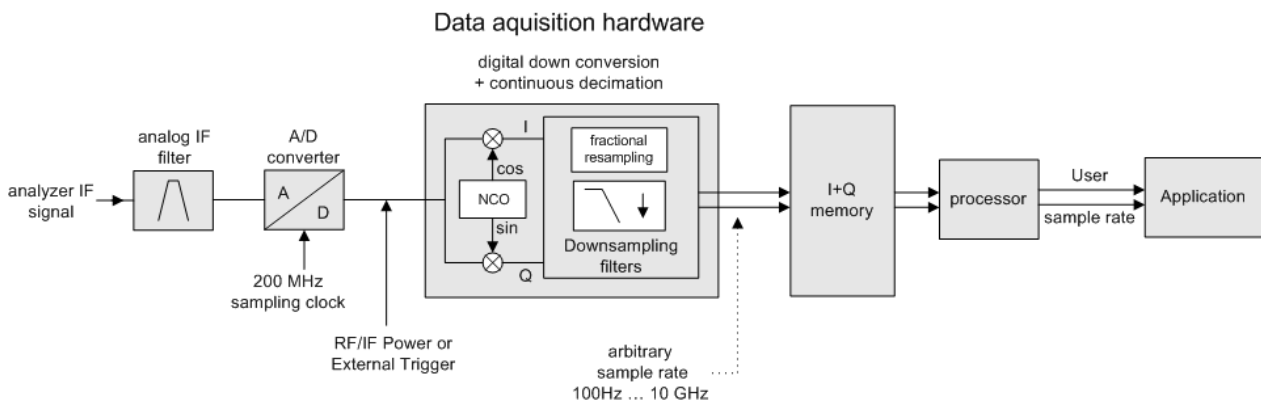


Figure 5-1: Block diagram illustrating the FSW signal processing for analog I/Q data (without bandwidth extension options)

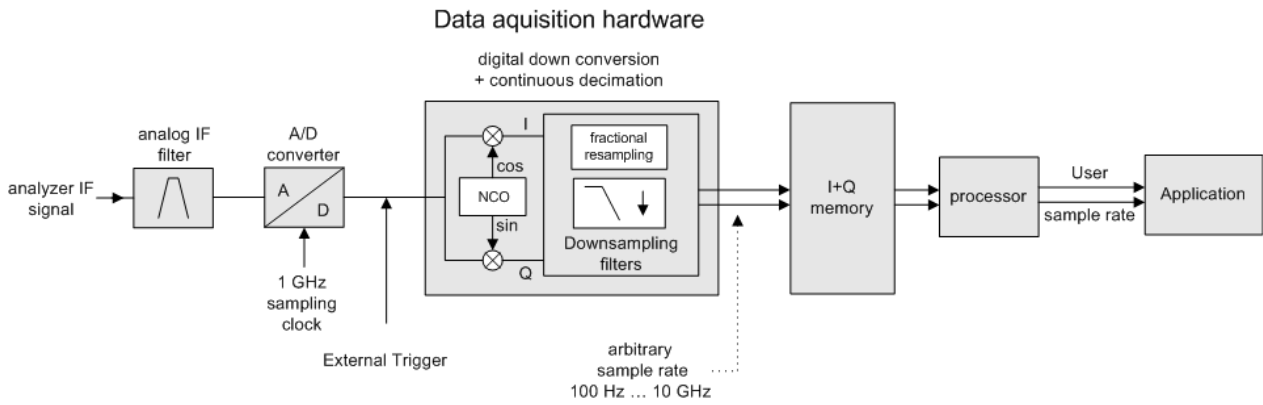


Figure 5-2: Block diagram illustrating the FSW signal processing for analog I/Q data (with option B160)

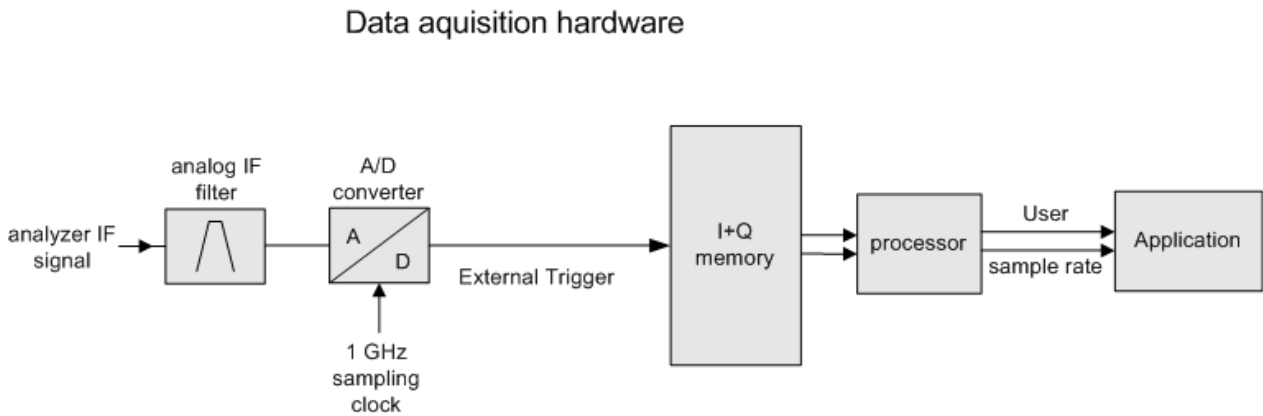


Figure 5-3: Block diagram illustrating the FSW signal processing for analog I/Q data (with option B320)

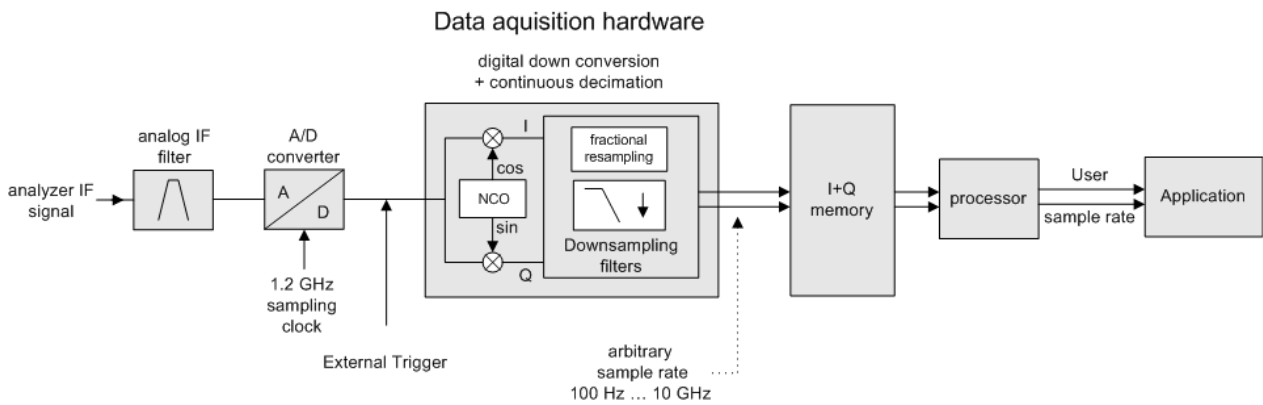


Figure 5-4: Block diagram illustrating the FSW signal processing for analog I/Q data (with option B512)

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 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 FSW
- **Record length:** the 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 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 sideband. 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 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.

- [Available bandwidth extension options](#)..... 26
- [Relationship between sample rate, record length and usable I/Q bandwidth](#)..... 26
- [FSW without additional bandwidth extension options](#)..... 29
- [FSW with I/Q bandwidth extension option B40 or U40](#)..... 29
- [FSW with I/Q bandwidth extension option B80 or U80](#)..... 30
- [FSW with activated I/Q bandwidth extension option B160 or U160](#)..... 30
- [FSW with activated I/Q bandwidth extension option B320/U320](#)..... 31
- [FSW with activated I/Q bandwidth extension option B512](#)..... 32
- [FSW with activated I/Q bandwidth extension option B1200](#)..... 34
- [FSW with activated I/Q bandwidth extension option B2001](#)..... 37
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- [FSW with activated I/Q bandwidth extension option B5000](#)..... 42
- [FSW with activated I/Q bandwidth extension option B4001/B6001/B8001](#)..... 43

5.1.1.1 Available bandwidth extension options

Table 5-1: Available bandwidth extension options

Max. usable I/Q bandwidth	Required B-option	Required U-options
28 MHz	-	-
40 MHz	B40	U40
80 MHz	B80	U40+U80 or B40+U80
160 MHz	B160	U40+U80+U160 or B40+U80+U160 or B80+U160
320 MHz	B320	U40+U80+U160+U320 or B40+U80+U160+U320 or B80+U160+U320 or B160+U320
512 MHz	B512	U40+U80+U512 or B40+U80+U512 or B80+U512 or
1200 MHz	B1200	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:

$$\text{Usable I/Q bandwidth} = 0.8 * \text{Output sample rate}$$

Regarding the record length, the following rule applies:

$$\text{Record length} = \text{Measurement time} * \text{sample rate}$$

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 5-9](#).

For activated option -B512, see [Table 5-11](#).

For activated option B1200, see [Table 5-13](#).

For activated option B2001, see [Chapter 5.1.1.10, "FSW with activated I/Q bandwidth extension option B2001"](#), on page 37.

For activated option B2000, see [Chapter 5.1.1.11, "FSW with activated I/Q bandwidth extension option B2000"](#), on page 40.

For activated option B5000, see [Chapter 5.1.1.12, "FSW with activated I/Q bandwidth extension option B5000"](#), on page 42.

For activated option B4001/B6001/B8001, see [Chapter 5.1.1.13, "FSW with activated I/Q bandwidth extension option B4001/B6001/B8001"](#), on page 43.

Table 5-2: Maximum record length (without I/Q bandwidth extension options 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.

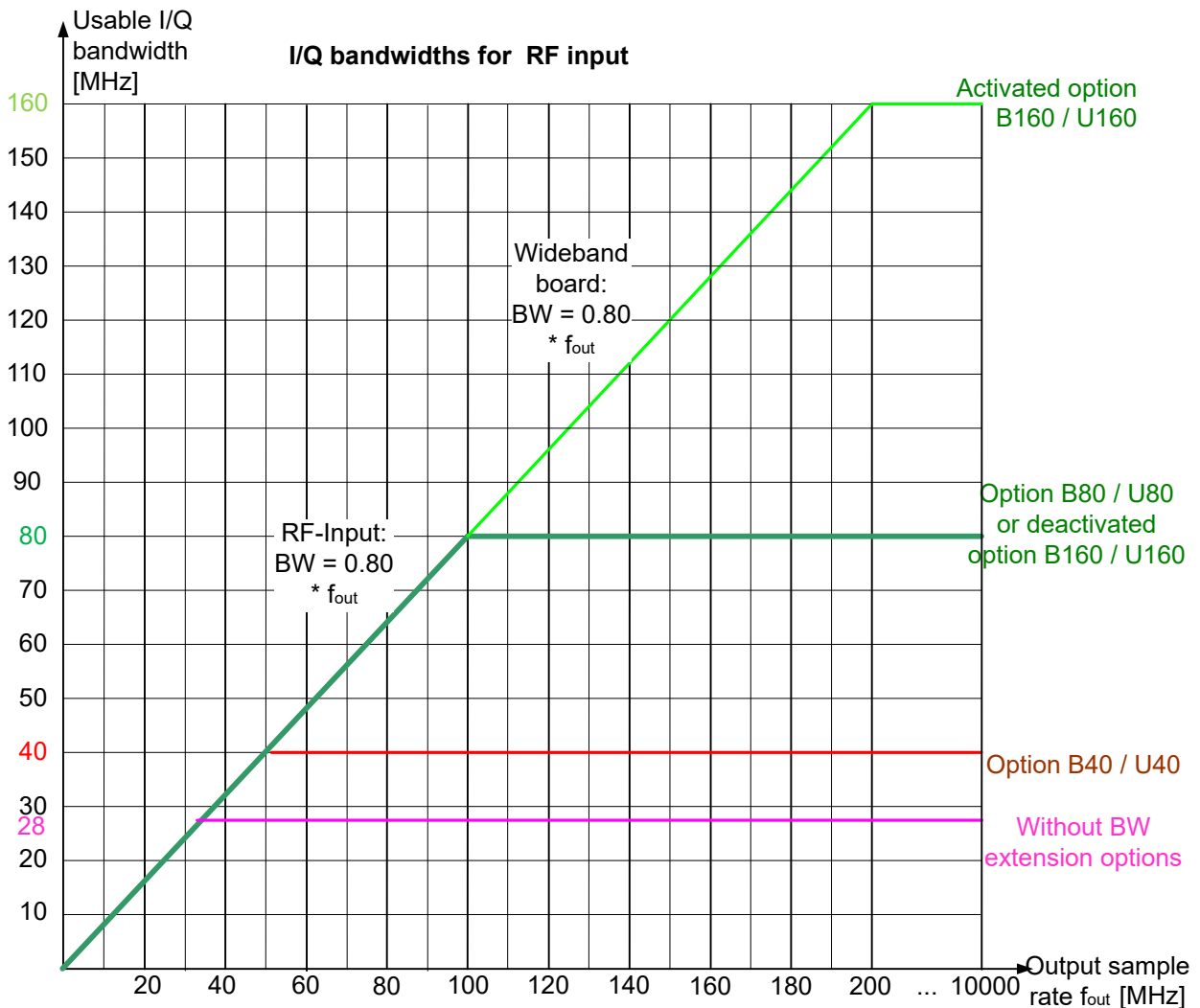


Figure 5-5: Relationship between maximum usable I/Q bandwidth and output sample rate with and without bandwidth extensions

Restricting the maximum bandwidth manually

By default, all installed bandwidth extension options are activated, allowing for the maximum bandwidth for measurements on the 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 can be necessary (for example due to postprocessing in an OFDM system), the wide bandwidth is not necessarily 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 "Maxi-

imum Bandwidth" on page 160). 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 10 times faster.
- Digital baseband output becomes available (with bandwidth extension options that do not support output).



General notes and restrictions

- The memory extension option FSW-B106 is only available together with the R&S FSW-B160 or B320 bandwidth extension options.
- The memory extension option FSW-B108 is only available together with the FSW-B1200/-B2001/-B800R options.
- The memory extension option FSW-B124 is only available together with the FSW-B4001/B6001/B8001 options.
- In MSRA operating mode, the MSRA primary 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 132

5.1.1.3 FSW without additional bandwidth extension options

Sample rate: 100 Hz - 20 GHz

Maximum I/Q bandwidth: 28 MHz

Table 5-3: Maximum I/Q bandwidth

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



MSRA operating mode

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

5.1.1.4 FSW with I/Q bandwidth extension option B40 or U40

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 40 MHz

Table 5-4: Maximum I/Q bandwidth

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 primary is restricted to a sample rate of 600 MHz.

5.1.1.5 FSW with I/Q bandwidth extension option B80 or U80

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 80 MHz

Table 5-5: Maximum I/Q bandwidth

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 primary is restricted to a sample rate of 600 MHz.

5.1.1.6 FSW with activated I/Q bandwidth extension option B160 or U160

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 160 MHz

Table 5-6: Maximum I/Q bandwidth

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 5-7: 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 FSW-B106 option: 1400 Msamples
200 MHz to 20 GHz	220 Msamples With FSW-B106 option: 700 Msamples With FSW-B106 option: 700 Msamples



Notes and restrictions for FSW-B160 or U160

- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 600 MHz.
- Digital baseband output is not available for an active FSW-B160 or U160 bandwidth extension. See "Digital Baseband Output" on page 132.

5.1.1.7 FSW with activated I/Q bandwidth extension option B320/U320

Table 5-8: Maximum I/Q bandwidth

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

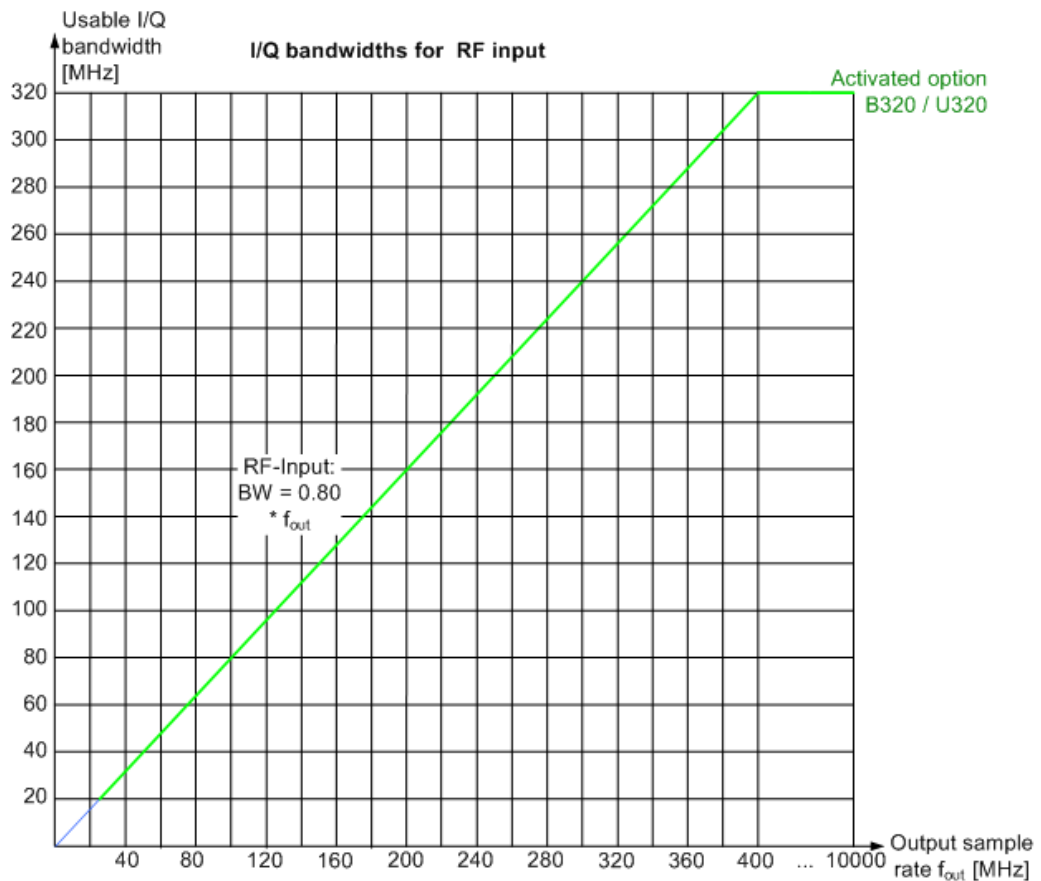


Figure 5-6: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B320

Table 5-9: 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 FSW-B106 option: 1400 Msamples
200 MHz to 468 MHz	470 Msamples * sample rate / 1GHz With FSW-B106 option: 1400 Msamples * sample rate / 1GHz
468 MHz to 20 GHz	220 Msamples With 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 FSW-B320**

- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 600 MHz.
- Digital baseband output is not available for an active FSW-B320 bandwidth extension. See "[Digital Baseband Output](#)" on page 132.

5.1.1.8 FSW with activated I/Q bandwidth extension option B512

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

Table 5-10: Maximum I/Q bandwidth

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

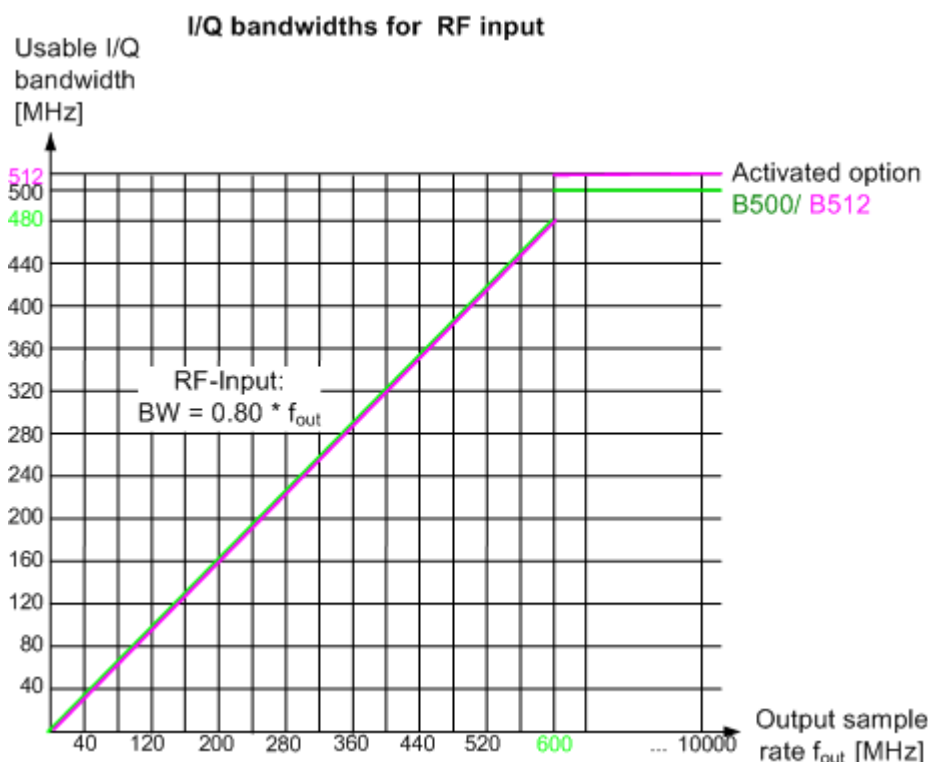


Figure 5-7: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B512

Table 5-11: Maximum record length with activated I/Q bandwidth extension option FSW-B512

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



Notes and restrictions for FSW-B512

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



Bandwidths between 480 MHz and 512 MHz with FSW-B512 option

Note the irregular behavior of the relationship between the sample rate and the usable I/Q bandwidth 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:

$$\text{Usable I/Q bandwidth} = 0.8 * \text{output sample rate}$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (500/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8333$$

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:

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (512/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8533$$

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

$$\text{Usable I/Q bandwidth} = 0.8 * \text{output sample rate}.$$

5.1.1.9 FSW with activated I/Q bandwidth extension option B1200

The bandwidth extension option FSW-B1200 provides measurement bandwidths up to 1200 MHz.

Table 5-12: Maximum I/Q bandwidth

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
*) Exception: for active digital I/Q 40G streaming output, a sample rate of 1200 MHz provides a maximum I/Q bandwidth of 1000 MHz	

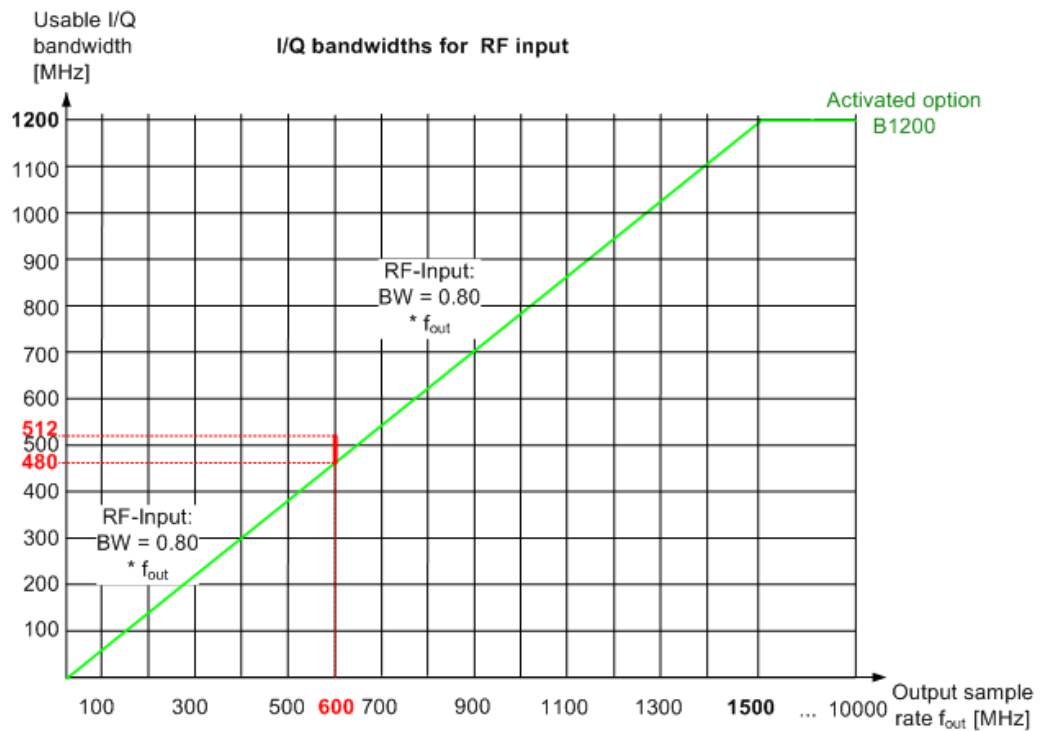


Figure 5-8: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B1200

Table 5-13: Maximum record length with activated I/Q bandwidth extension option FSW-B1200

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

**Notes and restrictions for FSW-B1200**

- The memory extension option FSW-B106 is not available together with the B1200 option.
- For an active FSW-B1200 bandwidth extension, the maximum output sample rate is 200 MHz. See "[Digital Baseband Output](#)" on page 132.
- Real-time measurements, and thus the entire MSRT operating mode, together with the FSW-B1200 bandwidth extension option, are only available with the R&S FSW-K800RE option.
In MSRT operating mode, the MSRT primary application is then restricted to a sample rate of 1000 MHz.
- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 600 MHz.
- When the FSW-B1200 option is active, only an external trigger (or no trigger) is available.



Irregular behavior in bandwidths between 480 MHz and R&S FSW512 MHz with FSW-B1200 option

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

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (500/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8333$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (512/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8533$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8$$

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

$$\text{Output sample rate} * 0.8533 = \mathbf{512 \text{ MHz}}$$

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:

$$\text{Usable I/Q bandwidth} = 0.8 * \text{output sample rate}.$$

5.1.1.10 FSW with activated I/Q bandwidth extension option B2001

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

Table 5-14: Maximum I/Q bandwidth

Sample rate	Maximum I/Q bandwidth
100 Hz to 600 MHz	$0.8 * \text{sample rate}$
600 MHz	$0.8533 * \text{sample rate} (=512 \text{ MHz})$
*) Exception: for active digital I/Q 40G streaming output, a sample rate of 1200 MHz provides a maximum I/Q bandwidth of 1000 MHz	

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

*) Exception: for active digital I/Q 40G streaming output, a sample rate of 1200 MHz provides a maximum I/Q bandwidth of 1000 MHz

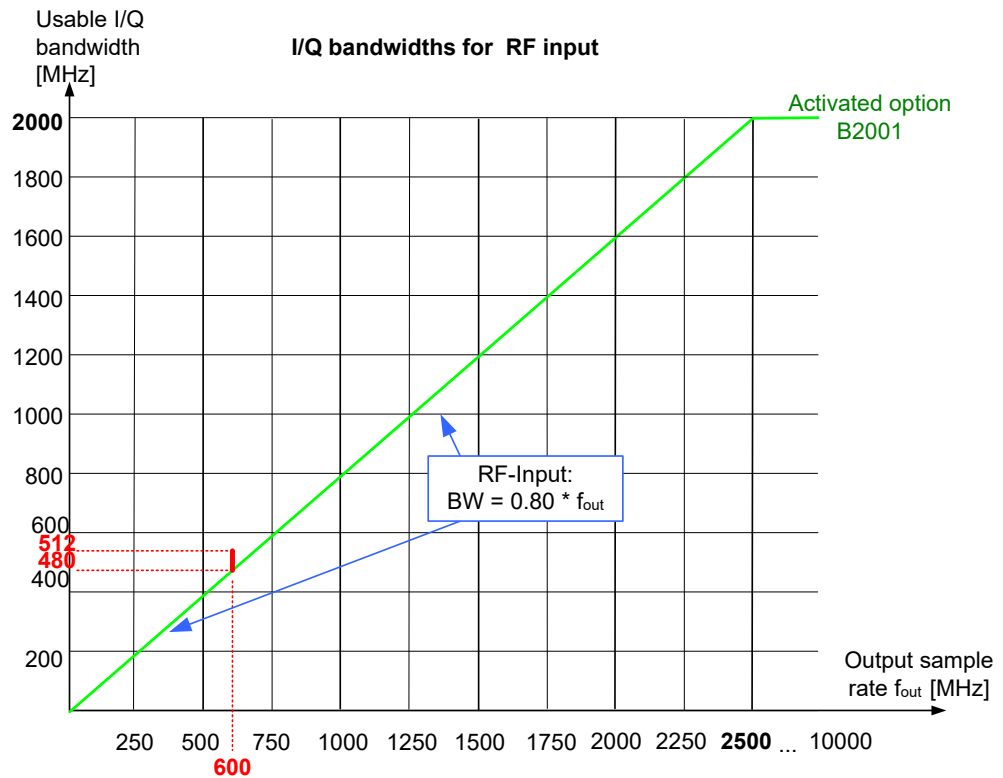


Figure 5-9: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B2001

Table 5-15: Maximum record length with activated I/Q bandwidth extension option FSW-B2001

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

**Notes and restrictions for FSW-B2001**

- The memory extension option FSW-B106 is not available together with the B2001 option.
- For an active FSW-B2001 bandwidth extension, the maximum output sample rate is 200 MHz. See "[Digital Baseband Output](#)" on page 132.
- Real-time measurements, and thus the entire MSRT operating mode, together with the FSW-B2001 bandwidth extension option, are only available with the R&S FSW-K800RE option.
In MSRT operating mode, the MSRT primary application is then restricted to a sample rate of 1000 MHz.
- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 600 MHz.
- When the 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 FSW-B2001 option

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

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (500/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8333$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / (512/600)$$

Or

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8533$$

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

$$\text{Output sample rate} = \text{usable I/Q bandwidth} / 0.8$$

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

$$\text{Output sample rate} * 0.8533 = \mathbf{512\ MHz}$$

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:

$$\text{Usable I/Q bandwidth} = 0.8 * \text{output sample rate}.$$

5.1.1.11 FSW with activated I/Q bandwidth extension option B2000

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

Table 5-16: Maximum I/Q bandwidth

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

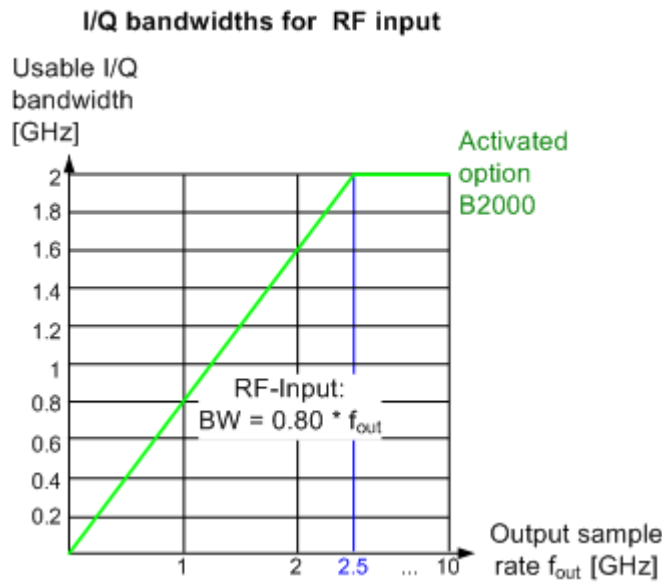


Figure 5-10: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B2000

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

The maximum record length provided by the 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 5-17: Maximum record length with activated I/Q bandwidth extension option B2000

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

Example:

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

$$((400 \text{ MSamples} * 2.5 \text{ GHz}) / 10 \text{ GHz}) - 100 = \mathbf{99.999900 \text{ MSamples}}$$

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



Notes and restrictions for FSW-B2000

- The memory extension options FSW-B106/-B108/-B124 are not available together with the B2000 option.
 - If the FSW-B2000 bandwidth extension option is active, MSRA operating mode is not available.
 - Digital baseband output is not available for an active FSW-B2000 bandwidth extension. See "[Digital Baseband Output](#)" on page 132.
 - The maximum memory size, and thus record length, available for a single input channel can be reduced by half in the following cases:
 - When using an external trigger in common B2000 mode, which uses another channel on the oscilloscope.
 - In power splitter mode, which uses two input channels on the oscilloscope.
- For details, see the oscilloscope's specifications document and documentation. For details on the power splitter mode, see [Chapter 5.6.8, "Power splitter mode"](#), on page 72.

5.1.1.12 FSW with activated I/Q bandwidth extension option B5000

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

Table 5-18: Maximum I/Q bandwidth

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

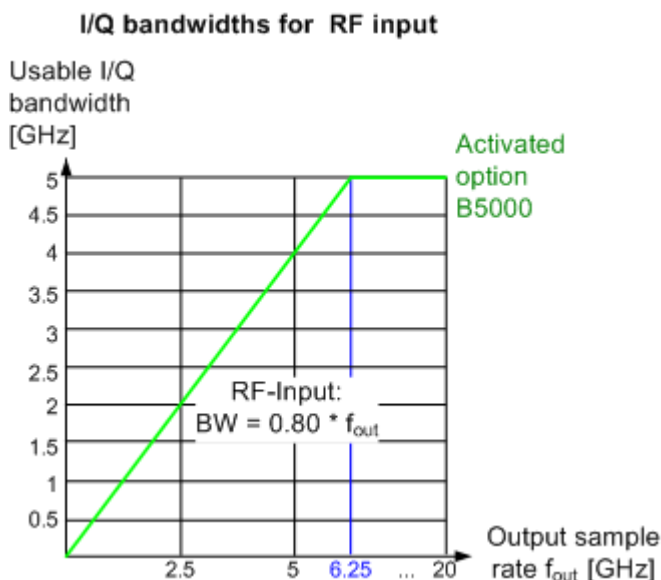


Figure 5-11: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B5000

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

The maximum record length provided by the 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 5-19: Maximum record length with activated I/Q bandwidth extension option B5000

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

Example:

Assume the following conditions:

- Maximum sample rate of 20 GHz on the FSW
- Maximum bandwidth of 5 GHz on the FSW
- Maximum memory depth of 400 MSamples on the oscilloscope
- Fixed sample rate of 20 GHz on the oscilloscope

Then the maximum record length is approximately:

$$((400 \text{ MSamples} * 20 \text{ GHz}) / 20 \text{ GHz}) - 100 = \mathbf{399.999900 \text{ MSamples}}$$

**Notes and restrictions for FSW-B5000**

- The memory extension options FSW-B106/-B108/-B124 are not available together with the B5000 option.
- If the FSW-B5000 bandwidth extension option is active, MSRA operating mode is not available.
- Digital baseband output is not available for an active FSW-B5000 bandwidth extension. See ["Digital Baseband Output"](#) on page 132.
- The maximum memory size, and thus record length, available for a single input channel can be reduced by half in the following cases:
 - When using an external trigger in common B5000 mode, which uses another channel on the oscilloscope.
 - In power splitter mode, which uses two input channels on the oscilloscope.

For details, see the oscilloscope's specifications document and documentation.

For details on the power splitter mode, see [Chapter 5.6.8, "Power splitter mode"](#), on page 72.

5.1.1.13 FSW with activated I/Q bandwidth extension option B4001/B6001/B8001

The (internal) bandwidth extension options 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.



Bandwidth extension options B6001 / B8001 at CF 9.933 GHz

For a center frequency of 9.933 GHz, you can enable the extended bandwidth using options B6001 / B8001, if available, using the "9.933 GHz Mode" on page 161.

As long as this mode is enabled, the following restrictions apply:

- You cannot change the center frequency. Disable the 9.933 GHz Mode first.
- The analysis bandwidth (ABW) is set to 6400 MHz (using B6001) / 8312 MHz (using B8001) and cannot be reduced below 4400 MHz.
- The 200 MHz filter is not available.

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

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

Table 5-20: Maximum I/Q bandwidth

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
	8000 MHz to 20 GHz	6400 MHz
B8001	100 Hz to 10390 MHz	0.8 * sample rate
	10390 MHz to 20 GHz	8312 MHz

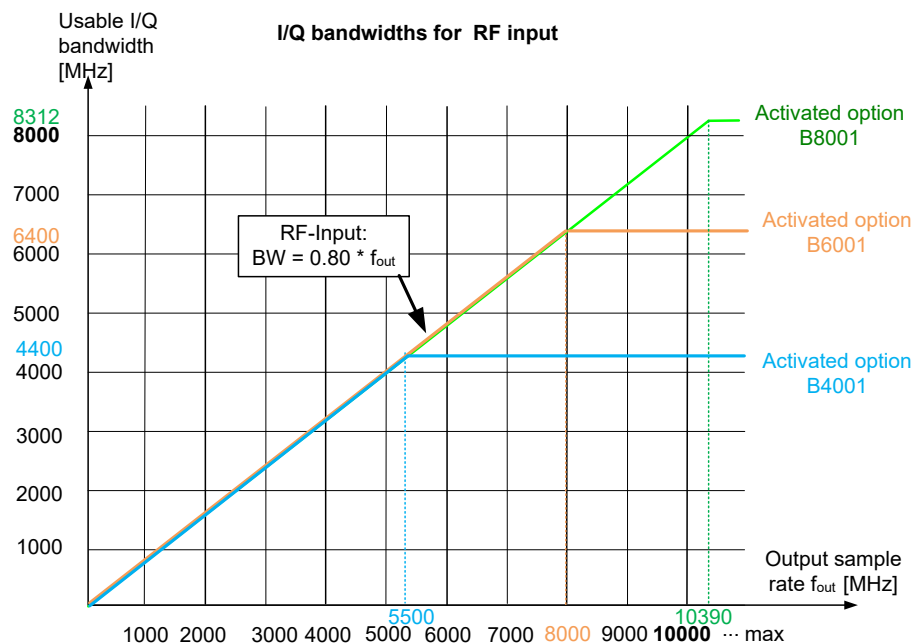


Figure 5-12: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B4001/B6001/B8001

Table 5-21: Maximum record length with activated I/Q bandwidth extension option FSW-B4001/B6001/B8001

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



Notes and restrictions for FSW-B4001/B6001/B8001

- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 200 MHz and a maximum bandwidth of 80 MHz.
- If a 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 FSW-B4001/B6001/B8001 bandwidth extension options are installed.
- Digital baseband output is not available for an active FSW-B4001/B6001/B8001 bandwidth extension. See "[Digital Baseband Output](#)" on page 132.

5.2 Processing data from the Digital Baseband interface

Alternatively to capturing (analog) I/Q data from the standard RF Input connector on the 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.

- [Digital input](#)..... 46
- [Digital output](#)..... 47
- [Sample rates and bandwidths for digital I/Q data](#)..... 48
- [Interface status information](#)..... 50

5.2.1 Digital input

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

Connecting the digital input instrument

The instrument that provides digital input must be connected to the "Digital Baseband" interface on the 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 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.

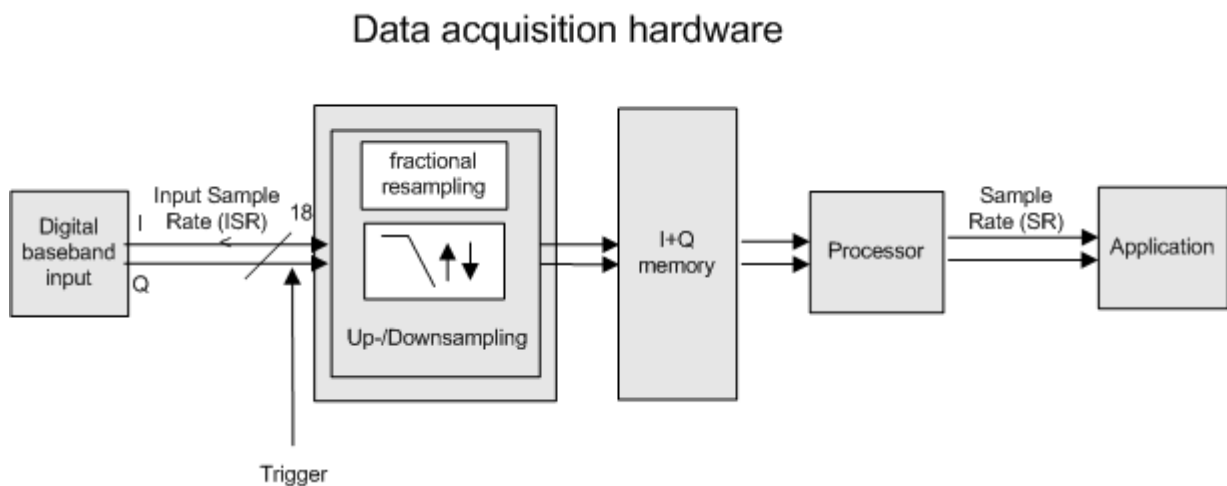


Figure 5-13: Signal path using digital input

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 149)
- BB Power (see ["Baseband Power"](#) on page 151)
- Time (see ["Time"](#) on page 153)
- Digital I/Q general purpose trigger (see ["Digital I/Q"](#) on page 152)

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, "Basics on I/Q data acquisition and processing"](#), 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 "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 FSW.

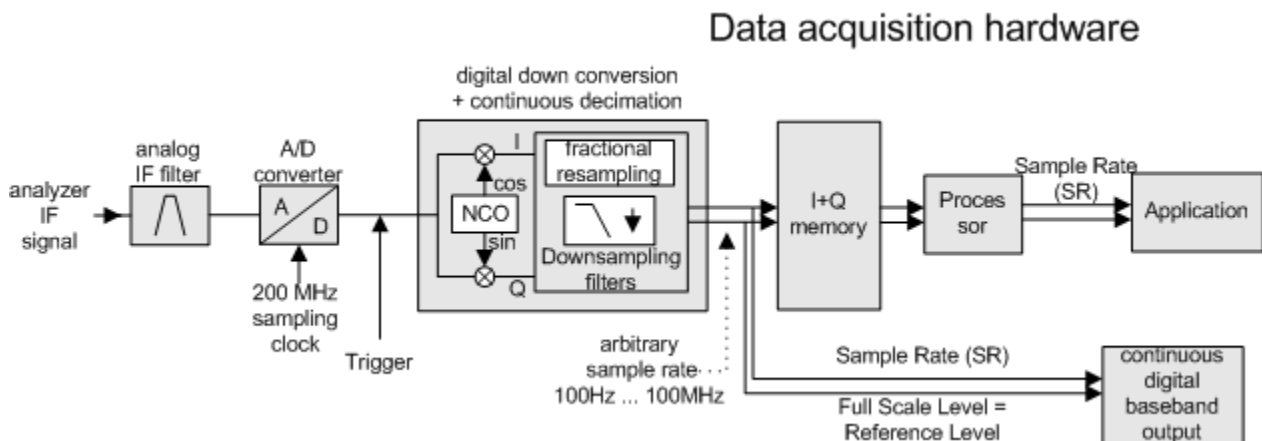


Figure 5-14: Signal path using the digital output

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 132). 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 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 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 28. For bandwidths larger than 80 MHz, digital output is automatically deactivated.



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

Digital I/Q output is also available with the bandwidth extension options 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 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 FSW and the connected device. Both instruments must be able to process data at this rate. The clock rate of the 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 Acquisition" dialog box in the "I/Q Analyzer" application). It 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 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 that 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 FSW via the Digital I/Q Interface with a sample rate of 100 Msps. Then the input sample rate on the 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 I/Q" 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 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 5-22: Restrictions for digital in- and output

Parameter	Minimum	Maximum
Record length	2 complex samples	200*1000*1000 complex samples With FSW-B106 option: 660*1000*1000 complex samples With 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)

Parameter	Minimum	Maximum
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 5-22](#) 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 161, the analysis sample rate is identical to the input sample rate. In this case, the usable I/Q bandwidth is not restricted by the FSW.

Bandwidths

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

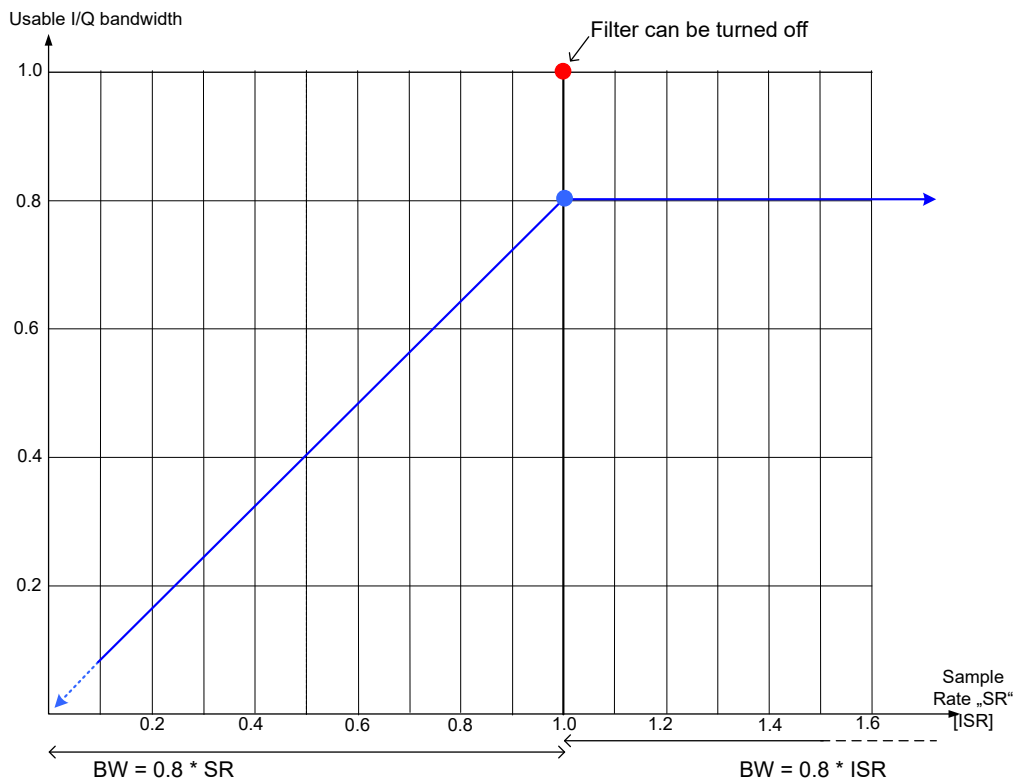


Figure 5-15: Bandwidths depending on sample rate for active digital input

5.2.4 Interface status information

When a digital input or output instrument is connected to the "Digital Baseband" interface, the "Input" or "Output" dialog boxes provide information on the status of the con-

nection (see ["Connected Instrument"](#) on page 116, ["Connected Instrument"](#) on page 132, ["Output Settings Information"](#) on page 132).









You can query the information in these dialog boxes using remote commands, see [INPut:DIQ:CDEvice](#) on page 290 and [OUTPut<up>:DIQ:CDEvice?](#) on page 292.

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 5-23: Status information for digital baseband connections

Icon	Status
Digital input	
	Connection setup in progress
	Connection established
	<ul style="list-style-type: none"> • 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
	<ul style="list-style-type: none"> • 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 11.11, "Querying the status registers"](#), on page 487)

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 FSW. Alternatively, analog baseband signals can also be captured via the optional **"Analog Baseband" interface**, if installed.

• (Analog) baseband input 50 ohm connectors (optional).....	52
• Analog baseband input.....	53
• I/Q processing modes.....	54
• Sample rates and bandwidths for analog baseband signals.....	56
• RF input from the analog baseband connector.....	57
• Average power consumption.....	58

5.3.1 (Analog) baseband input 50 ohm connectors (optional)

The "Analog Baseband" interface option provides four "Baseband input" BNC connectors on the front panel of the FSW for analog I and Q signals.

(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 specifications document)

The lower BNC connectors \bar{I} and \bar{Q} are used to input the negative signal for differential signals.



FSW85

The 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 specifications document.

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 connec-

tions 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 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 FSW.

An analog baseband signal is input at the "Baseband Input I" and "Baseband Input Q" connectors and processed from there.

As an alternative, an RF signal can be input at the "Baseband Input I" connector and redirected from there to the RF input path (not available for FSW67 or 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 FSW can process both single-ended (unbalanced) and differential (balanced) input. The signal is input to the 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.

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 the FSW User Manual.

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 149):

- 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 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 118).



Prerequisites for previous models of FSW

For 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.

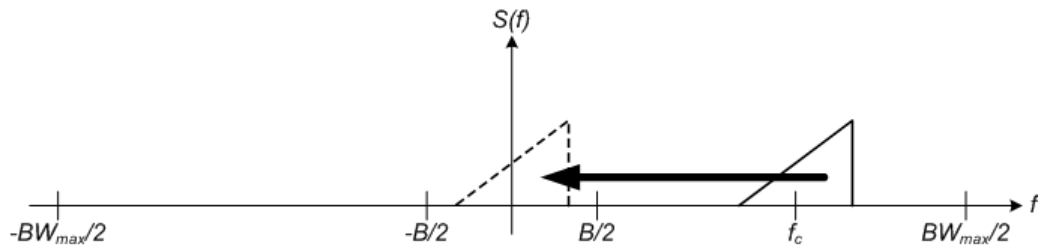


Figure 5-16: Spectrum in complex baseband (I+jQ) mode

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 56).

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 56.) 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 56).

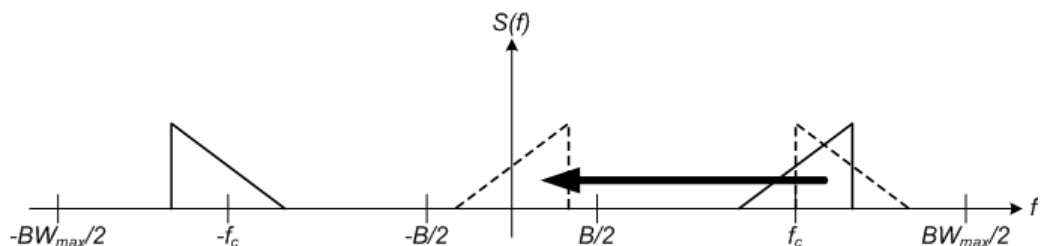


Figure 5-17: Spectrum in low IF mode

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).

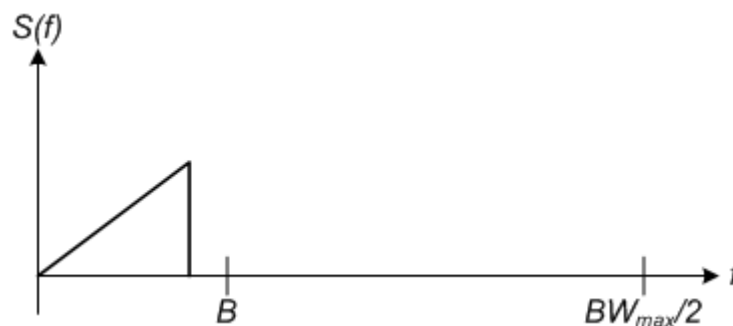


Figure 5-18: Spectrum in real baseband mode

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 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 FSW. The sample rate and the analysis bandwidth are interdependent and are adapted according to the following formula in the I/Q Analyzer

$$\text{Analysis bandwidth} = 0.8 * \text{sample rate}$$

$$\text{(For I or Q only: Analysis bandwidth} = 0.4 * \text{sample rate)}$$

See also [Chapter 5.1.1, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 25.

Bandwidth extension options

The standard 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 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 5-24](#)) 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 FSW to do so, but a warning message is displayed if the limits are exceeded.

Table 5-24: 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	$BW_{max} = +80 \text{ MHz}$ (default) $BW_{max} = +160 \text{ MHz}$ (with B71E option) $-BW_{max}/2 + BW/2 \leq f_c \leq BW_{max}/2 - BW/2$ *)	$BW_{max} = +40 \text{ MHz}$ (default) $BW_{max} = +80 \text{ MHz}$ (with B71E option) $-BW_{max}/2 + BW/2 \leq f_c \leq BW_{max}/2 - BW/2$ *)	$BW_{max} = +40 \text{ MHz}$ (default) $BW_{max} = +80 \text{ MHz}$ (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)	$f_c = 0 \text{ Hz}$
Span	= Sample rate	= Sample rate	= Sample rate / 2
*) not forced by 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, "Basics on I/Q data acquisition and processing"](#), 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.

For details on probes, see the FSW User Manual.

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 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 297

[TRACe: IQ:APCon:A](#) on page 298

[TRACe: IQ:APCon:B](#) on page 298

[TRACe: IQ:APCon:RESult?](#) on page 298

5.4 Processing Oscilloscope Baseband Input

In order to obtain analog baseband data directly from the 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 51)

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 FSW to the

oscilloscope via LAN, it receives the captured I/Q data. This measurement setup only requires a software option on the 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 specifications document.

Basic principle of Oscilloscope Baseband Input

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

Data acquisition hardware

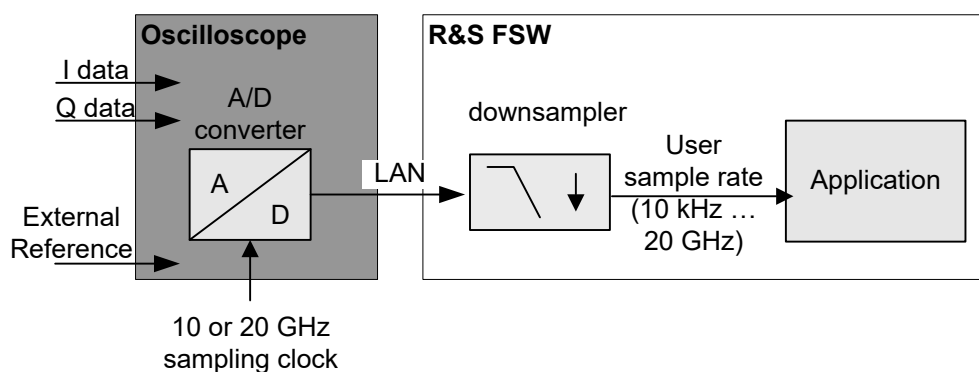


Figure 5-19: Signal processing using the optional Oscilloscope Baseband Input



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

Complex signal input (I+Q)

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



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

The 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": \bar{I}
- "Ch3": Q
- "Ch4": \bar{Q}



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 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 149):

- "Baseband Power" on page 151 (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.

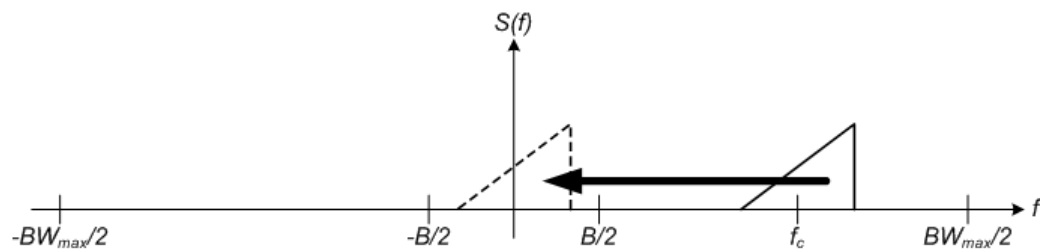


Figure 5-21: Spectrum in complex baseband (I+Q) mode

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 62).

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 62).

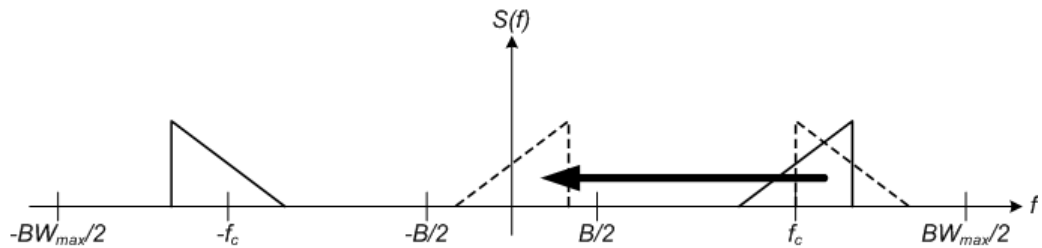


Figure 5-22: Spectrum in low IF mode

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 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 specifications document).
- 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 474).
- 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 FSW depends on the bandwidth provided by the oscilloscope.

$$\text{max. BW}_{\text{SA}} = \text{max. BW}_{\text{osci}} (\text{I-channel}) + \text{max. BW}_{\text{osci}} (\text{Q-channel}) = 2 * \text{max. BW}_{\text{osci}}$$

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 FSW. The analysis bandwidth and the sample rate are interdependent and are adapted according to the following formula in the I/Q Analyzer:

$$\text{Sample rate} = \text{Analysis bandwidth} / 0.8$$

$$(\text{For I only: Sample rate} = \text{Analysis bandwidth} / 0.4)$$

However, the maximum user sample rate on the 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 FSW to do so, but a warning message is displayed if the limits are exceeded.

5.5 Basics on input from I/Q data files

The I/Q data to be evaluated in a particular FSW application cannot 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 AM/FM/PM Modulation Analysis application.

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](#)

When importing data from an I/Q data file using the import functions provided by some FSW applications, the data is only stored temporarily in the capture buffer. It overwrites the current measurement data and is in turn overwritten by a new measurement. If you use an I/Q data file as input, the stored I/Q data remains available 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, 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 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 FSW.

Furthermore, you can create your own `iq.tar` files in the I/Q Analyzer, see [Chapter 8.3, "How to export and import I/Q data"](#), on page 231.

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.

5.6 Basics on the R&S FSW 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](#)

- [Basic principle of the B2000](#).....65
- [Basic principle of the B5000](#).....65
- [Prerequisites and measurement setup](#)..... 66
- [Controlling the oscilloscope](#)..... 68

- [Alignment](#)..... 68
- [Data acquisition](#).....69
- [Triggering](#)..... 70
- [Power splitter mode](#)..... 72
- [Restrictions](#)..... 73

5.6.1 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 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 FSW, where it is equalized and resampled to the sample rate required by the FSW measurement application. The entire measurement and both instruments are controlled by the FSW.

Data acquisition hardware

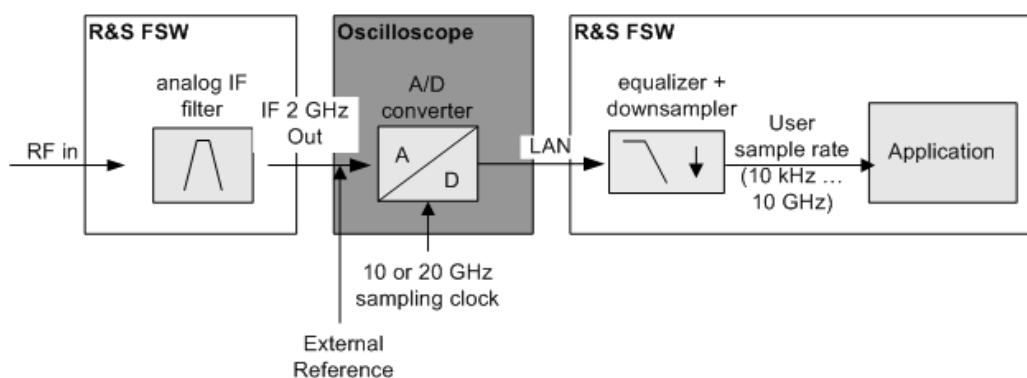


Figure 5-23: Signal processing using the optional 2 GHz bandwidth extension (R&S FSW-B2000)



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

For details see [Chapter 5.10, "I/Q data import and export"](#), on page 79.

5.6.2 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 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 FSW, where it is equalized and resampled to the sample rate required by the FSW measurement application. The entire measurement and both instruments are controlled by the FSW.

Data acquisition hardware

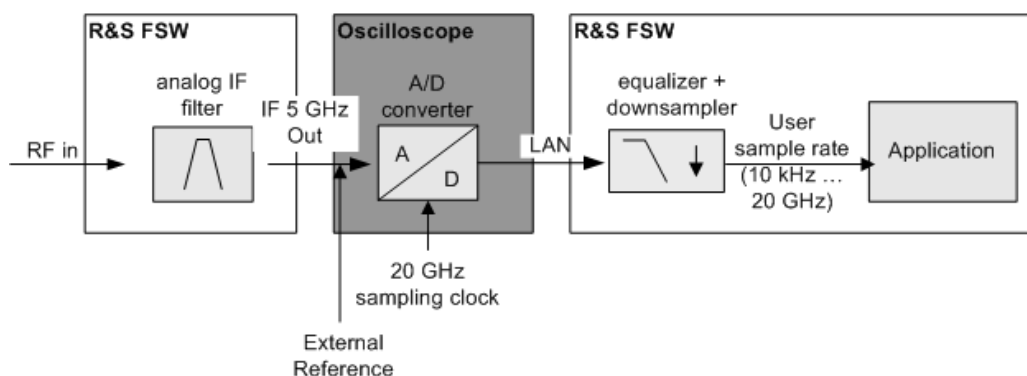


Figure 5-24: Signal processing using the optional 5 GHz bandwidth extension (R&S FSW-B5000)

5.6.3 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:

- FSW model with at least 26 GHz
- The R&S FSW-B2000 option and the IF OUT 2 GHz connector installed on the FSW
- A supported Rohde & Schwarz oscilloscope (see specifications document) 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

Basics on the R&S FSW bandwidth extensions (R&S FSW-B2000/B5000 options)

- The connector of the FSW is connected to the CH1 input of the oscilloscope
- An external reference (for example the REF OUTPUT 10 MHz connector of the FSW or a reference from a signal generator) is connected to the REF IN connector of the oscilloscope
- The oscilloscope is connected to the FSW via LAN, and the oscilloscope's address is made known to the FSW
- Optionally, a trigger signal (for example from the TRIG OUT connector of the FSW) can be connected to the CH3 input connector of the oscilloscope

For R&S FSW-B5000:

- FSW85
- The R&S FSW-B5000 option and the IF OUT 5 GHz connector installed on the FSW
- A supported Rohde & Schwarz oscilloscope (see specifications document) 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 FSW is connected to the CH1 input of the oscilloscope
- An external reference (for example the REF OUTPUT 10 MHz connector of the FSW or a reference from a signal generator) is connected to the REF IN connector of the oscilloscope
- The oscilloscope is connected to the FSW via LAN, and the oscilloscope's address is made known to the FSW
- Optionally, a trigger signal (for example from the TRIG OUT connector of the FSW) can be connected to the CH3 input connector of the oscilloscope

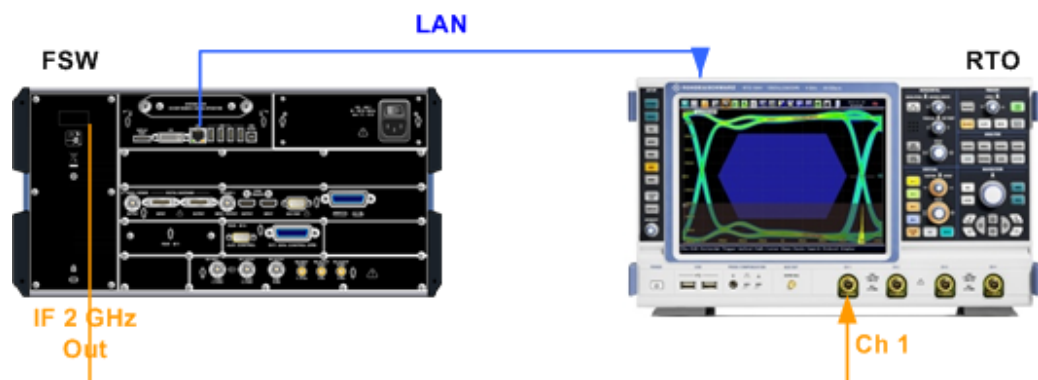


Figure 5-25: Measurement setup using the FSW and an R&S RTO



Prerequisites for power splitter mode

When using the power splitter mode, other (additional) prerequisites and setup conditions apply, see [Chapter 5.6.8, "Power splitter mode"](#), on page 72.

5.6.4 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 FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the FSW.



For tips on how to determine the oscilloscope's computer name or IP address see [Chapter 8.2.5, "How to capture data via the optional 2 GHz / 5 GHz bandwidth extension \(FSW-B2000/B5000\)"](#), on page 224.

As soon as the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000) is activated (see ["B2000/B5000 State"](#) on page 124), the FSW takes control of the oscilloscope. The display on the oscilloscope is turned off to improve performance during data export. As soon as the 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 344).

5.6.5 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 FSW
- A new cable is used between the IF OUT 2 GHz/ IF OUT 5 GHz connector of the FSW and the oscilloscope
- A power splitter is inserted between the IF OUT 2 GHz/ IF OUT 5 GHz connector of the FSW and the oscilloscope
- New firmware is installed on the oscilloscope or the 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 ($> 5\text{ °C}$)
- 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 FSW, together with the B2000/B5000 alignment.

General alignment process

The alignment process between the FSW and the oscilloscope is performed by selecting a button on the FSW. Successful alignment of the oscilloscope and the oscilloscope ADC are indicated in a dialog box on the 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 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 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 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 FSW. For a description of possible errors see [Table 10-5](#).

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 FSW.

5.6.6 Data acquisition

Once the B2000/B5000 option has been aligned and activated, the 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 specifications document). The record length may be restricted by the connected oscilloscope (see its specifications document).

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:

- FSW I/Q Analyzer
- FSW Analog Demodulation
- FSW Pulse Measurements
- FSW Amplifier Measurements
- FSW Transient Measurements

Basics on the R&S FSW bandwidth extensions (R&S FSW-B2000/B5000 options)

- FSW Vector Signal Analysis
- FSW OFDM Vector Signal Analysis
- FSW 802.11ad Measurements
- FSW HRP UWB Measurements

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

- FSW I/Q Analyzer
- FSW Analog Demodulation
- FSW Pulse Measurements
- FSW Amplifier Measurements
- FSW Transient Measurements
- FSW Vector Signal Analysis
- FSW OFDM Vector Signal Analysis
- FSW 802.11ad Measurements

5.6.7 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 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 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 FSW assumes a cable the length of 1 m between the 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 specifications document 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 FSW, with a default value of 1 μ s.

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.

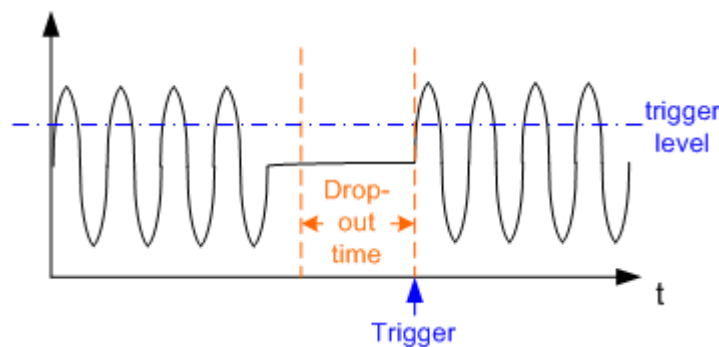


Figure 5-26: Trigger event for IF power trigger using B2000/B5000

A **Hysteresis** defined on the 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

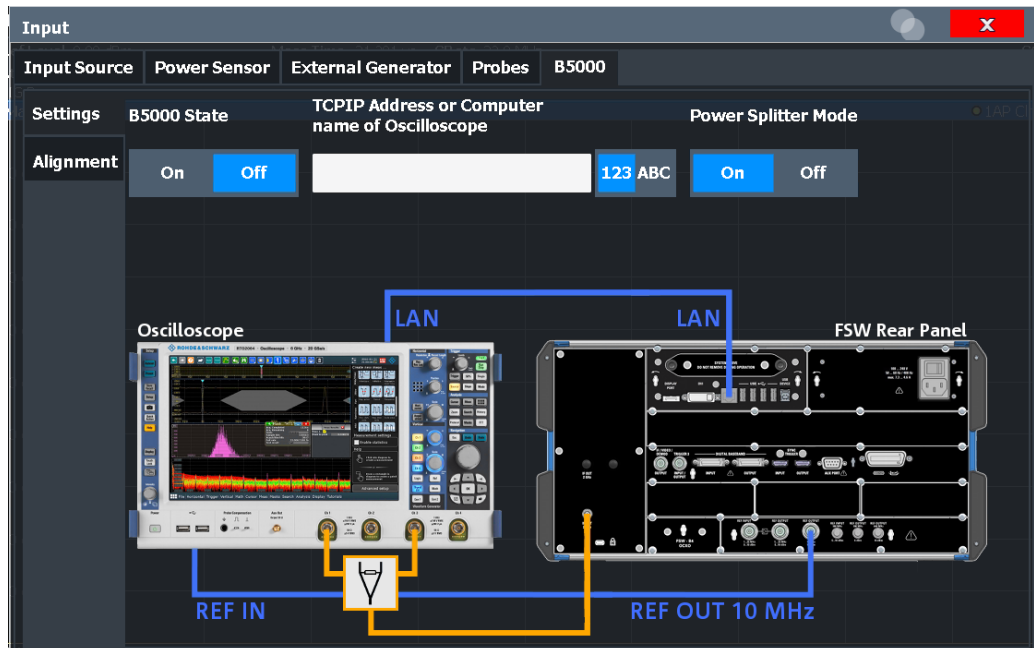
The coupling mode of the external trigger to the oscilloscope can be configured in the "Trigger" settings.

5.6.8 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 FSW is connected to the Ch1 input of the oscilloscope (see [Measurement setup using the FSW and an R&S RTO](#)). In some cases, splitting the output power of the 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 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 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 6.3.1.7, "Settings for 2 GHz / 5 GHz bandwidth extension \(R&S FSW-B2000/ B5000\)"](#), on page 123). 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 149).

(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 5.6.3, "Prerequisites and measurement setup"](#), on page 66), the following applies when using the power splitter mode:

- The IF OUT 2 GHz/ IF OUT 5 GHz connector of the 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 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 specifications document and documentation.

5.6.9 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 FSW controlling the option, is not possible.
- MSRA mode is not available.
- The center frequency must lie between 5.5 GHz (9.5 GHz for B5000) 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 specifications document).
- 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 474).
- 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 FSW firmware.

5.7 Digital I/Q 40G streaming output

The Digital I/Q 40G Streaming Output options (FSW-B517/-B1017) provide raw, unprocessed I/Q data to the QSFP+ connector on the rear panel of the FSW. Any supported

device (see specifications document) can be connected to the FSW to process the I/Q data further.

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

- I/Q Analyzer (not MSRA mode, sample rate up to 1200 MHz)
- Real-Time measurements (R&S FSW-K512R/RE, R&S FSW-K800R/RE, sample rate up to 600 MHz, not MSRT mode)
- Analog Modulation Analysis (R&S FSW-K7, sample rate up to 600 MHz)
- Vector Signal Analysis (R&S FSW-K70, sample rate up to 600 MHz)
- Pulse measurements (R&S FSW-K6, sample rate up to 600 MHz)
- Transient Analysis (R&S FSW-K60, sample rate up to 600 MHz)



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 FSW Getting Started manual.

The "Digital Baseband" interface (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 132).



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 (for B517) or 1200 MHz (for B1017). 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 134).

Note the exception in the available bandwidth for active digital I/Q 40G output with a sample rate of 1200 MHz (for B1017). As opposed to the general rule $Usable\ I/Q\ bandwidth = 0.8 * Output\ sample\ rate$, a sample rate of 1200 MHz provides a bandwidth of 1000 MHz (instead of 960 MHz).

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 mes-

sage 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 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 (see ["Insert Marker"](#) on page 133). 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.

I/Q 40G Recording window

The "I/Q 40G Recording" window is available from the "Display Config" menu and can be inserted in the SmartGrid like a result display. It 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.



Interface Status Information

When an instrument is connected to the Digital I/Q 40G Streaming Output connector on the FSW, the "Output" > "Digital I/Q 40G" dialog box provides information on the status of the connection (see ["Connected Instrument"](#) on page 134).






You can query the information in this dialog box using a remote command, see [OUTPut:IQHS:CDEvice?](#) on page 353.

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 5-25: Status information for Digital I/Q 40G Streaming Output connections

Icon	Status
	Connection established
	<ul style="list-style-type: none"> • Connection error • No cable connected although "Digital I/Q 40G Streaming Out" state = "ON"
	"Digital I/Q 40G Streaming Out" state = "OFF"

5.8 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 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 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64.

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 specifications document.

2ND IF Output

For instrument models 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 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 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 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64

Prerequisites

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

- Instrument model FSW26/43/50/67/85; external mixers can be used
- Zero span mode, I/Q Analyzer, or optional application supporting B2000 (See [Chapter 5.6.6, "Data acquisition"](#), on page 69)
- Center frequency ≥ 5.5 GHz
- Optional 2 GHz bandwidth extension (R&S FSW-B2000) is not active

Prerequisites for output to the **"IF OUT 5 GHz"** connector ("2ND IF"):

- Instrument model FSW43/85; external mixers can be used
- Zero span mode, I/Q Analyzer, or optional application supporting B5000
- Center frequency ≥ 9.5 GHz
- Optional 5 GHz bandwidth extension (R&S FSW-B5000) is not active

5.9 Receiving and providing trigger signals

Using one of the "TRIGGER INPUT / OUTPUT" connectors of the FSW, the FSW can use a signal from an external device as a trigger to capture data. Alternatively, the internal trigger signal used by the 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 FSW "Getting Started" manual.

External trigger as input

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



External triggers with R&S FSW-B2000/B5000

When the input is provided from an 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 FSW.

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

For details, see [Chapter 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64.

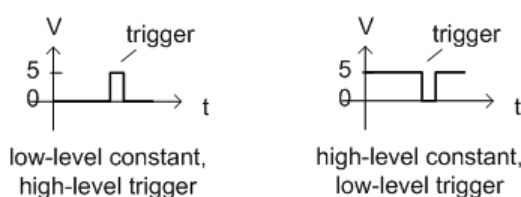
Trigger output

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

The trigger signal can be output by the FSW automatically, or manually by the user. If it is provided automatically, a high signal is output when the FSW has triggered due to a sweep start ("Device Triggered"), or when the 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 "Send Trigger" is selected. Then, a low pulse is provided.



5.10 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 inphase (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 FSW later.
The FSW supports various I/Q data formats for import.
See [Chapter D, "Reference: supported I/Q file formats"](#), on page 507.
- Capturing and saving I/Q signals with the FSW to analyze them with the FSW or an external software tool later
As opposed to storing trace data, which can 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 file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

For example, you can capture I/Q data using the I/Q Analyzer application and then perform analog demodulation on that data using the FSW Analog Demodulation 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 93.

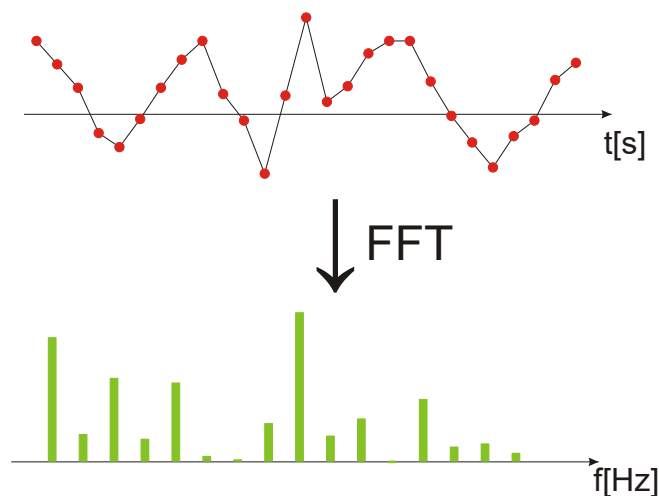


Export only in MSRA mode

In MSRA mode, I/Q data can only be exported to other applications; I/Q data cannot be imported to the MSRA primary or any MSRA secondary applications.

5.11 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.



5.11.1 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 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

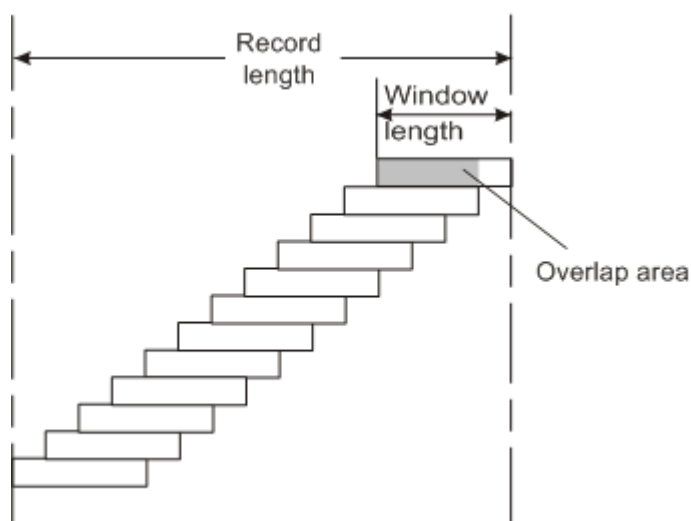
The rectangular window function is in effect not a function at all, it maintains the original sampled data. This may be useful to minimize the required bandwidth. However, be aware that if the window does not contain exactly one period of your signal, heavy sidelobes may occur, which do not exist in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

Table 5-26: 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

5.11.2 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.

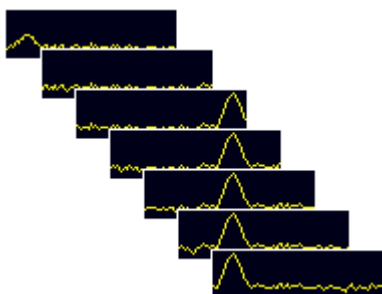


Figure 5-27: Overlapping FFTs

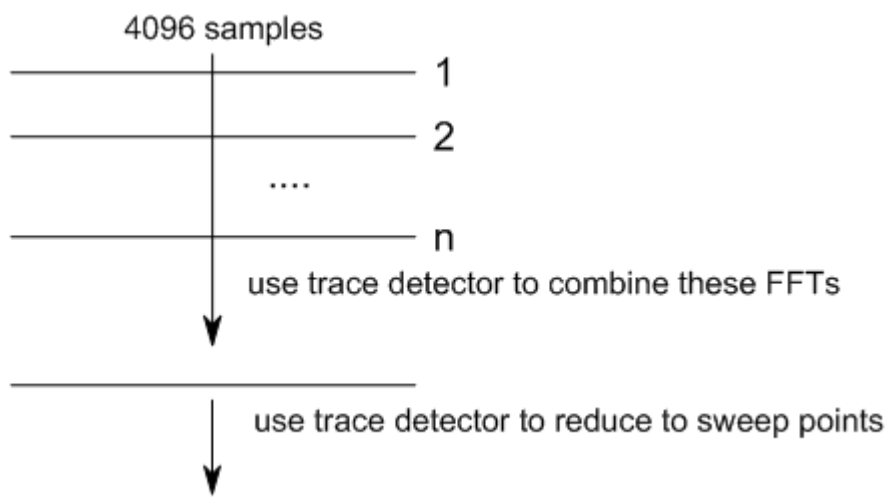
In "Manual" or "Auto" FFT mode, an FFT length of 4096 and a window length of 4096 (or the record length, if shorter) is used to calculate the spectrum.

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.



5.11.3 Dependencies between FFT parameters

FFT analysis in the 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 162.)

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 163).

5.11.4 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:

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

Equation 5-1: 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:

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

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:

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

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 5-1](#). 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.

5.11.5 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 5-28: 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](#).

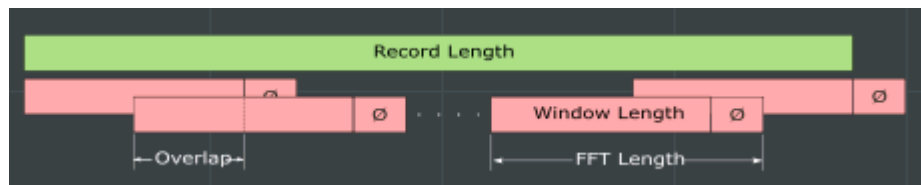


Figure 5-29: FFT parameters for averaged FFT calculation

5.12 Concept of I/Q noise cancellation

This function requires the R&S FSW-K575 option and a repetitive input signal. It is only available in selected applications.

Noise components

[Figure 5-30](#) illustrates the components of a signal measured by an FSW. In this sample setup, a reference signal is input to a DUT, and the signal output is measured by the FSW. The measured signal on the FSW contains not only noise contributions from the signal path up to the FSW input (i.e., the external contributions), but also instrument-inherent noise. The wideband receiver noise n_{RX} increases with increasing bandwidth and can have a major impact on the instrument-residual EVM.

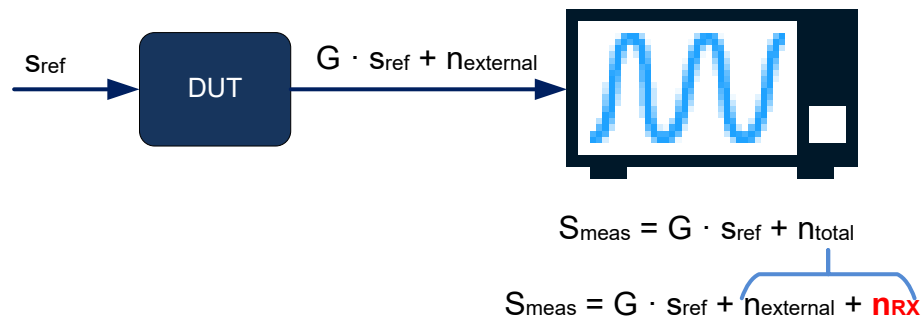


Figure 5-30: Components of measured signal at the FSW

S_{ref}	= reference signal
G	= Gain due to the DUT
n_{external}	= external noise components (noise at the RF port of the receiver)
S_{meas}	= measured signal
n_{total}	= total noise
n_{RX}	= noise caused by receiver

The R&S FSW-K575 I/Q noise cancellation option aims at reducing this wideband receiver noise, while leaving external noise contributions (not caused by the instrument) untouched. The result is a corrected signal that contains only external noise contributions.

$$S_{\text{corrected}} = G \cdot s_{\text{ref}} + n_{\text{external}}$$

Using this function, the residual EVM of the signal analyzer can be improved, even for very low signal levels.

Correction process

The I/Q noise cancellation process requires a repetitive input signal.

1. A single data capture is performed on the input signal to obtain a signal that contains all noise contributions (S_{meas}).
2. The application attempts to estimate the reference signal.
If synchronization fails, the I/Q noise cancellation process is not started. An error message is displayed in the status bar.
For tips on possible causes for synchronization failure, see [Chapter 10.2, "Troubleshooting I/Q noise cancellation"](#), on page 242.
3. A defined number of data captures is performed and the values are averaged.
Since the signal is repetitive, averaging removes the total noise almost completely. The result is an ideal (noise-free) signal.

$$S_{\text{avg}} = G \cdot S_{\text{ref}}$$

4. The total noise is determined as

$$n_{\text{total}} = S_{\text{meas}} - S_{\text{avg}}$$

5. The total noise power (N_{total}) is calculated from n_{total} .

6. Using an internal, terminated (calibration) input signal, the receiver noise power (N_{RX}) is measured.
7. The ratio of the external noise to the total noise is determined as

$$w^2 = \frac{N_{external}}{N_{total}} = \frac{(N_{total} - N_{RX})}{N_{total}}$$

Where w is a weighting factor

8. For the most recently captured I/Q data, the measured noise components are added to the ideal, noise-free signal to obtain a corrected signal without internal noise components.

The "Magnitude Capture" display shows the most recently captured I/Q data without I/Q noise cancellation.

All other measurement results are based on the corrected signal. For statistical evaluation, the entire I/Q noise cancellation process is counted as one measurement.

An additional function is available to export the corrected signal data.

I/Q noise cancellation via remote control

If you have an input file (.wav or .iq.tar) with the reference signal, you can remove the internal noise from the measured raw I/Q data in the I/Q Analyzer application remotely. The resulting data is stored in a specified iq.tar file, but it is not displayed in the result displays. You can load the file in any other I/Q application for analysis.



Set the same sample rate and level settings in the I/Q Analyzer as in the application you require for analysis.

5.13 I/Q analyzer in MSRA/MSRT operating mode

The I/Q Analyzer can also be used in MSRA and MSRT operating mode. The MSRA primary 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 primary. 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 primary performs a real-time measurement to capture data.

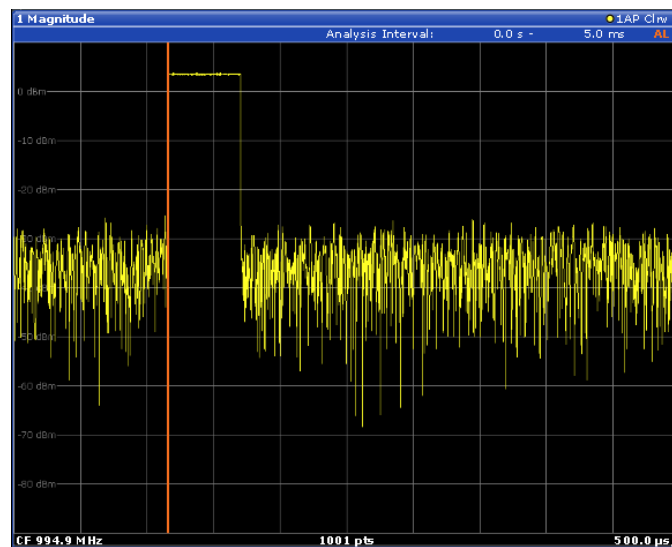
Note that the available functions and settings for the I/Q Analyzer in MSRA mode vary depending on whether the MSRA primary channel or an I/Q Analyzer application channel is selected. For example, data acquisition settings for an I/Q Analyzer **application** channel in MSRA mode configure the analysis 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 secondary applications. It can be positioned in any MSRA secondary application or the MSRA primary and is then adjusted in all other secondary applications. Thus, you can easily analyze the results at a specific time in the measurement in all secondary applications and determine correlations.

If the analysis interval of the secondary application contains the marked point in time, 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, you can hide it 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 FSW MSRA User Manual. For details on the MSRT operating mode see the FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

5.14 Measurements in the time and frequency domain

The I/Q Analyzer secondary application (*not Primary*) 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 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 secondary 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 FSW User Manual.

Limitations

However, since the data in the I/Q Analyzer secondary application is captured by the Primary, independently of the specific time or frequency measurement requirements concerning the RBW, filter type and number of sweep points in the secondary 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 secondary 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 25 and [Chapter 5.2.3, "Sample rates and bandwidths for digital I/Q data"](#), on page 48).

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 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 11](#), "Remote commands to perform measurements with I/Q data", on page 245.



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 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 5.10](#), "I/Q data import and export", on page 79.

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- [Configuring an I/Q analyzer as an MSRA/MSRT secondary application](#)..... 171

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".

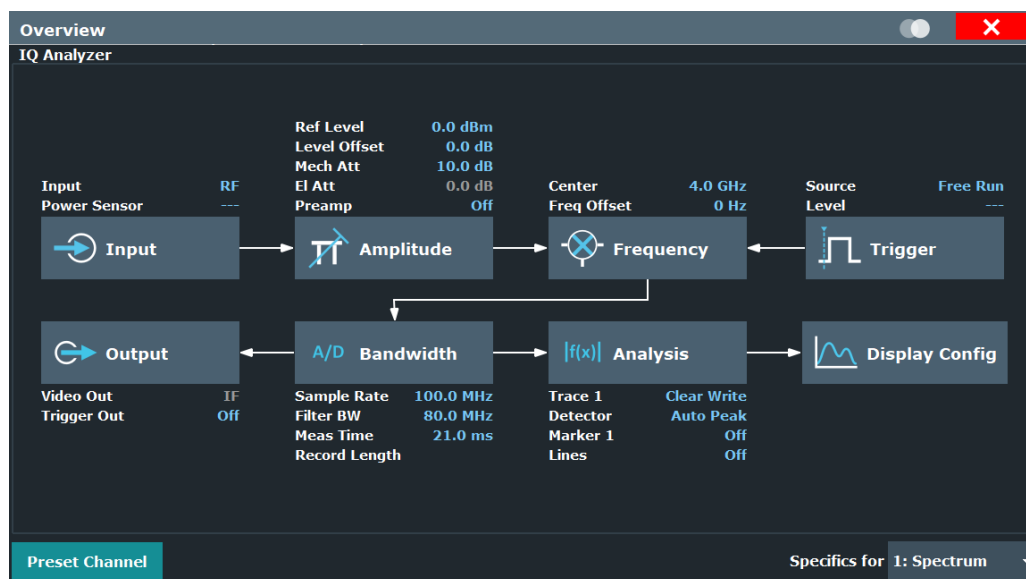


Figure 6-1: Configuration Overview for I/Q Analyzer primary

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 98
2. Amplitude settings
See [Chapter 6.4, "Amplitude"](#), on page 134
3. Frequency settings
See [Chapter 6.5, "Frequency settings"](#), on page 146
4. Optionally, Trigger/Gate settings
See [Chapter 6.6, "Trigger settings"](#), on page 147
5. Bandwidth settings

See [Chapter 6.7, "Data acquisition and bandwidth settings"](#), on page 158

6. Optionally, output settings
See [Chapter 6.3.2, "Output settings"](#), on page 129
7. Analysis settings and functions
See [Chapter 7, "Analysis"](#), on page 173
8. Display configuration
See [Chapter 6.8, "Display configuration"](#), on page 168

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 217.

Preset Channel

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

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

Remote command:

`SYSTem:PRESet:CHANnel [:EXEC]` on page 256

Specific Settings for

The channel can 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 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 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.

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L File Explorer.....	94
Export.....	95
L Export Trace to ASCII File.....	95
L File Type.....	96
L Decimal Separator.....	96
L Column Separator.....	96
L File Explorer.....	96
L Export Configuration.....	96
L I/Q Export.....	96
L File Type.....	97
L File Explorer.....	97



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 485

File Explorer ← I/Q Import ← Import

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

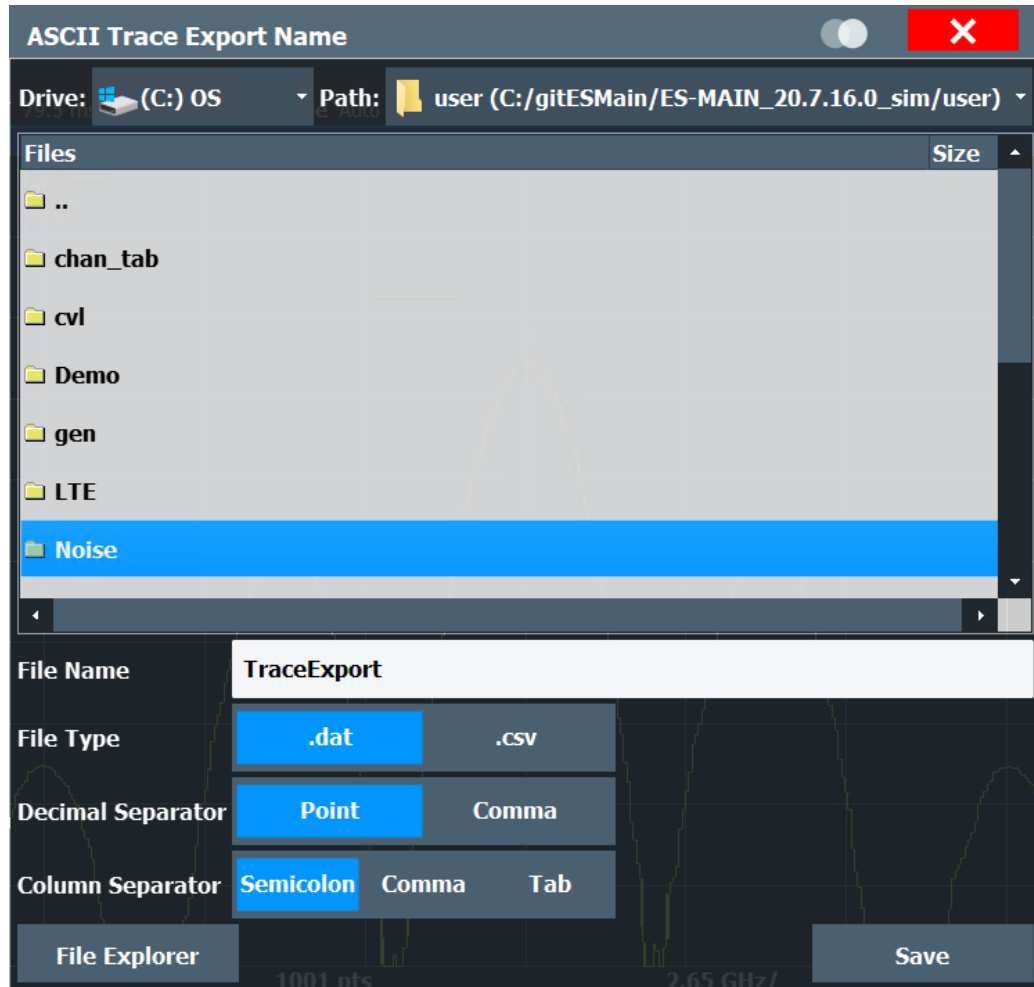
**Export****Access:** "Save/Recall" > Export

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 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 FSW base unit user manual.

Remote command:

`MMEMoRY:STORe<n>:TRACe` on page 482

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 481

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 480

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;1.00;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSW13,
Version,1.00,
Date,01.Jan 3000,
```

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

```
Type      FSW13
Version   1.00
Date      01.Jan 3000
```

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

Remote command:

`FORMat:DEXPort:CSEParator` on page 480

File Explorer ← Export Trace to ASCII File ← Export

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

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 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 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 FSW base unit user manual.

Remote command:

[MMEMory:STORe<n>:IQ:STATe](#) on page 486

[MMEMory:STORe<n>:IQ:COMMeNt](#) on page 485

File Type ← I/Q Export ← Export

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

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

Note: Not all applications support all formats.

For details on formats, see [Chapter D, "Reference: supported I/Q file formats"](#), on page 507.

Remote command:

The file type is determined by the file extension of the file name parameter. If no file extension is provided, the file type is assumed to be .iq.tar. For .mat files, Matlab® v4 is assumed.

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 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, see the FSW User Manual.

- [Input source settings](#)..... 98
- [Output settings](#)..... 129
- [Digital I/Q output settings](#)..... 131
- [Digital I/Q 40G output settings](#)..... 132

6.3.1 Input source settings

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

The input source determines which data the FSW analyzes.

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



Input from other sources

The I/Q Analyzer application application can also process input from the following sources:

- External mixer
- Probes

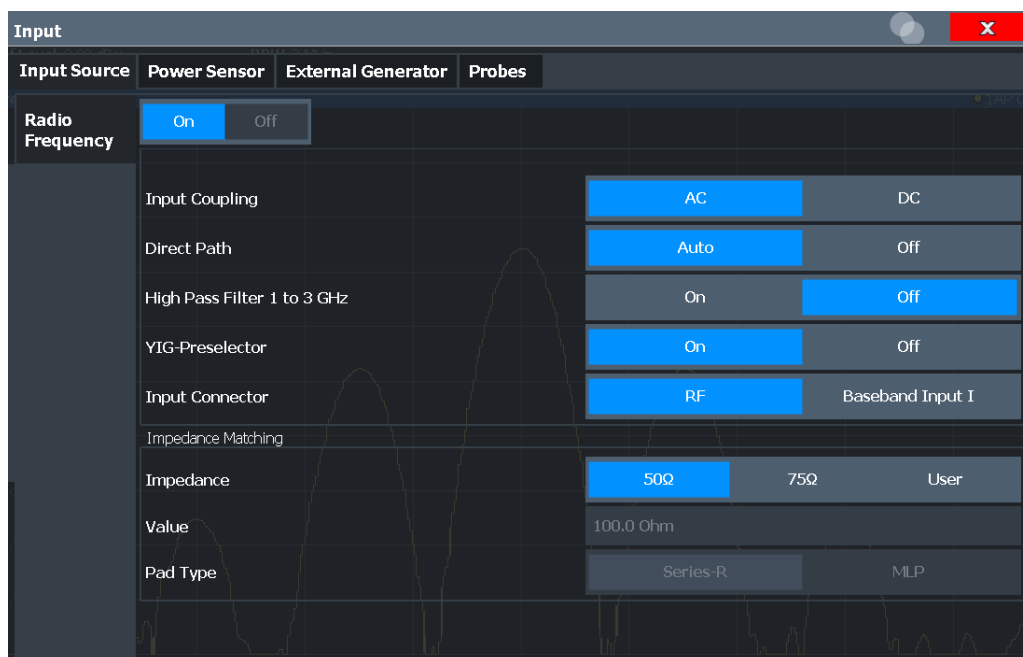
For details, see the FSW User Manual.

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

- [Radio frequency input](#)..... 98
- [Settings for input from I/Q data files](#)..... 102
- [External frontend settings](#)..... 104
- [Digital I/Q input settings](#)..... 115
- [Analog baseband input settings](#)..... 116
- [Oscilloscope Baseband Input](#)..... 119
- [Settings for 2 GHz / 5 GHz bandwidth extension \(R&S FSW-B2000/B5000\)](#)..... 123

6.3.1.1 Radio frequency input

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



RF Input Protection

The RF input connector of the FSW must be protected against signal levels that exceed the ranges specified in the specifications document. Therefore, the 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.

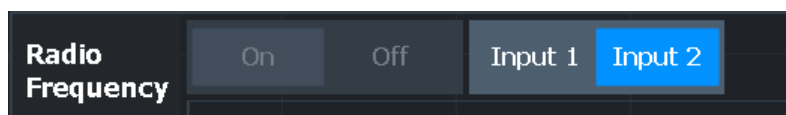
When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case, you must decrease the level at the 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:ATTenuation:PROTection:RESet`.

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Input Coupling.....	100
Impedance.....	100
Direct Path.....	101
High Pass Filter 1 to 3 GHz.....	101
YIG-Preselector.....	101
Input Connector.....	102

Radio Frequency State

Activates input from the "RF Input" connector.

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



If an external frontend is active, select the connector the external frontend is connected to. You cannot use the other RF input connector simultaneously for the same channel. However, you can configure the use of the other RF input connector for another active channel at the same time.

"Input 1" 1.00 mm RF input connector for frequencies up to 85 GHz (90 GHz with option R&S FSW-B90G)

"Input 2" 1.85 mm RF input connector for frequencies up to 67 GHz

Remote command:

[INPut:SElect](#) on page 261

[INPut:TYPE](#) on page 262

Input Coupling

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

For an active external frontend, input coupling is always AC.

Not available for input from the optional "Analog Baseband" interface.

Not available for input from the optional "Digital Baseband" interface.

AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can 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 specifications document.

Remote command:

[INPut:COUPling](#) on page 259

Impedance

The FSW has an internal impedance of 50 Ω . However, some applications use other impedance values. To match the impedance of an external application to the impedance of the 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 FSW, it can convert the measured units accordingly so that the results are calculated correctly.

For an active external frontend, impedance is always 50 Ω .

This function is not available for input from the optional "Digital Baseband" interface. Not all settings are supported by all FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output).

"50 Ω " (Default:) no conversion takes place

"75 Ω " 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:IMPedance](#) on page 260

[INPut:IMPedance:PTYPe](#) on page 261

For Analog Baseband input:

[INPut:IQ:IMPedance](#) on page 295

[INPut:IQ:IMPedance:PTYPe](#) on page 296

For Oscilloscope Baseband Input:

[INPut:IQ:OSC:IMPedance](#) on page 301

[INPut:IQ:OSC:IMPedance:PTYPe](#) on page 301

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.

For an active external frontend, the direct path is always used automatically for frequencies close to zero.

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

"Off" The analog mixer path is always used.

Remote command:

[INPut:DPATH](#) on page 259

High Pass Filter 1 to 3 GHz

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

This function requires an additional hardware option.

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

Remote command:

[INPut:FILTer:HPASs\[:STATe\]](#) on page 260

YIG-Preselector

Enables or disables the YIG-preselector.

An internal YIG-preselector at the input of the FSW ensures that image frequencies are rejected. However, image rejection 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 FSW, which can lead to image-frequency display.

Note: 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.

To use the optional 90 GHz frequency extension (R&S FSW-B90G), the YIG-preselector must be disabled.

The "YIG-Preselector" is off by default.

Note:

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

- I/Q Analyzer
- All secondary applications in MSRA operating mode
- Real-time (and thus in all secondary applications in MSRT operating mode)
- Multicarrier "Group Delay"
- GSM
- VSA
- OFDM VSA

Remote command:

[INPut:FILTer:YIG\[:STATe\]](#) on page 260

Input Connector

Determines which connector the input data for the measurement is taken from.

For more information on the optional "Analog Baseband" interface, see the FSW I/Q Analyzer and I/Q Input user manual.

"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. It is not available for an active external frontend.
"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 FSW67. For FSW85 models with two input connectors, this setting is only available for "Input 1".

Remote command:

[INPut:CONNector](#) on page 258

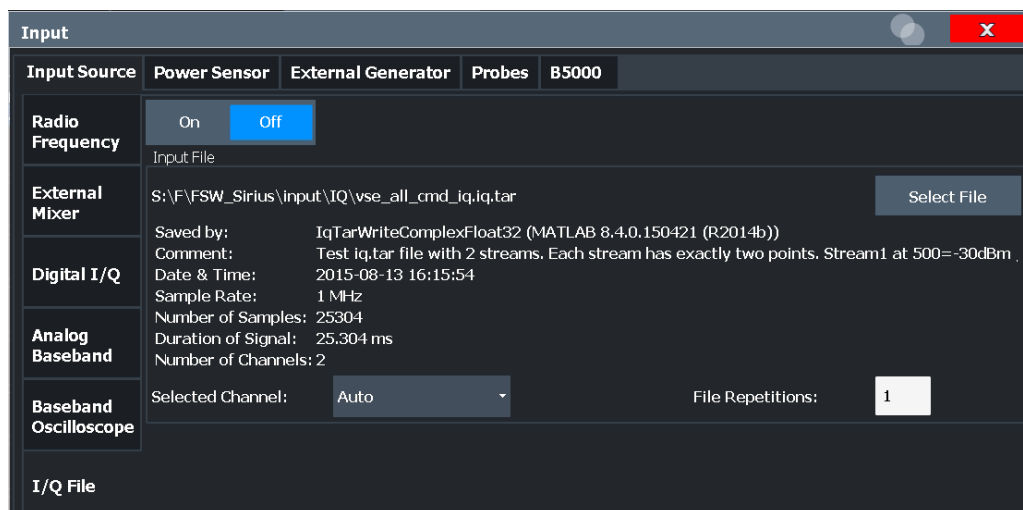
6.3.1.2 Settings for input from I/Q data files

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 5.5, "Basics on input from I/Q data files"](#), on page 63.

I/Q Input File State	103
Select I/Q data file	103
Selected Channel	104
File Repetitions	104

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:SElect](#) on page 261

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 507.

The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

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:FILE:PATH](#) on page 263

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 264

[MMEMory:LOAD:IQ:STReam:AUTO](#) on page 265

[MMEMory:LOAD:IQ:STReam:LIST?](#) on page 265

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 265

6.3.1.3 External frontend settings

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend"

The following settings are only available if the external frontend control option (R&S FSW-K553) is installed on the FSW.

They are only available for measurements that support FFT sweeps or I/Q-based measurements, such as in the I/Q Analyzer application.

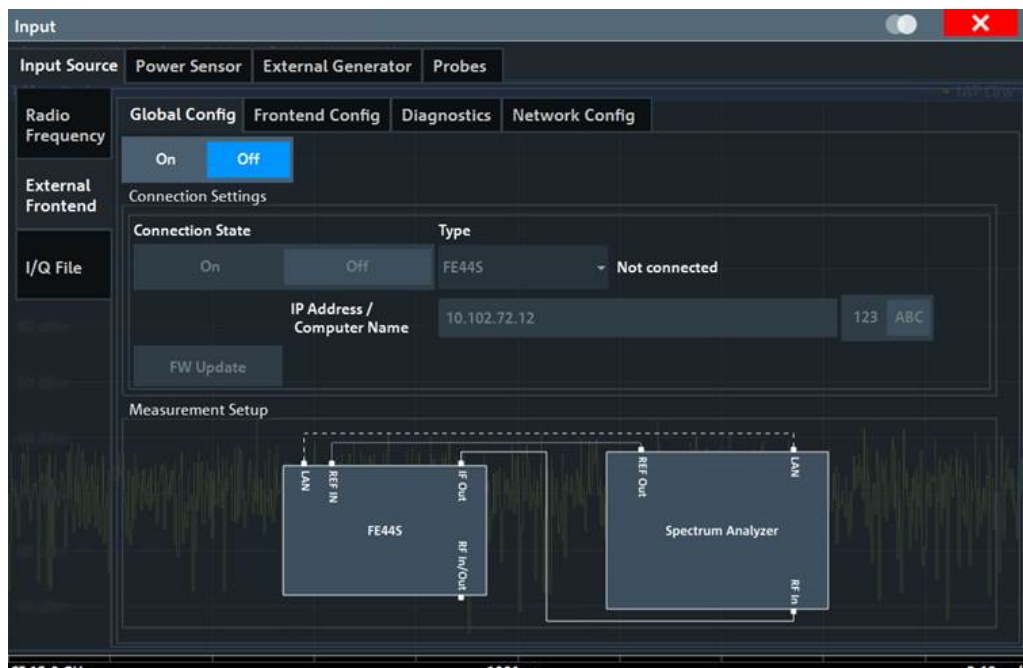
For details see the FSW user manual.

- [Global configuration settings](#)..... 105
- [Frontend configuration settings](#)..... 106
- [Diagnostics](#)..... 110
- [Network configuration](#)..... 111
- [External Devices](#)..... 113

Global configuration settings

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend" > "Global Config"

In the global configuration settings, you define general settings for the connected external frontend. The general measurement setup is indicated for reference.



Global activation.....105
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 IP Address/ Computer Name.....106
 FW Update.....106

Global activation

If enabled, the FSW allows you to configure and connect an external frontend. The application adapts the available measurement settings to the connected frontend, for example the available frequency range, reference level and attenuation.

If a measurement is active that does not support an FFT sweep, the basic frequency sweep measurement is automatically selected. For all measurements, the "Sweep type" is set to "FFT".

If no frontend is configured yet, the configuration settings become available. The channel bar indicates "Inp: ExtFe".

If disabled, the frontend is disconnected. The application adapts the measurement settings to the common settings supported by the FSW.

Remote command:

[SENSe:]EFRontend[:STATe] on page 275

External Frontend Connection State

Connects or disconnects the configured frontend for use in a measurement. Note that this setting is only available if [Global activation](#) of external frontends is set to "On".

It can take up to 10 seconds to determine that LAN connection failed.

If disabled, the connection to the frontend is deactivated temporarily. A running measurement is aborted, the measurement results are indicated as invalid. The measurement settings for the FSW remain untouched.

Remote command:

`[SENSe:]EFRontend:CONNECTION[:STATe]` on page 267

`[SENSe:]EFRontend:CONNECTION:CState?` on page 268

Frontend Type

Defines the type of frontend to be connected.

Currently, the FSW supports the following external frontend types:

- R&S FE44S
- R&S FE50DTR
- R&S FE110SR
- R&S FE170SR

Remote command:

`[SENSe:]EFRontend:CONNECTION:CONFig` on page 267

IP Address/ Computer Name

The IP address or computer name of the frontend connected to the FSW via LAN. The IP address and computer name are indicated on the electronic ink display on the side panel of the frontend.

By default, the TCPIP address is expected. To enter the computer name, toggle "123"/"ABC" to "ABC".

Note: You can change the IP address of the connected frontend directly from the FSW, in the ["Network configuration"](#) on page 111.

Remote command:

`[SENSe:]EFRontend:CONNECTION:CONFig` on page 267

FW Update

When the FSW establishes a connection to the frontend, it checks the firmware version of the frontend. If the FSW does not support the firmware installed on the frontend, you are asked to update the frontend firmware. You can either start the firmware update immediately, or abort the connection process and update the firmware on the frontend later. In this case, the frontend is not available for use with the FSW until you perform the update.

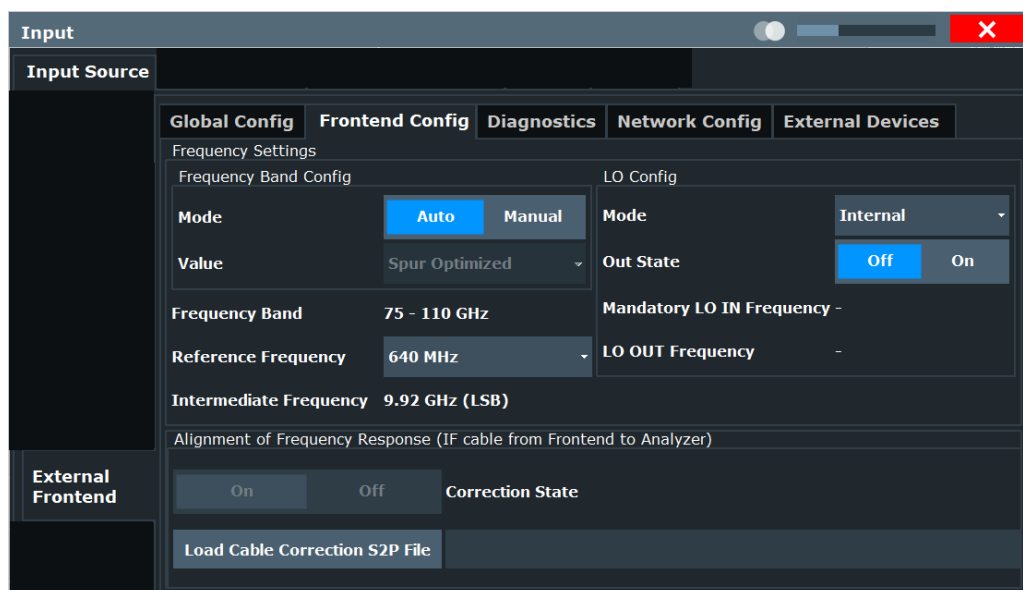
Remote command:

`[SENSe:]EFRontend:FWUPdate` on page 277

Frontend configuration settings

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend" > "Frontend Config"

In the frontend configuration tab, frequency information on the connected frontend is provided and you can configure the frequency response for the IF cable.



Mismatched settings on multiple connected instruments

Multiple instruments can be connected to and use the same frontend at the same time. The frequency conversion settings are identical for all connected instruments. Thus, if you change a frequency setting on one instrument while the other is performing a measurement, the measurement results no longer match the original measurement settings. In this case, an error message is displayed ("Settings mismatch"). To restore the original measurement settings on the frontend, change a frontend setting in the FSW dialog.

Only one instrument can access the frontend to change settings at a time. While one connected instrument changes hardware settings on the external frontend, the frontend is locked for the other connected instrument. The second instrument gets a "Device busy" message and must retry when the frontend is available again. In this case, start a new measurement to access the frontend and change the settings.

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Reference Frequency.....108

Intermediate Frequency..... 109

LO Mode..... 109

LO Out State..... 109

Mandatory LO IN Frequency..... 110

LO OUT Frequency..... 110

Correction State.....110

Load Cable Correction S2P File..... 110

Frequency Band Configuration

Defines the intermediate frequency (output) range of the external frontend.

The used [Intermediate Frequency](#) and the resulting [Frequency Band](#) sideband that can be analyzed on the FSW are indicated for reference.

The selected frequency band configuration is also indicated in the channel bar.

R&S FE50DTR-type frontends can be used by an analyzer and a signal generator simultaneously. In this case, both channels use the same internal LO and thus both signal paths operate on the same frequency. Therefore, if you want to analyze the signal from the generator using the same frontend, make sure that the configured frequency bands are identical on both instruments.

You can select the required IF output range manually, or it can be determined automatically, according to the other frequency settings.

Currently, auto mode always applies the "IF Low" range for R&S FE44S and R&S FE50DTR-type frontends. For R&S FE170SR and R&S FE110SR frontends, the "Spur Optimized" range is used.

In manual mode, select one of the following IF output ranges:

"IF High"	(R&S FE44S/ R&S FE50DTR) A higher intermediate frequency is used on the external frontend, resulting in a higher input frequency at the FSW.
"IF Low"	(R&S FE44S/ R&S FE50DTR) A lower intermediate frequency is used on the external frontend, resulting in a lower input frequency at the FSW.
"Spur Optimized"	(R&S FE170SR/R&S FE110SR only) The selected IF range avoids unwanted spurious effects.
"EVM Optimized"	(R&S FE170SR only) The selected IF range provides an optimal EVM result.
"Shared LO"	(R&S FE170SR/R&S FE110SR only) Ensures that multiple external frontends of a different type (R&S FE170SR/ R&S FE170ST or R&S FE110SR/R&S FE110ST) use the same LO frequencies for upconversion and downconversion.

Remote command:

[\[SENSe:\]EFRontend:FREQuency:BCONfig:AUTO](#) on page 269

[\[SENSe:\]EFRontend:FREQuency:BCONfig:LIST?](#) on page 270

[\[SENSe:\]EFRontend:FREQuency:BCONfig:SElect](#) on page 270

Frequency Band

Displays the range of the frequency band supported by the connected frontend (for reference only).

Remote command:

[\[SENSe:\]EFRontend:FREQuency:BAND:COUNT?](#) on page 268

[\[SENSe:\]EFRontend:FREQuency:BAND:LOWer?](#) on page 268

[\[SENSe:\]EFRontend:FREQuency:BAND:UPPer?](#) on page 269

Reference Frequency

Sets the reference frequency that is used for frequency conversion on the frontend. Depending on the connected type of frontend, different values are available.

Remote command:

[\[SENSe:\]EFRontend:FREQuency:REFerence](#) on page 274

[\[SENSe:\]EFRontend:FREQuency:REFerence:LIST?](#) on page 274

Intermediate Frequency

Indicates the currently used intermediate frequency (IF) and sideband (upper/lower) for frequency conversion (for reference only).

This value depends on the ["Frequency Band Configuration"](#) on page 107.

For FFT sweep measurements, the LO is adapted during the measurement to cover the entire sweep range. The resulting IF range is indicated.

For FE50DTR-type frontends that are used by an analyzer and a signal generator simultaneously, make sure that the used intermediate frequency is identical on both instruments.

Make sure the IF frequency required by the external frontend lies within the IF frequency range of the FSW.

"USB" Upper sideband

"LSB" Lower sideband

Remote command:

For I/Q measurements:

[\[SENSe:\]EFRontend:FREQuency:IFrequency\[:VALue\]?](#) on page 272

[\[SENSe:\]EFRontend:FREQuency:IFrequency:SIDeband?](#) on page 271

For FFT sweep measurements:

[\[SENSe:\]EFRontend:FREQuency:IFrequency:MAXimum?](#) on page 271

[\[SENSe:\]EFRontend:FREQuency:IFrequency:MINimum?](#) on page 271

LO Mode

Determines whether the external frontend uses its internal LO or an external LO.

The LO configuration settings are not available for FFT sweep measurements. The external frontend always uses its internal LO.

For details, see the FSW base unit user manual.

"External" Uses the external signal provided at the "LO Input" connector of the external frontend. The frequency at which the LO must be input to the external frontend is indicated as ["Mandatory LO IN Frequency"](#) on page 110.

If enabled, "LO EXT" is displayed in the channel bar.

"Internal" Uses the internal LO

Remote command:

[\[SENSe:\]EFRontend:FREQuency:LOSCillator:MODE](#) on page 272

LO Out State

Enables or disables output of the LO at the "LO OUT" connector of the external frontend. Which LO is provided depends on [LO Mode](#). The frequency at which the LO is provided to the connector is indicated as [LO OUT Frequency](#).

Remote command:

[\[SENSe:\]EFRontend:FREQuency:LOSCillator:OUTPut:STATe](#) on page 273

Mandatory LO IN Frequency

Indicates the required frequency of the LO input at the external frontend when using an external LO. If the coupled device does not provide the external LO at this frequency, the results of the external frontend are inaccurate.

Remote command:

`[SENSe:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?`

on page 272

LO OUT Frequency

Indicates the frequency of the LO output, if **LO Out State** is "ON".

Remote command:

`[SENSe:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?`

on page 273

Correction State

Activates correction of the IF signal due to cable loss from the frontend to the analyzer.

Remote command:

`[SENSe:]EFRontend:ALIGnment<ch>:STATe` on page 276

Load Cable Correction S2P File

Opens a common file selection dialog to load correction data to compensate for signal losses in the cable occurring at different IF signal frequencies.

To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external frontend.

Frequency response files are usually provided with the IF cable. The calibration data for the IF cable provided with the FSW is installed on the instrument at the factory.

The `.s2p` files are stored on the instrument under

```
C:\R_S\INSTR\USER\external_frontends\\
touchstonefiles\. For example, the files for the IF cable are stored under
C:\R_S\Instr\user\external_frontends\FE44S\touchstonefiles\
if_default_cable_1347_7552_00.s2p.
```

Remote command:

`[SENSe:]EFRontend:ALIGnment<ch>:FILE` on page 276

Diagnostics

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend" > "Diagnostics"

The "Diagnostics" tab provides information on the performance of the connected frontend and allows you to perform a self-test on the frontend.

The screenshot shows the 'Input' configuration window with the 'Diagnostics' sub-tab selected. The 'Selftest Results' section contains the following data:

test description	min	act	max	state
Frontend Voltages				
FEL_3V3	3.000	3.311	3.600	PASSED
FEL_5V	4.250	5.027	5.750	PASSED
FEL_6V5	6.000	5.893	7.000	FAILED***
FEL_MS3				FAILED***
Frontend Voltages Test	-3.600	3.347	-3.000	FAILED***
Frontend Temperature				
TEMP_FE1	0.000	39.300	60.000	PASSED
Frontend Temperature Test				PASSED
Synthesizer Voltage				
SYNTH_3V4	3.200	3.576	3.910	PASSED
SYNTH_SV4_SYN	4.860	5.405	5.940	PASSED
SYNTH_SV4_YIG	4.860	5.438	5.940	PASSED
SYNTH_MS3	-5.500	-4.948	-4.500	PASSED
SYNTH_REFSV				PASSED
Synthesizer Voltage Test	4.500	5.031	5.500	PASSED
Supply Voltage				
SUPPLY_12V	10.800	11.909	13.200	PASSED
SUPPLY_3V3	2.970	3.318	3.630	PASSED
SUPPLY_4V	3.650	4.053	4.460	PASSED
SUPPLY_6V	5.400	6.076	6.600	PASSED
SUPPLY_MS3	-6.050	-5.507	-4.950	PASSED
Supply Voltage Test				PASSED

Selftest state: FAILED
FW-Version: 1.50-21.1.1.0 Beta
External Frontend Library Version: 0.8.0
Date (dd/mm/yyyy): 15/01/2021 Time: 08:51:35

Start Selftest.....	111
Abort Selftest.....	111
Selftest Results.....	111

Start Selftest

Performs a self-test on the frontend to compare the current performance and characteristic values with the specified values for the frontend.

Remote command:

[\[SENSe:\]EFRontend<fe>:SELfTest?](#) on page 277

Abort Selftest

Aborts a running self-test.

Remote command:

not supported

Selftest Results

Indicates the results of a selftest performed on the connected frontend.

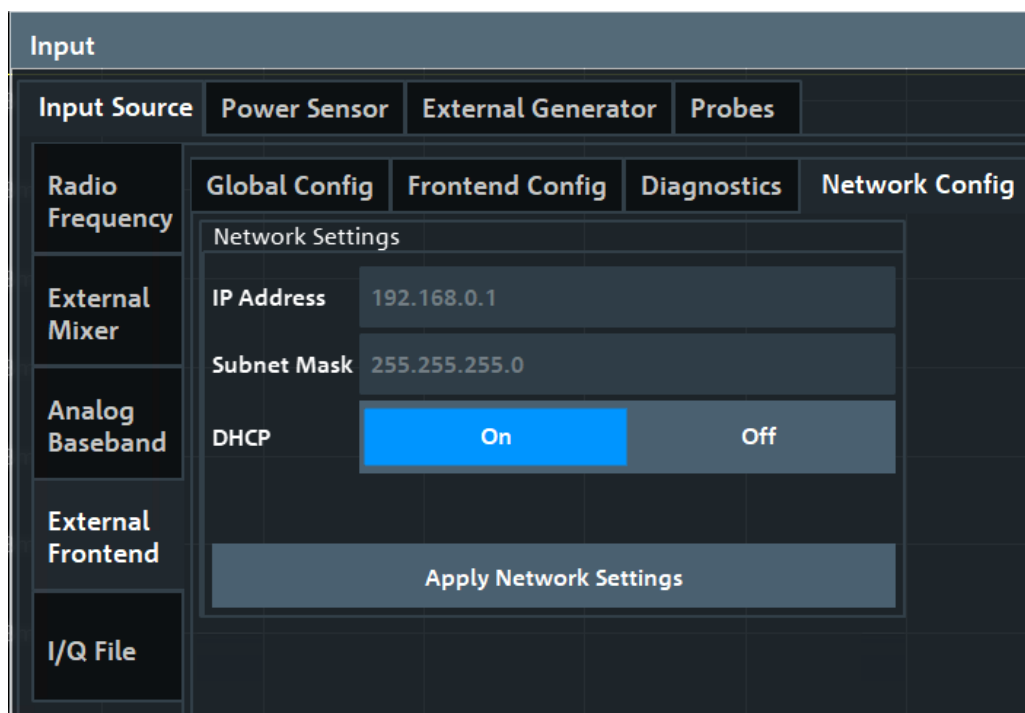
Remote command:

[\[SENSe:\]EFRontend<fe>:SELfTest:RESult?](#) on page 277

Network configuration

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend" > "Network Config"

After connection, you can assign a static IP address or switch to a dynamic IP address for the external frontend directly from the FSW.



IP Address.....	112
Subnet Mask.....	112
DHCP.....	112
Apply Network Settings.....	112

IP Address

Defines the IP address of the external frontend. If the DHCP server is used ("DHCP On"), the setting is read-only.

Remote command:

[SENSe:]EFRontend:NETWork on page 274

Subnet Mask

Defines the subnet mask of the external frontend. If the DHCP server is used ("DHCP On"), this setting is read-only.

Remote command:

[SENSe:]EFRontend:NETWork on page 274

DHCP

Switches between DHCP server available ("On") or not available ("Off"). If a DHCP server is available in the network, the IP address and subnet mask of the external frontend are obtained automatically from the DHCP server.

Remote command:

[SENSe:]EFRontend:NETWork on page 274

Apply Network Settings

Any changes to the external frontend network configuration are applied.

Beware that if you change the network information, the connection is aborted and you must re-establish a connection to the frontend (see "External Frontend Connection State" on page 106).

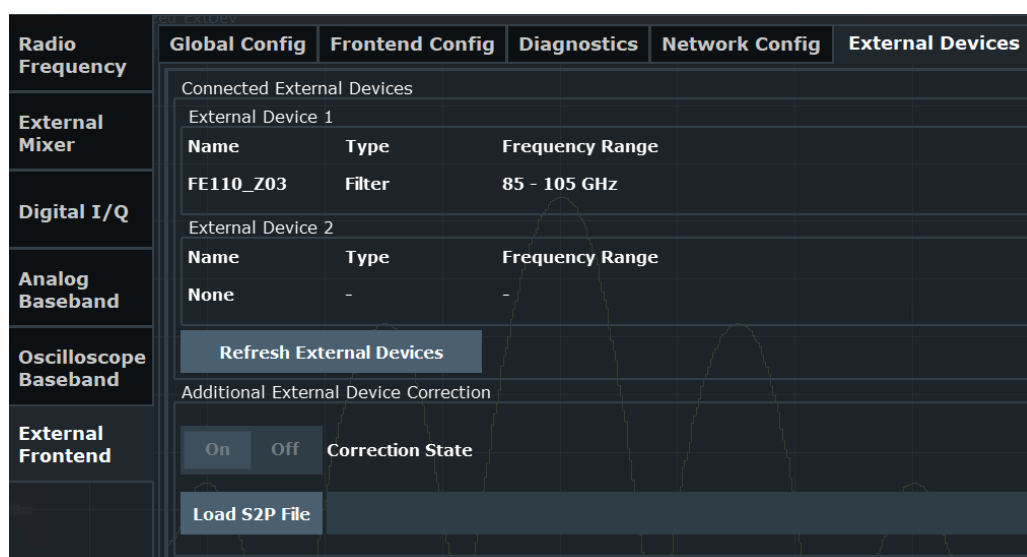
Remote command:

[SENSe:]EFRontend:NETWork on page 274

External Devices

Access: "Overview" > "Input" > "Input Source Config" > "Input Source" > "External Frontend" > "External Devices"

You can insert additional external devices in the signal path between the DUT and the external frontend, such as preamplifiers or filters. The external frontend must then consider the additional gain or correction values.



When the FSW initially connects to the external frontend, the instrument automatically detects any devices connected to the external frontend. The FSW displays information on detected devices in the "External Devices" tab of the dialog.

Name.....	113
Type.....	114
Frequency Range.....	114
Gain.....	114
Refresh External Devices.....	114
Correction State.....	114
Load S2P File.....	114

Name

Name of the external device for reference.

Remote command:

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME? on page 281

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST? on page 279

Type

Type of the detected device for reference.

Currently, the following device types are supported:

- Filter
- Amplifier (R&S FE170SR only)

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?` on page 282

Frequency Range

The supported frequency range of the connected device.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?`
on page 281

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?`
on page 280

Gain

For connected external amplifiers only: provided gain.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?` on page 281

Refresh External Devices

Scans the ports of the external frontend and refreshes the display with detected information on connected devices. This function is useful after connecting a new device to the frontend.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFresh` on page 280

Correction State

Enables or disables the use of an additional correction file for the connected external devices. Additional correction is useful, for example, if you do not use the IX cable to connect the external device to the external frontend. In this case, automatic compensation cannot be applied.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe`
on page 278

Load S2P File

Opens a common file selection dialog to load correction data to compensate for signal losses by the external devices occurring at different RF signal frequencies.

To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external devices.

The dialog indicates whether the loaded file is valid or not.

Remote command:

[SENSE:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE
on page 278

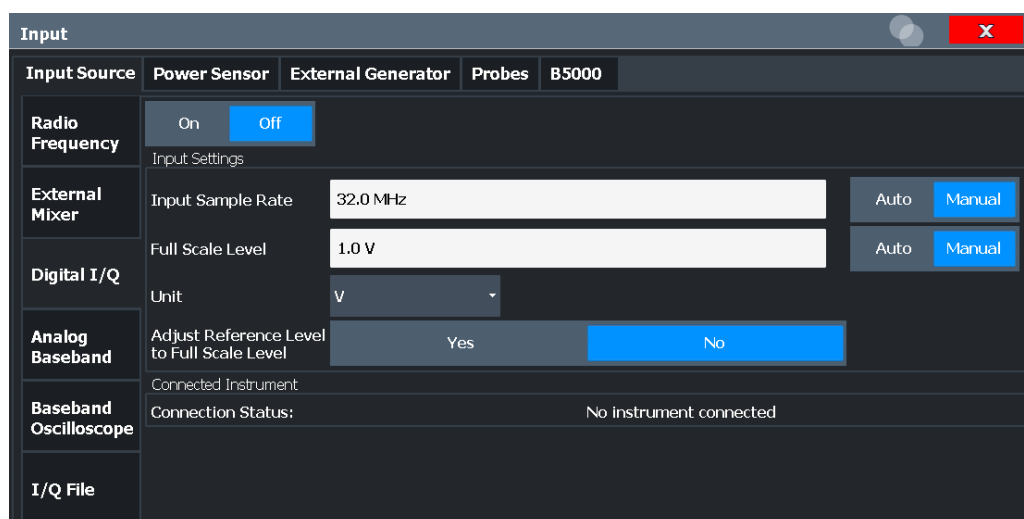
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?
on page 279

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" in the applications that support it.

These settings are only available if the "Digital Baseband" option is installed on the FSW.



Digital I/Q Input State.....	115
Input Sample Rate.....	115
Full Scale Level.....	116
Adjust Reference Level to Full Scale Level.....	116
Connected Instrument.....	116

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" is installed.

Remote command:

INPut:SElect on page 261

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:DIQ:SRATe](#) on page 291

[INPut:DIQ:SRATe:AUTO](#) on page 292

Full Scale Level

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

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

Remote command:

[INPut:DIQ:RANGe\[:UPPer\]](#) on page 291

[INPut:DIQ:RANGe\[:UPPer\]:UNIT](#) on page 291

[INPut:DIQ:RANGe\[:UPPer\]:AUTO](#) on page 291

Adjust Reference Level to Full Scale Level

If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

Remote command:

[INPut:DIQ:RANGe:COUPling](#) on page 290

Connected Instrument

Displays the status of the "Digital Baseband" interface connection.

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

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

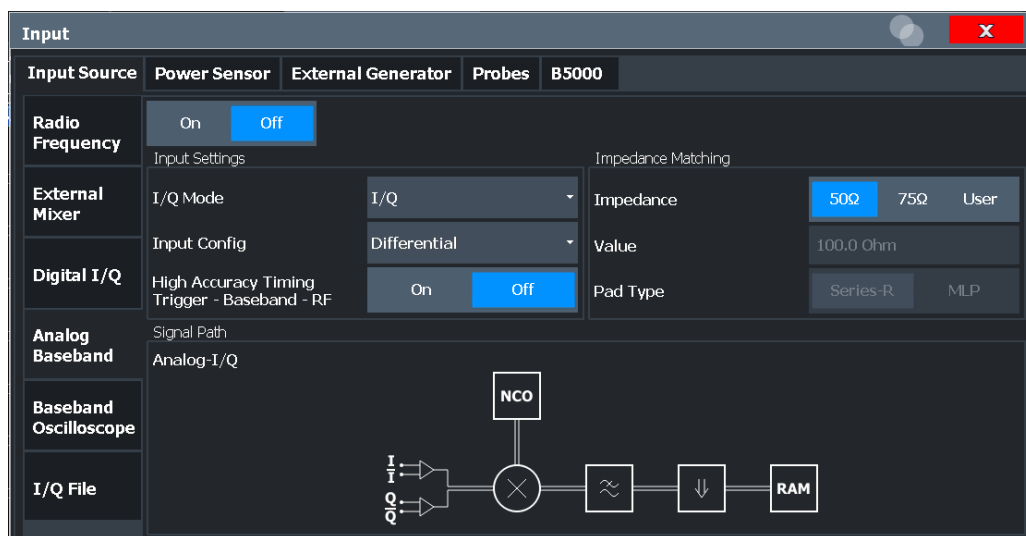
Remote command:

[INPut:DIQ:CDEvice](#) on page 290

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](#)..... 117
[I/Q Mode](#)..... 117
[Input Configuration](#)..... 118
[High Accuracy Timing Trigger - Baseband - RF](#)..... 118
[Impedance](#)..... 119
[Center Frequency](#)..... 119

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" is installed.

Remote command:

[INPut : SElect](#) on page 261

I/Q Mode

Defines the format of the input signal.

For more information, see [Chapter 5.3.3, "I/Q processing modes"](#), on page 54.

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

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

"Q Only / Low IF Q"

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

Remote command:

`INPut:IQ:TYPE` on page 296

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 single-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 FSW85)

Remote command:

`INPut:IQ:BALanced[:STATe]` on page 294

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 FSW.

For 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 54.

Remote command:

`CALibration:AIQ:HATiming[:STATe]` on page 297

Impedance

The FSW has an internal impedance of 50 Ω . However, some applications use other impedance values. To match the impedance of an external application to the impedance of the 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 FSW, it can convert the measured units accordingly so that the results are calculated correctly.

For an active external frontend, impedance is always 50 Ω .

This function is not available for input from the optional "Digital Baseband" interface. Not all settings are supported by all FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output).

"50 Ω "	(Default:) no conversion takes place
"75 Ω "	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:IMPedance](#) on page 260

[INPut:IMPedance:PTYPe](#) on page 261

For Analog Baseband input:

[INPut:IQ:IMPedance](#) on page 295

[INPut:IQ:IMPedance:PTYPe](#) on page 296

For Oscilloscope Baseband Input:

[INPut:IQ:OSC:IMPedance](#) on page 301

[INPut:IQ:OSC:IMPedance:PTYPe](#) on page 301

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 or the maximum frequency, 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 51.

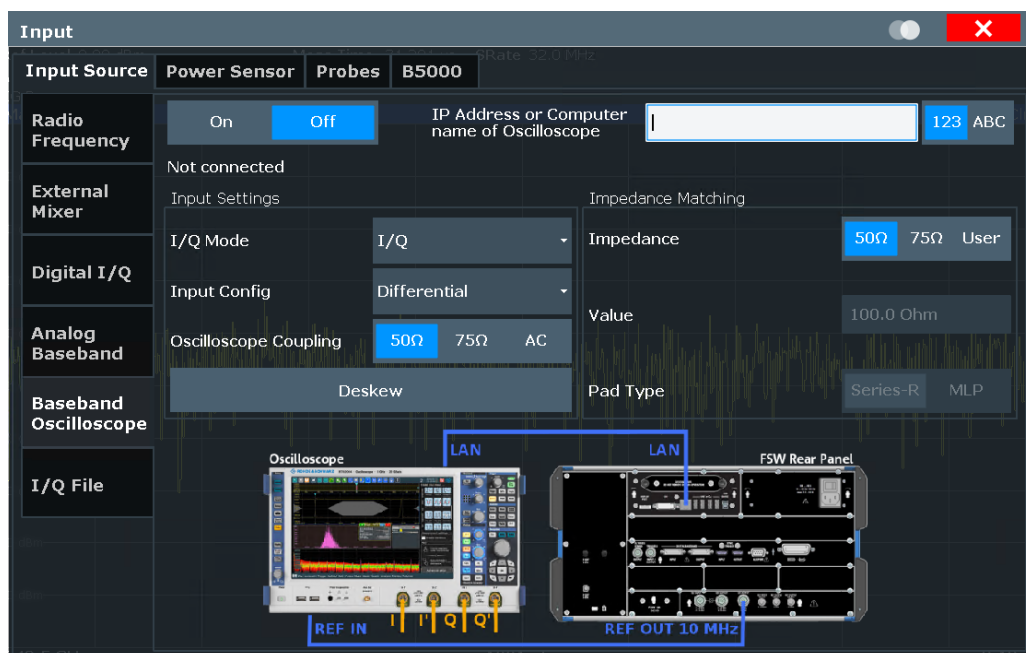
Remote command:

[\[SENSe:\]FREQuency:CENTer](#) on page 365

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 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 58.

Oscilloscope Baseband Input State	120
TCPIP Address / Computer Name	120
I/Q Mode	121
Input Configuration	121
Oscilloscope Coupling	121
I/Q Skew	122
Impedance	122

Oscilloscope Baseband Input State

Activates the optional Oscilloscope Baseband Input.

Note: Manual operation on the connected oscilloscope, or remote operation other than by the FSW, is not possible while the Oscilloscope Baseband Input is active.

Remote command:

`INPut:IQ:OSC[:STATE]` on page 303

TCPIP Address / Computer Name

When using the optional Oscilloscope Baseband Input, the entire measurement, as well as both instruments, are controlled by the FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the FSW.

For tips on how to determine the computer name or TCPIP address, see ["To determine the oscilloscope's computer name"](#) on page 222, ["To determine the oscilloscope's TCPIP address"](#) on page 223, or the oscilloscope's user documentation.

By default, the TCPIP address is expected. To enter the computer name, toggle "123"/"ABC" to "ABC".

As soon as a name or address is entered, the 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:IQ:OSC:TCPIp](#) on page 303

[INPut:IQ:OSC:IDN?](#) on page 301

To check whether the connected oscilloscope is supported for Oscilloscope Baseband Input:

[INPut:IQ:OSC:VDEvice?](#) on page 304

[INPut:IQ:OSC:VFIRmware?](#) on page 304

I/Q Mode

Defines the format of the input signal.

For more information, see [Chapter 5.4, "Processing Oscilloscope Baseband Input"](#), on page 58.

"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:IQ:OSC:TYPE](#) on page 304

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 FSW85)

Remote command:

[INPut:IQ:OSC:BALanced\[:STATe\]](#) on page 299

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 M Ω "	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.

Remote command:

[INPut:IQ:OSC:COUPling](#) on page 300

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:IQ:OSC:SKEW:I](#) on page 302

[INPut:IQ:OSC:SKEW:I:INVerted](#) on page 302

[INPut:IQ:OSC:SKEW:Q](#) on page 302

[INPut:IQ:OSC:SKEW:Q:INVerted](#) on page 302

Impedance

The FSW has an internal impedance of 50 Ω . However, some applications use other impedance values. To match the impedance of an external application to the impedance of the 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 FSW, it can convert the measured units accordingly so that the results are calculated correctly.

For an active external frontend, impedance is always 50 Ω .

This function is not available for input from the optional "Digital Baseband" interface. Not all settings are supported by all FSW applications.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output).

"50 Ω " (Default:) no conversion takes place

"75 Ω " 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:IMPedance](#) on page 260

[INPut:IMPedance:PTYPe](#) on page 261

For Analog Baseband input:

[INPut:IQ:IMPedance](#) on page 295

[INPut:IQ:IMPedance:PTYPe](#) on page 296

For Oscilloscope Baseband Input:

[INPut:IQ:OSC:IMPedance](#) on page 301

[INPut:IQ:OSC:IMPedance:PTYPe](#) on page 301

6.3.1.7 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.

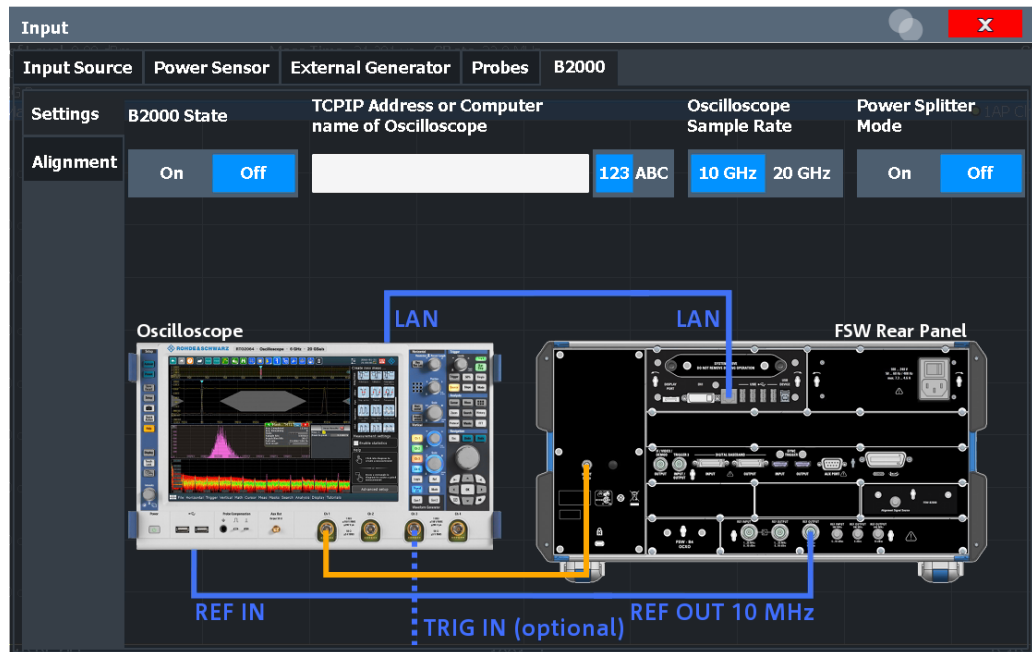
For details on prerequisites and restrictions, see [Chapter 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64.

The following settings are available for the optional 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000).

- [General settings](#)..... 123
- [Alignment](#)..... 125

General settings

Access: [Input/Output] > "B2000/B5000 Config" > "Settings"



The required connections between the FSW and the oscilloscope are illustrated in the dialog box.

For details, see [Chapter 5.6.3, "Prerequisites and measurement setup"](#), on page 66.

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 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 345

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 FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the FSW.

For tips on how to determine the computer name or TCPIP address, see [Chapter 8.2.5, "How to capture data via the optional 2 GHz / 5 GHz bandwidth extension \(FSW-B2000/B5000\)"](#), on page 224, or the oscilloscope's user documentation.

By default, the TCPIP address is expected. To enter the computer name, toggle "123"/"ABC" to "ABC".

As soon as a name or address is entered, the 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 125).

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 348

[SYSTem:COMMunicate:RDEvice:OSCilloscope:IDN](#) on page 346

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 348

Power Splitter Mode

Activates the use of the power splitter inserted between the "IF OUT 2 GHz/ IF OUT 5 GHz" connector of the 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 5.6.8, "Power splitter mode"](#), on page 72.

Remote command:

[SYSTem:COMMunicate:RDEvice:OSCilloscope:PSMode\[:STATe\]](#) on page 347

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

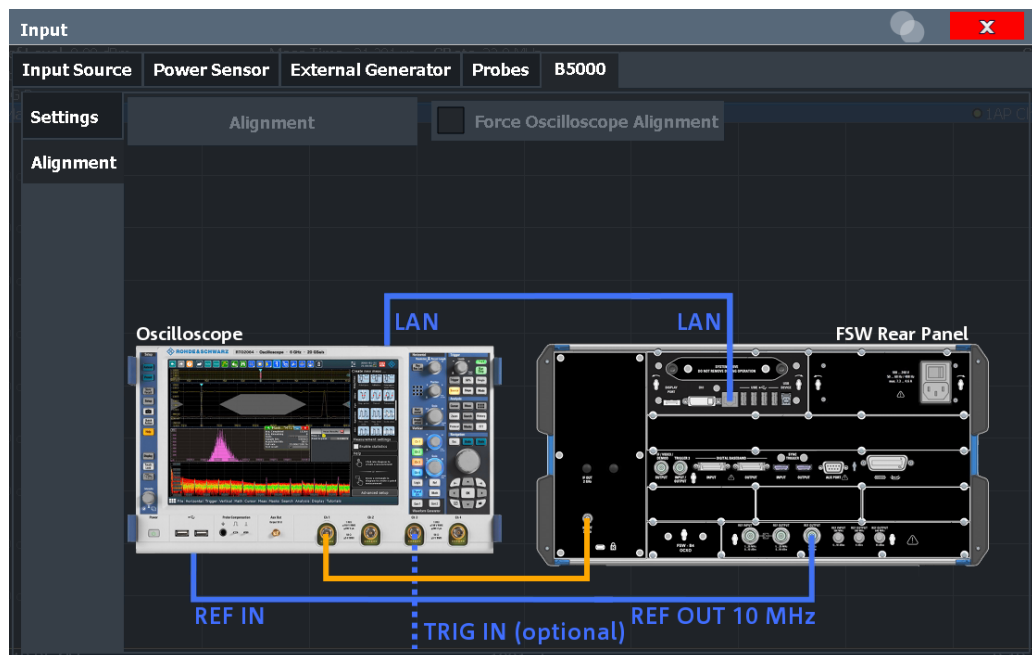


Sometimes, it is useful to force a self-alignment on the oscilloscope before the actual B5000 alignment, see ["Force Oscilloscope Alignment"](#) on page 126.

Alignment of the R&S FSW-B5000 option

Access: "Input / Output" > "B5000 Config"

The required connections between the FSW and the oscilloscope are illustrated in the dialog box.



For details, see [Chapter 5.6.3, "Prerequisites and measurement setup"](#), on page 66.

Alignment requires a connection from the "IF OUT 2 GHz" connector on the FSW to the "Ch1" input on the oscilloscope.

(In power splitter mode: connection from the "IF OUT 2 GHz" connector on the 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 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. Self-alignment can take a few minutes.

Sometimes, it is useful to force a self-alignment on the oscilloscope manually, see ["Force Oscilloscope Alignment"](#) on page 126.

Remote command:

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:STEP<st>[:STATe]` on page 345

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:DATE` on page 346

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 ($> 5\text{ }^{\circ}\text{C}$)
- The last alignment on the oscilloscope was significantly longer than 1 week ago

To perform a self-alignment on the oscilloscope before the B2000/B5000 alignment on the FSW, select this option before selecting [Alignment](#).

Note, however, that the self-alignment on the oscilloscope can take a few minutes.

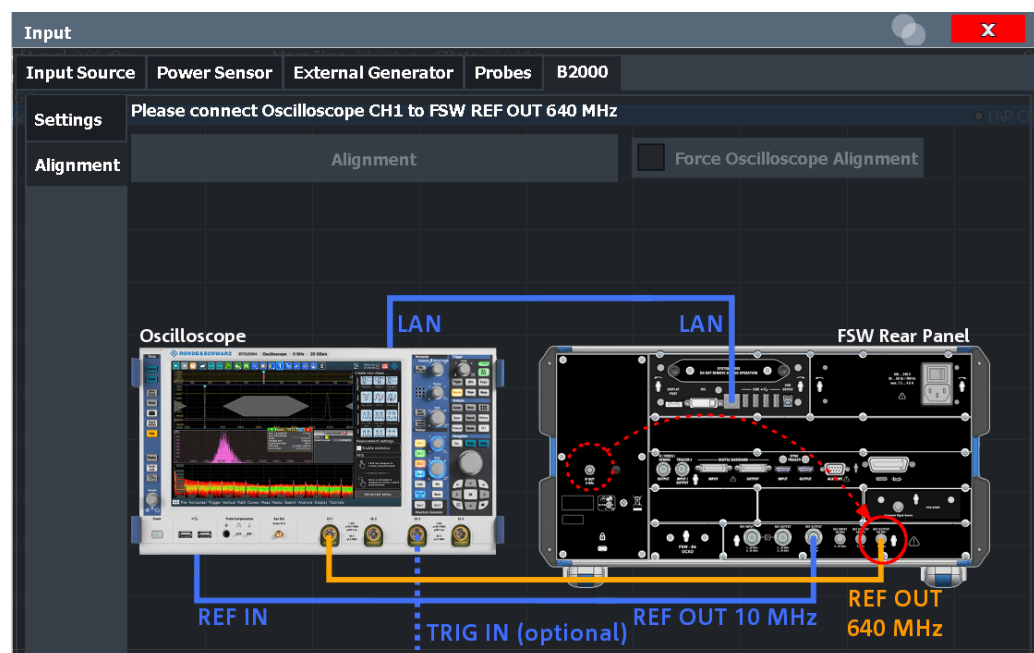
Remote command:

`SYSTEM:COMMunicate:RDEvice:OSCilloscope:ALIGnment:FAliGnment`
on page 346

Alignment of the R&S FSW-B2000 option

Access: "Input / Output" > "B2000 Config"

The required connections between the FSW and the oscilloscope are illustrated in the dialog box.



The required connections between the FSW and the oscilloscope are illustrated in the dialog box.

For details, see [Chapter 5.6.3, "Prerequisites and measurement setup"](#), on page 66.

Alignment consists of two steps. The first step requires a (temporary) connection from the "REF OUTPUT 640 MHz" connector on the FSW to the "Ch1" input on the oscilloscope.

(In power splitter mode: connection from the "REF OUTPUT 640 MHz" connector on the FSW to the power splitter, which is connected to the "Ch1" and "Ch3" inputs on the oscilloscope.)

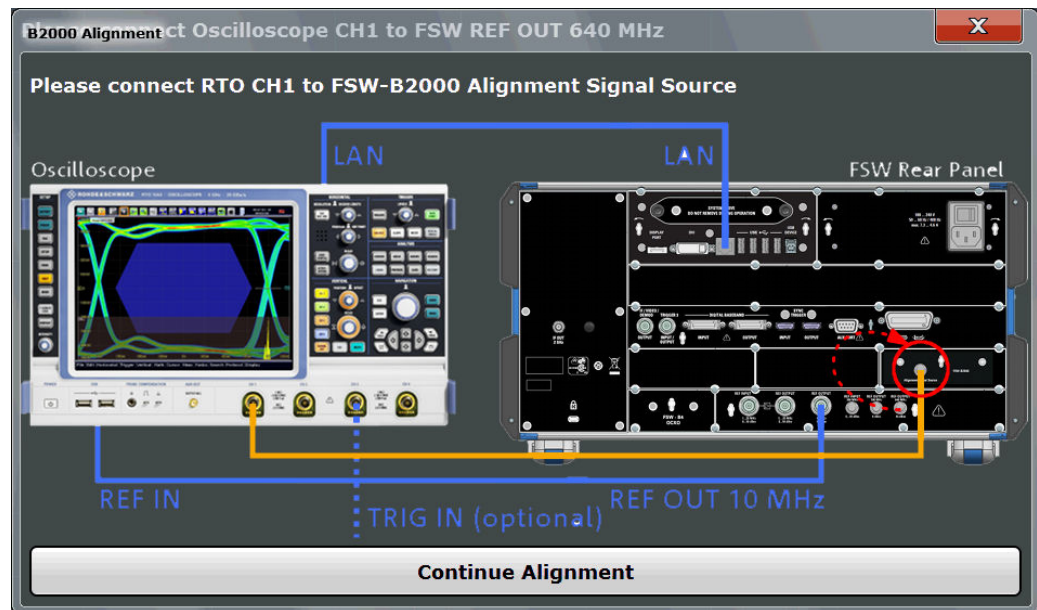
To perform the alignment, select "Alignment".



If the oscilloscope is detected to be uncalibrated, a self-alignment is performed on the oscilloscope before the actual B2000 alignment on the FSW starts. Self-alignment can take a few minutes.

Sometimes, it is useful to force a self-alignment on the oscilloscope manually, see "[Force Oscilloscope Alignment](#)" on page 126.

If the oscilloscope and the oscilloscope ADC are aligned successfully, a new dialog box is displayed.

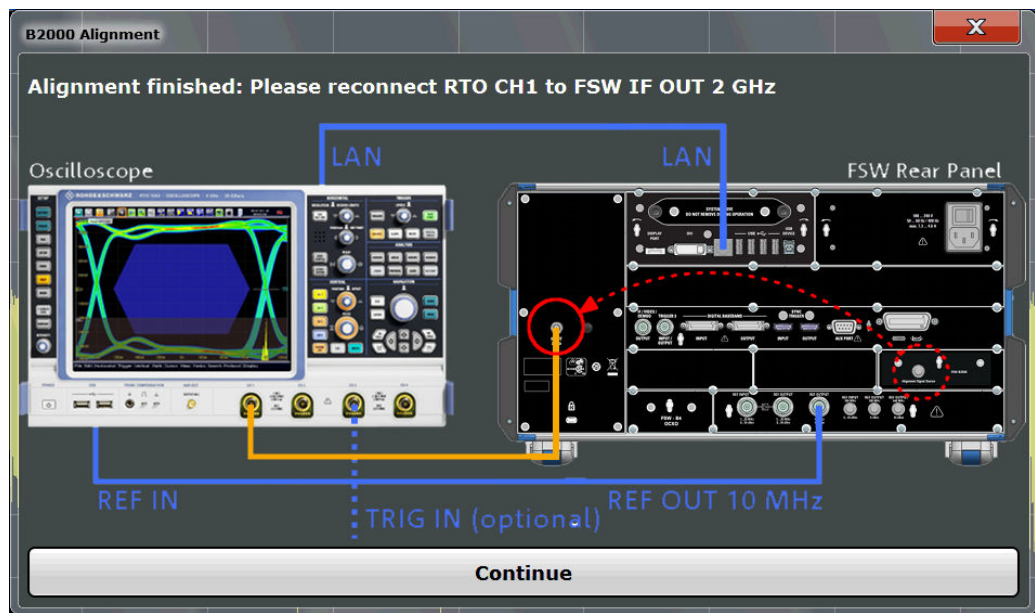


For the second alignment step, the connector must be disconnected from the "REF OUTPUT 640 MHz" connector and instead connected to the "FSW B2000 Alignment Signal Source" connector on the FSW.

(In power splitter mode: connection from the "FSW B2000 Alignment Signal Source" connector on the FSW to the power splitter.)

To continue the alignment, select "Continue Alignment".

After the second alignment step has been completed successfully, a new dialog box is displayed.



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 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 \(FSW-B2000/B5000\) and possible solutions](#).

Remote commands:

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:STEP<st>[:STATe]` on page 345

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:DATE` on page 346

6.3.2 Output settings

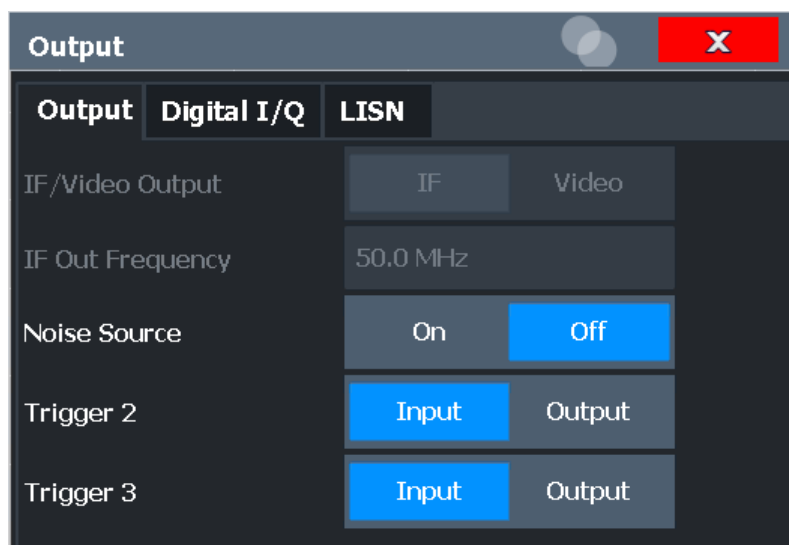
Access: [Input/Output] > "Output"

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

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



How to provide trigger signals as output is described in detail in the FSW base unit user manual.



Data Output.....	130
Noise Source Control.....	131

Data Output

Defines the type of signal available at one of the output connectors of the FSW.

For restrictions and additional information, see [Chapter 5.8, "IF and video signal output"](#), on page 76.

"IF"	<p>The measured IF value is provided at the IF/VIDEO/DEMODO output connector.</p> <p>For bandwidths up to 80 MHz, the IF output is provided at the specified "IF Out Frequency".</p> <p>If an optional bandwidth extension 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 specifications document. This setting is not available for bandwidths larger than 512 MHz.</p>
"2ND IF"	<p>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.</p> <p>This setting is not available if the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) is active.</p>
"Video"	<p>The displayed video signal (i.e. the filtered and detected IF signal) is available at the IF/VIDEO/DEMODO 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.</p>

Remote command:

`OUTPut:IF[:SOURce]` on page 351

`OUTPut:IF:IFFrequency` on page 351

Noise Source Control

Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise source control / Power sensor") connector. 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 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 FSW and measure the total noise power. From this value, you can determine the noise power of the 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 350

6.3.3 Digital I/Q output settings

Access: "Overview" > "Output" > "Digital I/Q" tab

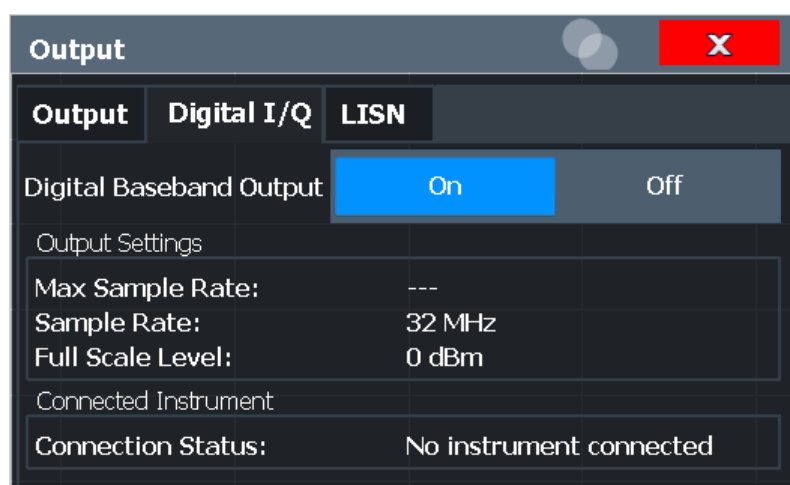
The optional "Digital Baseband" interface allows you to output I/Q data from any FSW application that processes I/Q data to an external device.

These settings are only available if the "Digital Baseband" interface option is installed on the FSW.



Digital I/Q output is available with bandwidth extension option FSW-B512, but not with R&S FSW-B512R (Real-Time).

However, see the note regarding "[Digital I/Q output and FSW-B512/-B1200/-B2001 options](#)" on page 48.



For details on digital I/Q output, see [Chapter 5.2.2, "Digital output"](#), on page 47.

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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 49.

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 47.

Remote command:

[OUTPut:DIQ\[:STATe\]](#) on page 292

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 292

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 292

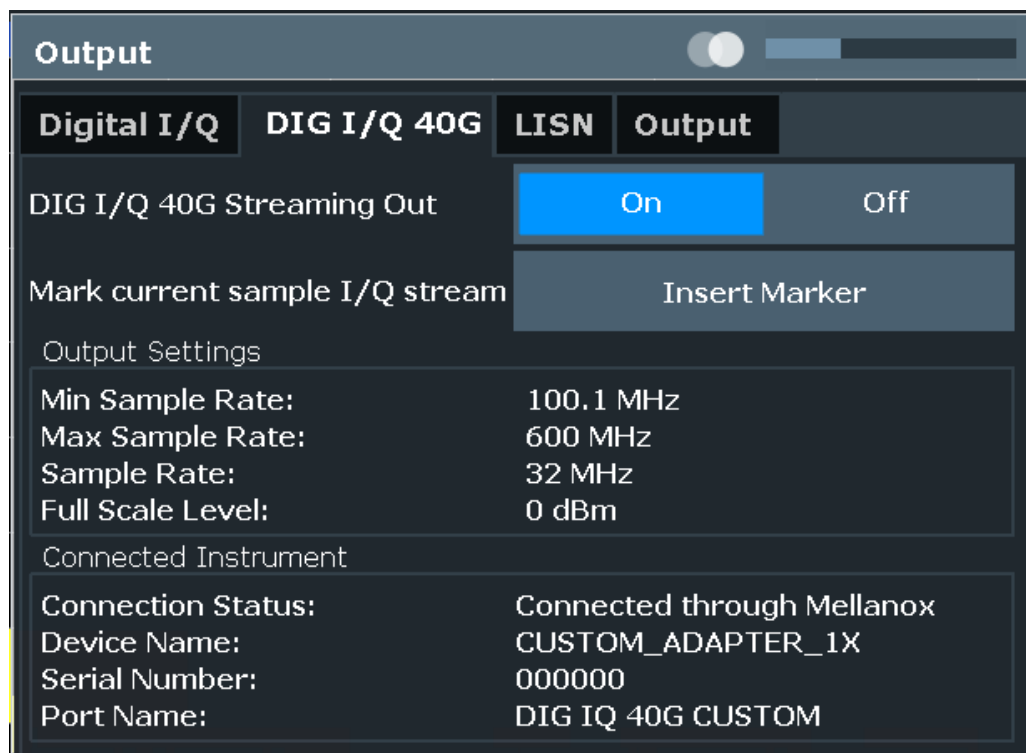
6.3.4 Digital I/Q 40G output settings

Access: "Overview" > "Output" > "Digital I/Q 40G" tab

The optional Digital I/Q 40G Streaming Output interface (FSW-B517/-B1017) allows you to output I/Q data to an external device at very high sample rates.

These settings are only available if one of the Digital I/Q 40G Streaming Output options is installed on the FSW.

For details see [Chapter 5.7, "Digital I/Q 40G streaming output"](#), on page 73.



Digital I/Q 40G Streaming Out	133
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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: IQHS [: STATe]` on page 354

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 5.7, "Digital I/Q 40G streaming output"](#), on page 73.

Remote command:

`OUTPut: IQHS: MARKer` on page 353

Output Settings Information

Displays information on the settings for output via the Digital I/Q 40G Streaming Output option (FSW-B517/-B1017).

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: IQHS:SRATe?](#) on page 353

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: IQHS:CDEvice?](#) on page 353

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 145).

For background information on amplitude settings see the FSW User Manual.

6.4.1 Amplitude settings

Access: "Overview" > "Amplitude"

Amplitude settings determine how the FSW must process or display the expected input power levels.

Configuring amplitude settings allows you to:

- Adapt the instrument hardware to the expected maximum signal level by setting the [Reference Level](#) to this maximum
- Consider an external attenuator or preamplifier (using the "Offset").

- Optimize the SNR of the measurement for low signal levels by configuring the [Reference Level](#) as high as possible without introducing compression, clipping or overload. Use early amplification by the preamplifier and a low attenuation.
- Optimize the SNR for high signal levels and ensure that the instrument hardware is not damaged, using high attenuation and AC coupling (for DC input voltage).
- Adapt the reference impedance for power results when measuring in a 75-Ohm system by connecting an external matching pad to the RF input.



Using external frontends

For an active external frontend, the amplitude settings refer to the RF input at the external frontend, not the levels at the RF input of the FSW. You can configure the attenuation at the external frontend and the analyzer separately. Electronic attenuation, preamplifier and noise cancellation are not available. Input coupling is always DC. Impedance is always 50 Ω .

Amplitude settings for input from the optional "Analog Baseband" interface are described in the FSW I/Q Analyzer and I/Q Input User Manual.

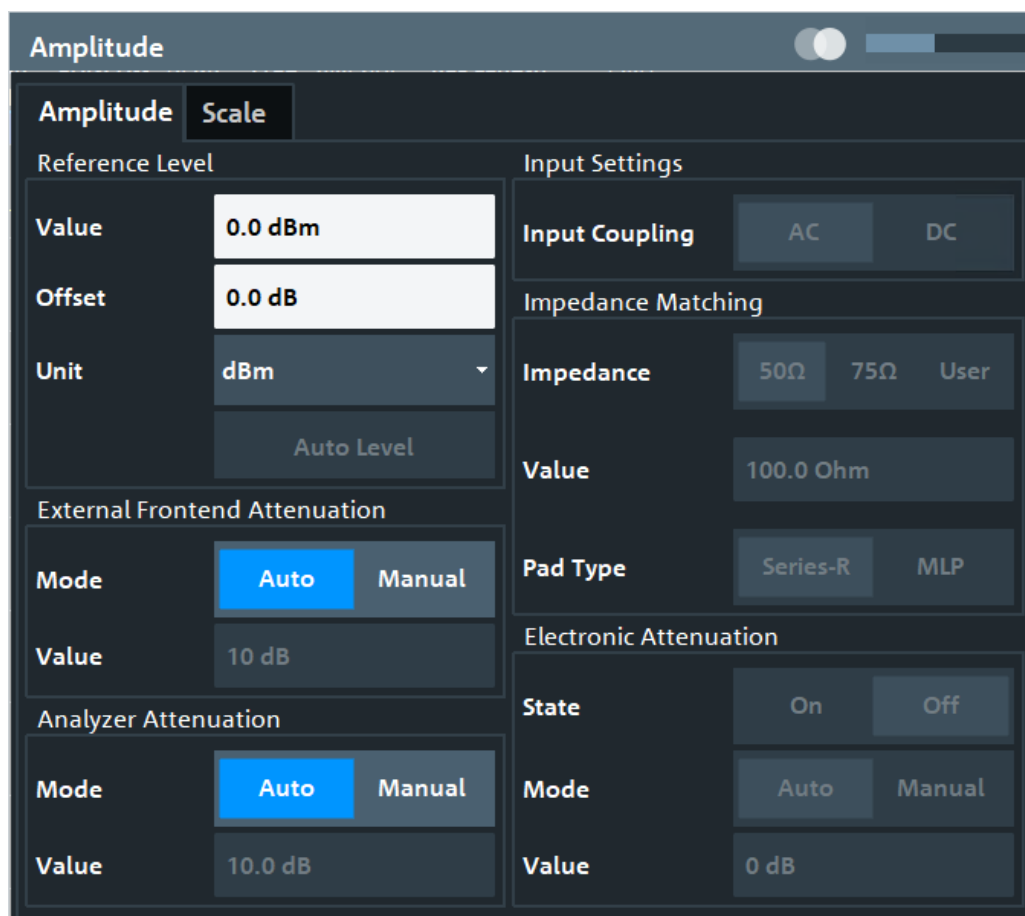


Figure 6-2: Amplitude settings for active external frontend

Reference Level.....	136
└ Shifting the Display (Offset).....	137
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└ Ext. PA Correction.....	141

Reference Level

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" or "OVL" status display.

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

Since the hardware of the 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 optimal 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 FSW base unit user manual for details.

For an active external frontend, the reference level refers to the RF input at the external frontend, not the levels at the RF input of the FSW. The hardware is adjusted to the defined reference level optimally for input signals with a crest factor of 10 dB. Thus, the required reference level for an optimal measurement can differ depending on the crest factor of the input signal.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel`
on page 355

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 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 FSW must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 356

Unit ← Reference Level

The 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 100), conversion to other units is possible.

Remote command:

`INPut:IMPedance` on page 260
`CALCulate<n>:UNIT:POWer` on page 355

Setting the Reference Level Automatically (Auto Level) ← Reference Level

Automatically determines a reference level which ensures that no overload occurs at the 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. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the 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 \(Meas Time Manual\)](#)" on page 170).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 392

External Frontend Attenuation

If an external frontend is active, you can configure the attenuation for the external frontend and the analyzer separately.

For more information, see the FSW User Manual.

When using an external frontend, only mechanical attenuation is available.

The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

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 specifications document. 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 can lead to hardware damage.

Remote command:

[INPut:ATTenuation](#) on page 356

[INPut:ATTenuation:AUTO](#) on page 357

Attenuation Mode / Value

Defines the attenuation applied to the RF input of the FSW.

This function is not available for input from the optional "Digital Baseband" interface.

The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

Note: Using an external frontend. If an external frontend is active, you can configure the attenuation for the external frontend and the analyzer separately. When using an external frontend, only mechanical attenuation is available.

For more information, see the FSW base unit user manual.

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 specifications document. 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 can lead to hardware damage.

Remote command:

[INPut:ATTenuation](#) on page 356

[INPut:ATTenuation:AUTO](#) on page 357

Defining attenuation for the analyzer when using an external frontend:

[INPut:SANalyzer:ATTenuation:AUTO](#) on page 359

[INPut:SANalyzer:ATTenuation](#) 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:

- One of the following options that provide a separate wideband processing path in the FSW is installed:
 - Bandwidth extension R&S FSW-B160/-B320 Extension Board 1, Revision 2 or higher
 - Bandwidth extension R&S FSW-B512, B1200, B2001, B4001, B6001, or B8001
 - Real-time option R&S FSW-B160R
(Currently not supported for K161R, B512R and B800R/K800RE)
- An I/Q bandwidth that requires 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:ATTenuation:AUTO:MODE](#) on page 357

Signal Path

Selects the signal path for signal processing.

"Narrowband" (Default:) The narrowband signal path is used.

"Wideband" The wideband signal path is used. With this setting, the dynamic range for EVM measurements is increased.

This function is only available under the following conditions:

- Instrument models FSW50/67/85
- One of the following bandwidth extension options is installed:

- R&S FSW-B1200
- R&S FSW-B2001
- R&S FSW-B800R
- An I/Q bandwidth between 80 MHz and 512 MHz is used.
- The center frequency is higher than 43.5 GHz.
- The optional "Digital Baseband" interface is not active.

Remote command:

[\[SENSe:\] IQ:WBANd](#) on page 360

Using Electronic Attenuation

If the (optional) Electronic Attenuation hardware is installed on the 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.

For an active external frontend, electronic attenuation is not available.

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 can 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 FSW85, the mechanical attenuation can be varied only in 10 dB steps.

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

Remote command:

[INPut:EATT:STATE](#) on page 358

[INPut:EATT:AUTO](#) on page 358

[INPut:EATT](#) on page 358

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 98.

Preamplifier ← Input Settings

If the (optional) internal preamplifier hardware is installed on the FSW, 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: If an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For an active external frontend, a preamplifier is not available.

This function is not available for input from the (optional) "Digital Baseband" interface.

For all FSW models except for FSW85, 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 older FSW43/FSW50/FSW67 models, the input signal is always amplified by about 30 dB when the preamplifier is active.

For FSW85 models, no preamplifier is available.

Remote command:

[INPut:GAIN:STATe](#) on page 361

[INPut:GAIN\[:VALue\]](#) on page 362

Ext. PA Correction ← Input Settings

This function is only available if an external preamplifier is connected to the 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 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 FSW, the preamplifier is permanently on and ready to use. However, you must enable data correction based on the stored data explicitly on the FSW using this setting.

When enabled, the FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results. Any internal preamplifier, if available, is disabled.

For 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.

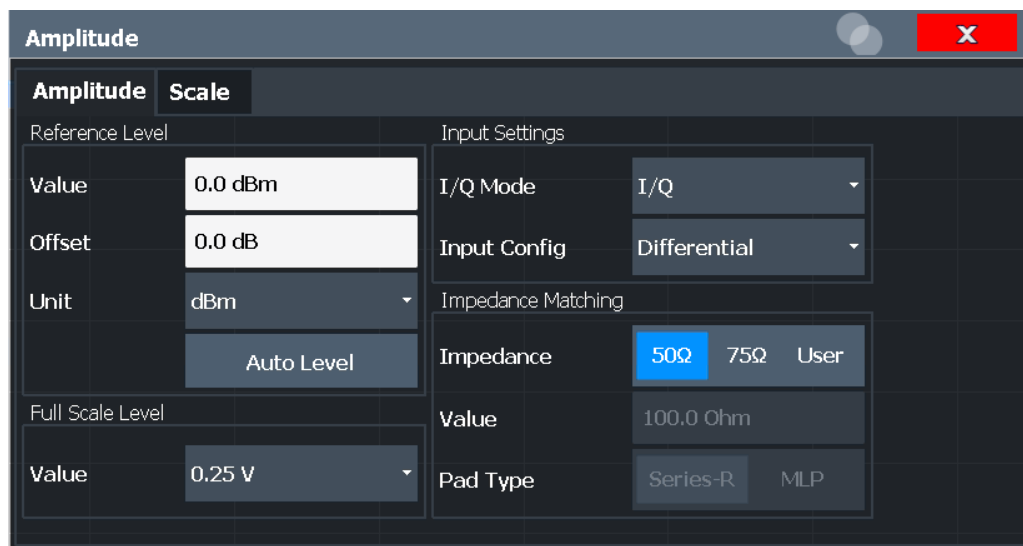
Remote command:

[INPut:EGAIN\[:STATe\]](#) on page 360

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 116.

Reference Level.....	142
L Shifting the Display (Offset).....	143
L Unit.....	143
L Setting the Reference Level Automatically (Auto Level).....	143
Full Scale Level Mode / Value.....	144

Reference Level

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" or "OVLd" status display.

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

Since the hardware of the 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 optimal 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 FSW base unit user manual for details.

For an active external frontend, the reference level refers to the RF input at the external frontend, not the levels at the RF input of the FSW. The hardware is adjusted to the defined reference level optimally for input signals with a crest factor of 10 dB. Thus, the required reference level for an optimal measurement can differ depending on the crest factor of the input signal.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel`
on page 355

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 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 FSW must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 356

Unit ← Reference Level

The 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 100), conversion to other units is possible.

Remote command:

`INPut:IMPedance` on page 260
`CALCulate<n>:UNIT:POWer` on page 355

Setting the Reference Level Automatically (Auto Level) ← Reference Level

Automatically determines a reference level which ensures that no overload occurs at the 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. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the 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 \(Meas Time Manual\)](#)" on page 170).

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 the FSW User Manual.

Remote command:

For Analog Baseband input:

[INPut:IQ:FULLscale:AUTO](#) on page 294

[INPut:IQ:FULLscale\[:LEVel\]](#) on page 295

For Oscilloscope Baseband Input:

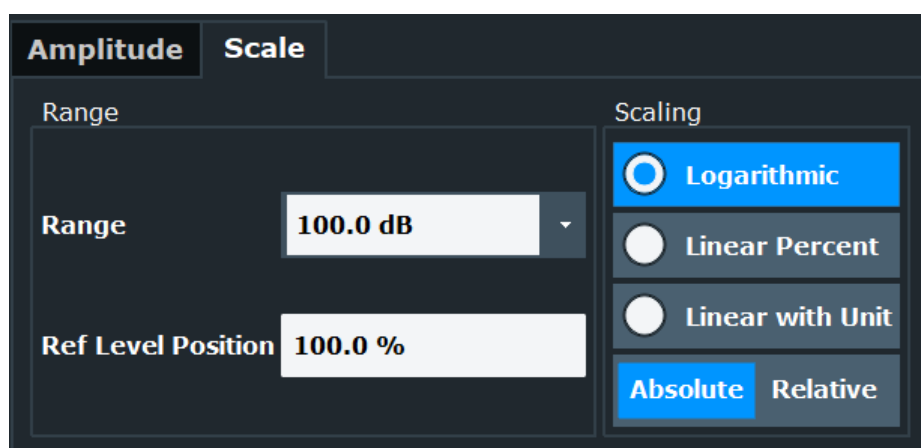
[INPut:IQ:OSC:FULLscale\[:LEVel\]](#) on page 300

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.....	145
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Scaling.....	145
Y-Axis Max.....	145

Range

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 362

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 +280 % 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>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 364

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 364
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE`
 on page 363

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).

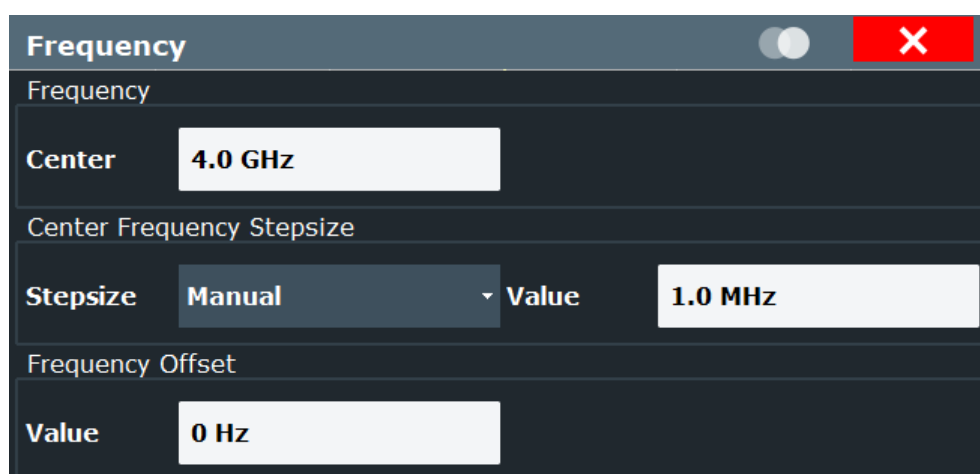
This command is only available if the evaluation mode for the I/Q Analyzer is set to "I/Q-Vector" or "Real/Imag (I/Q)".

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 362

6.5 Frequency settings

Access: "Overview" > "Frequency"



Center Frequency.....	146
Center Frequency Step size.....	146
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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.

$$\text{span} > 0: \text{span}_{\min}/2 \leq f_{\text{center}} \leq f_{\text{max}} - \text{span}_{\min}/2$$

f_{max} and span_{\min} depend on the instrument and are specified in the specifications document.

Remote command:

`[SENSe:]FREQuency:CENTer` on page 365

Center Frequency Step size

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 366

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, 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 primary.

Remote command:

[\[SENSe:\] FREQuency:OFFSet](#) on page 366

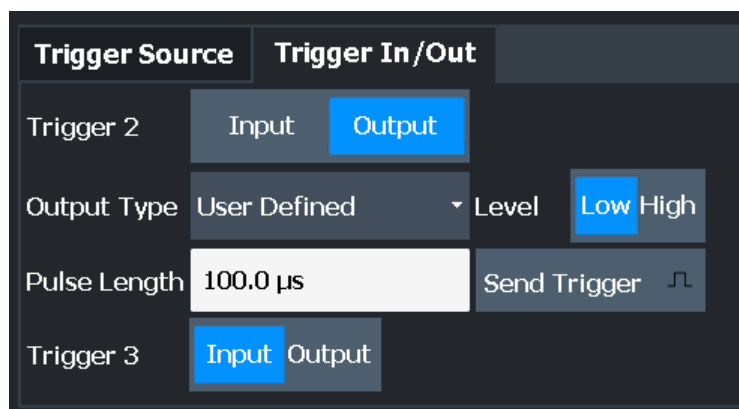
6.6 Trigger settings

Access: "Overview" > "Trigger" (> "Trigger In/Out")

Trigger settings determine when the input signal is measured.

Trigger	
Trigger Source	Trigger In/Out
Source	I/Q Power
Level	-20.0 dBm
Offset	0 s
Hysteresis	3.0 dB
Correct TPIS	On <input type="radio"/> Off <input checked="" type="radio"/>
Drop-Out Time	0 s
Slope	Rising <input checked="" type="radio"/> Falling <input type="radio"/>
Holdoff	0 s

External triggers from one of the "TRIGGER INPUT/OUTPUT" connectors on the 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 11.4.4.3, "Configuring I/Q gating"](#), on page 377.

For step-by-step instructions on configuring triggered measurements, see the FSW User Manual.

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L External Trigger 1/2/3.....	149
L External Channel 3.....	150
L External Analog.....	150
L IF Power.....	150
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L I/Q Power.....	151
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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.

For an active external frontend, only external triggers, I/Q power triggers and (periodic) time triggers are supported as trigger sources.

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 372

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 372

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 153).

Note: "External Trigger 1" 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 150 is supported.

If the optional Oscilloscope Baseband Input is active, only "[External Analog](#)" on page 150 is supported.

For details, see the "Instrument Tour" chapter in the 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 FSW85 models, "Trigger 2" is not available due to the second RF input connector on the front panel.

(See the FSW base unit 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 372

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 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 (FSW-B2000/B5000) is active (see FSW I/Q Analyzer and I/Q Input User Manual).

If power splitter mode is active, use the ["External Analog"](#) on page 150 option.

For details, see [Chapter 5.6.7, "Triggering"](#), on page 70.

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 specifications document and documentation.

Remote command:

```
TRIG:SOUR EXT
```

See [TRIGger\[:SEquence\]:SOURce](#) on page 372

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 22.

Remote command:

```
TRIG:SOUR EXT
```

See [TRIGger\[:SEquence\]:SOURce](#) on page 372

IF Power ← Trigger Source ← Trigger Source

The 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 threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document. 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.

Available for input from the optional "Analog Baseband" interface.

Available for input from the optional "Digital 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 71.

For details on available trigger levels and trigger bandwidths, see the specifications document.

Remote command:

TRIG:SOUR IFP, see [TRIGger\[:SEQuence\]:SOURce](#) on page 372

Baseband Power ← Trigger Source ← Trigger Source

Defines triggering on the baseband power for baseband input.

Available for input from the optional "Analog Baseband" interface.

Available for input from the optional "Digital Baseband" interface.

Remote command:

TRIG:SOUR BBP, see [TRIGger\[:SEQuence\]:SOURce](#) on page 372

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.

Not available for the optional "Digital Baseband" interface.

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 159).

Remote command:

TRIG:SOUR IQP, see [TRIGger\[:SEQuence\]:SOURce](#) on page 372

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 49.)

A [Trigger Offset](#), and ["Slope"](#) on page 155 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 502)

Table 6-1: Assignment of general-purpose bits to LVDS connector pins

Bit	LVDS pin
GP0	SDATA4_P - Trigger1
GP1	SDATA4_P - Trigger2
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 372

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 specifications document.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the sweep can 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".

Not available for input from the optional "Analog Baseband" interface.

Not available for input from the optional "Digital Baseband" interface.

If the trigger source "RF Power" is selected and you enable baseband input, the trigger source is automatically switched to "Free Run".

Remote command:

TRIG:SOUR RFP, see [TRIGger\[:SEquence\]:SOURce](#) on page 372

Power Sensor ← Trigger Source ← Trigger Source

Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

If a B4001/B6001/B8001 bandwidth extension option is active, this trigger is not available for bandwidths ≥ 80 MHz.

Note: For Rohde & Schwarz power sensors, the "Gate Mode" *Lvl* is not supported. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed.

Remote command:

TRIG:SOUR PSE, see [TRIGger\[:SEquence\]:SOURce](#) on page 372

Time ← Trigger Source ← Trigger Source

Triggers in a specified repetition interval.

See ["Repetition Interval"](#) on page 153.

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 372

Trigger Level ← Trigger Source

Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the instrument specifications document.

For time triggers, the repetition interval is defined. See ["Repetition Interval"](#) on page 153.

Remote command:

[TRIGger\[:SEquence\]:LEVel:IFPower](#) on page 370

[TRIGger\[:SEquence\]:LEVel:IQPower](#) on page 371

[TRIGger\[:SEquence\]:LEVel\[:EXternal<port>\]](#) on page 370

[TRIGger\[:SEquence\]:LEVel:RFPower](#) on page 371

For baseband input only:

[TRIGger\[:SEquence\]:LEVel:BBPower](#) on page 370

Repetition Interval ← Trigger Source

Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If the required interval cannot be set with the available granularity, configure a multiple of the interval that can be set. Thus, the trigger remains synchronized to the signal.

Remote command:

[TRIGger\[:SEquence\]:TIME:RINTerval](#) on page 374

Drop-Out Time ← Trigger Source

Defines the time that 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 μ s. For external triggers, no drop-out time is available when using the B2000/B5000 option.

(For details, see ["IF Power trigger"](#) on page 71)

Remote command:

[TRIGger\[:SEquence\]:DTIME](#) on page 368

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:	<p>Sweep starts earlier (pretrigger)</p> <p>Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off</p> <p>Maximum allowed range limited by the sweep time:</p> $\text{Pretrigger}_{\text{max}} = \text{sweep time}_{\text{max}}$ <p>When using the optional "Digital Baseband" interface, the maximum range is limited by the number of pretrigger samples. (See Table 5-22)</p>

Tip: To determine the trigger point in the sample (for "External" or "IF Power" trigger source), use the [TRACe:IQ:TPIsample?](#) command.

Remote command:

[TRIGger\[:SEquence\]:HOLDoff\[:TIME\]](#) on page 369

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 M Ω "	Direct connection with 1 M Ω 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 349

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 71)

Remote command:

[TRIGger\[:SEquence\]:SLOPe](#) on page 371

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 369

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 369


Correct TPIS ← Trigger Source

If enabled, the trigger event is set to the actual trigger point within the sample (TPIS). See also [TRACe:IQ:TPISample?](#) on page 386.

This setting is available for all trigger sources except "Free Run".

TPIS correction is not supported if user frequency response correction (R&S FSW-K544) is active. If you activate frequency response correction, TPIS correction is automatically deactivated in all channels.

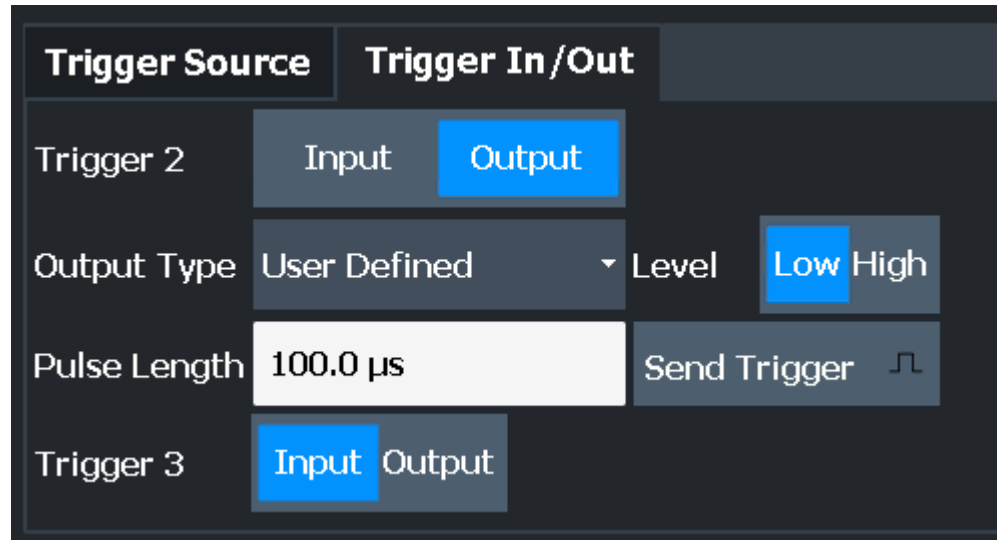
For details see frequency response correction in the FSW user manual.

Note that when you enable this setting, the displayed trace no longer matches the instrument settings. Thus, the  yellow star icon is displayed on the tab label. Start a new measurement for the correction to take effect and to update the display.

Remote command:

[TRIGger\[:SEquence\]:CTPis](#) on page 368

Trigger 2/3



The trigger input and output functionality depends on how the variable "Trigger Input/Output" connectors are used.

Note: Providing trigger signals as output is described in detail in the FSW base unit user manual.

"Trigger 1" "Trigger 1" is input only.

"Trigger 2" Defines the usage of the variable "Trigger Input/Output" connector on the front panel
(not available for FSW85 models with 2 RF input connectors)

"Trigger 3" Defines the usage of the variable "Trigger 3 Input/Output" connector on the rear panel

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

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

Remote command:

[OUTPut:TRIGger<tp>:DIRection](#) on page 374

Output Type ← Trigger 2/3

Type of signal to be sent to the output

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

- "Trigger Armed" Sends a (high level) trigger when the 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 FSW base unit user manual and the description of the "AUX" port in the FSW Getting Started manual.
- "User Defined" Sends a trigger when you select "Send Trigger".
In this case, further parameters are available for the output signal.

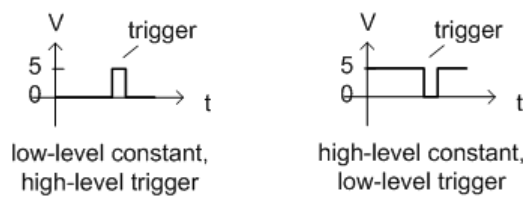
Remote command:

`OUTPut:TRIGger<tp>:OTYPe` on page 375

Level ← Output Type ← Trigger 2/3

Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User Defined").

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



Remote command:

`OUTPut:TRIGger<tp>:LEVel` on page 375

Pulse Length ← Output Type ← Trigger 2/3

Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:

`OUTPut:TRIGger<tp>:PULSe:LENGth` on page 376

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 is sent is indicated by a graphic on the button.

Remote command:

`OUTPut:TRIGger<tp>:PULSe:IMMediate` on page 376

6.7 Data acquisition and bandwidth settings

Access: "Overview" > "Bandwidth"

- [Data acquisition](#).....158
- [Sweep settings](#).....165

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.

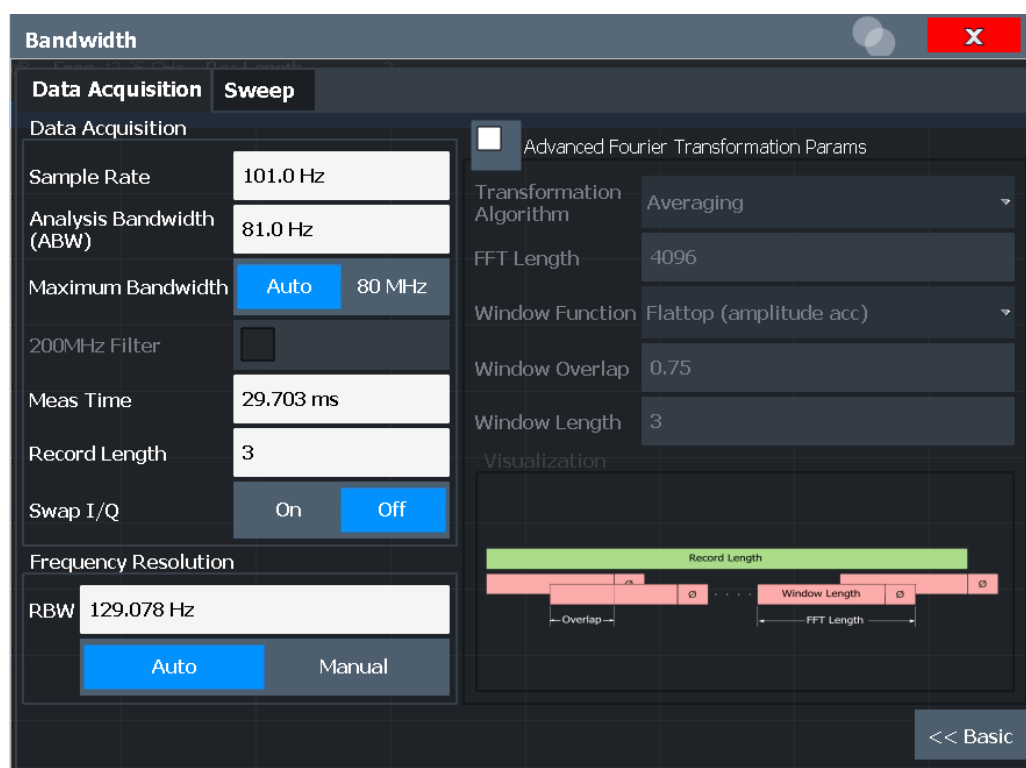


Figure 6-3: Data acquisition settings with advanced FFT parameters



MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT primary 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 FSW MSRA User Manual. For details on the MSRT operating mode see the FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

The remote commands required to perform these tasks are described in [Chapter 11.4.5, "Configuring data acquisition"](#), on page 379.

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L Window Length.....	164
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Sample Rate

Defines the I/Q data sample rate of the FSW. This value depends on the defined [Analysis Bandwidth](#).

Up to the [Maximum Bandwidth](#), the following rule applies:

$$\text{sample rate} = \text{analysis bandwidth} / 0.8$$

For details on the dependencies see [Chapter 5.1.1, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 25.

In particular, note the irregularities mentioned in [Chapter 5.1.1.8, "FSW with activated I/Q bandwidth extension option B512"](#), on page 32 and ["Irregular behavior in bandwidths between 480 MHz and R&S FSW512 MHz with FSW-B1200 option"](#) on page 37.

This rate may differ from the sample rate of the connected device (see ["Input Sample Rate"](#) on page 115).

If the "Digital Baseband" interface (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 48.

Remote command:

[TRACe: IQ:SRATe](#) on page 386

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:

$$\text{analysis bandwidth} = 0.8 * \text{sample rate}$$

Note: Bandwidths up to 2 GHz / 5 GHz are only available if the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) is installed *and active* (see ["B2000/B5000"](#)

State" on page 124). The option is not activated automatically by defining a larger bandwidth.

If the **9.933 GHz Mode** mode is enabled, the ABW is set to 6400 MHz (using B6001) / 8600 MHz (using B8001) and cannot be reduced below 4400 MHz. See also "**Bandwidth extension options B6001 / B8001 at CF 9.933 GHz**" on page 44.

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 51.

Remote command:

TRACe: IQ:BWIDth on page 383

Maximum Bandwidth

Defines the maximum bandwidth to be used by the 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 FSW. Otherwise the maximum bandwidth is determined automatically.

Note: This setting is not available for the optional 2 GHz / 5 GHz bandwidth extension (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 28). 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 FSW, the "IF WIDE OUTPUT" connector is automatically used to provide IF output. See the 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 387

[TRACe: IQ:WBANd:MBWidth](#) on page 387

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 115).

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 383

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 FSW.

This is useful for signals that have a bandwidth of approximately 200 MHz (for example Docsis 3.1). In this case, the 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:

- One of the following options that provide a separate wideband processing path in the FSW is installed:
 - Bandwidth extension R&S FSW-B160/-B320 Extension Board 1, Revision 2 or higher
 - Bandwidth extension R&S FSW-B512, B1200, B2001, B4001, B6001, or B8001
 - Real-time option R&S FSW-B160R
(Currently not supported for K161R, B512R and B800R/K800RE)
- An I/Q bandwidth that requires 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 388

9.933 GHz Mode

Enables the optional analysis bandwidth extensions B6001/B8001, if available, for a center frequency of 9.933 GHz.

Note the restrictions described in ["Bandwidth extension options B6001 / B8001 at CF 9.933 GHz"](#) on page 44.

Remote command:

[TRACe: IQ:M9933:STATe](#) on page 384

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 25.

Remote command:

[\[SENSe:\] SWEEp:TIME](#) on page 406

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 specifications document).

Remote command:

[TRACe:IQ:RLENgth](#) on page 384

[TRACe:IQ:SET](#) on page 384

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 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 383

RBW

Defines the resolution bandwidth for Spectrum results. The available RBW values depend on the sample rate and record length.

(See [Chapter 5.11.4, "Frequency resolution of FFT results - RBW"](#), on page 84).

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 5.11, "Basics on FFT"](#), on page 80.

- "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 380

[\[SENSe:\] IQ:BWIDth:RESolution](#) on page 380

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 5.11.4, "Frequency resolution of FFT results - RBW"](#), on page 84.

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 381

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 381

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 382

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 382

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 162.)

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 381

Capture Offset

This setting is only available for secondary 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 secondary 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 Mode User Manual](#).

For details on the MSRT operating mode, see the [R&S®FSW Real-Time Measurements User Manual](#).

Remote command:

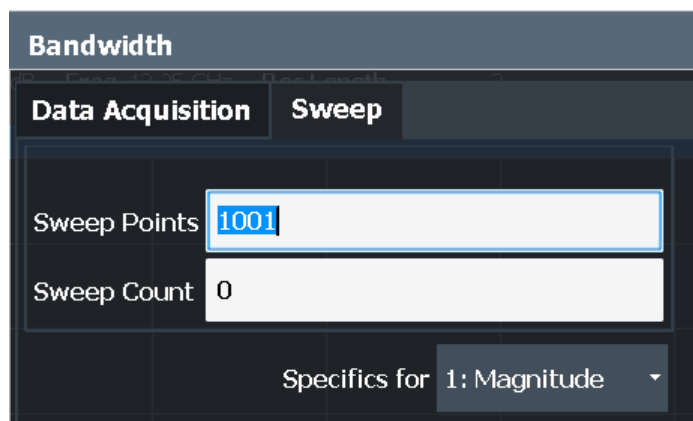
[SENSe:]MSRA:CAPTure:OFFSet on page 468

MSRT mode:

[SENSe:]RTMS:CAPTure:OFFSet on page 470

6.7.2 Sweep settings

Access: "Overview" > "Bandwidth" > "Sweep" tab



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Single Sweep / Run Single.....	166
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Continue Frame.....	167
Frame Count.....	168
Clear Spectrogram.....	168

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 82.

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 405

`[SENSe:] AVERAge<n>: COUNT` on page 414

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, "Continuous Sweep" and [RUN CONT] 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, "Continuous Sweep" 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, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the FSW base unit user manual.

Remote command:

`INITiate<n>: CONTInuous` on page 402

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, "Single Sweep" and [RUN SINGLE] are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, "Single Sweep" 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, [RUN SINGLE] 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 FSW base unit user manual.

Remote command:

`INITiate<n>[:IMMediate]` on page 403

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, "Continue Single Sweep" and [RUN SINGLE] 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 FSW User Manual.

Remote command:

`CALCulate<n>:SPECTrogram:FRAMe:SElect` on page 417

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 considered.
- **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 416

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 180).

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 416

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 477).

6.9 Adjusting settings automatically

Access: [AUTO SET]

Some settings can be adjusted by the FSW automatically according to the current measurement settings. 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 primary, not the secondary 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 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

Remote command:

[SENSe:]ADJust:CONFigure:TRIGger on page 391

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Lower Level Hysteresis.....	170

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings, including:

- [Auto Frequency](#)
- [Auto Level](#)

Note: MSRA/MSRT operating modes. In MSRA/MSRT operating mode, this function is only available for the MSRA/MSRT primary, not the secondary applications.

Remote command:

[SENSe:]ADJust:ALL on page 389

Adjusting the Center Frequency Automatically (Auto Frequency)

The 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 391

Setting the Reference Level Automatically (Auto Level)

Automatically determines a reference level which ensures that no overload occurs at the 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. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the 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 \(Meas Time Manual\)](#)" on page 170).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 392

Resetting the Automatic Measurement Time (Meas Time Auto)

Resets the measurement duration for automatic settings to the default value.

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 390

Changing the Automatic Measurement Time (Meas Time Manual)

This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Note: The maximum measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration actually used to determine the automatic settings can be shorter than the value you define here.

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 390

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation](#) on page 389

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 that 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 391

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 that 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 390

6.10 Configuring an I/Q analyzer as an MSRA/MSRT secondary 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 secondary application (*not primary*) in MSRA/MSRT mode can also perform measurements on the captured I/Q data in the time and frequency domain (see also [Chapter 5.14, "Measurements in the time and frequency domain"](#), on page 89). 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 "Select Meas".
- Press [MEAS].

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 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 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 252

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 FSW MSRA User Manual. For details on the MSRT operating mode see the 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 173.

- [Trace settings](#)..... 173
- [Spectrogram settings](#)..... 178
- [Trace / data export configuration](#)..... 184
- [Marker usage](#)..... 188
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7.1 Trace settings

Access: "Overview" > "Analysis" > "Traces"

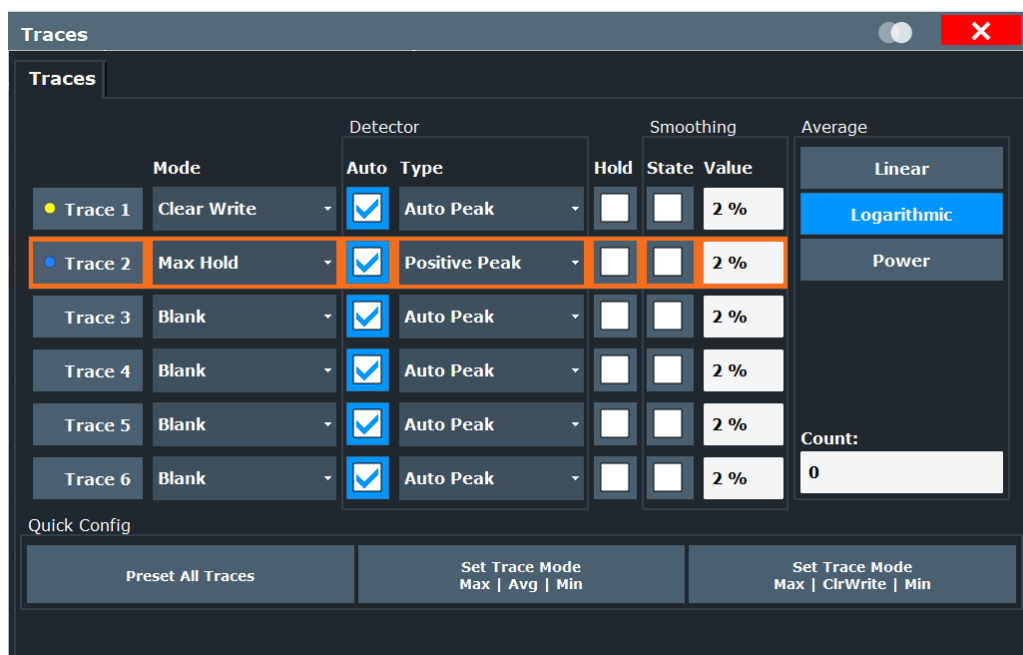
Or: [TRACE] > "Trace Config"

You can configure the settings for up to 6 individual traces in the same result display. Each trace is displayed in a different color, indicated in the window title bar and the trace settings.



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 184.

For I/Q Vector evaluation mode, only 1 trace is available and the detector is not editable.



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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 411

Trace Mode

Defines the update mode for subsequent traces.

- "Clear/ Write" Overwrite mode (default): the trace is overwritten by each sweep. All available detectors can be selected.
- "Max Hold" The maximum value is determined over several measurements and displayed. The FSW saves the sweep result in the trace memory only if the new value is greater than the previous one. This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope. This mode is not available for statistics measurements.

"Min Hold"	<p>The minimum value is determined from several measurements and displayed. The FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.</p> <p>This mode is useful for example for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level.</p> <p>This mode is not available for statistics measurements.</p>
"Average"	<p>The average is formed over several sweeps.</p> <p>The Sweep/Average Count determines the number of averaging procedures.</p> <p>This mode is not available for statistics measurements.</p>
"View"	<p>The current contents of the trace memory are frozen and displayed.</p> <p>Note: If a trace is frozen, you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk * on the tab label. If you change any parameters that affect the scaling of the diagram axes, the FSW automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.</p>
"Blank"	Removes the selected trace from the display.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE` on page 409

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 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 can lead to wrong level results. For details, see ["Combining results - trace detector"](#) on page 82.

"Auto"	(default:) Selects the optimum detector for the selected trace and filter mode
"Type"	<p>Defines the selected detector type.</p> <p>Note: If the EMI (R&S FSW-K54) measurement option is installed, additional detectors are available, even if EMI measurement is not active. If you select a CISPR trace detector, the RBW filter type is automatically also set to CISPR.</p> <p>CISPR detectors are only available under the following conditions:</p> <ul style="list-style-type: none"> • Time domain measurements and frequency measurements in sweep mode (not FFT mode, not power measurements, emission measurements, or statistics measurements)

Remote command:

`[SENSe:] [WINDow<n>:] DETector<t> [:FUNction]` on page 413

`[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 410

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 FSW User Manual.

Remote command:

`DISPlay[:WINDow<n>] [:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]`
on page 412

`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 the trace is averaged).

(See the chapter on ACLR power measurements in the FSW User Manual.)

How many sweeps are averaged is defined by the "[Sweep/Average Count](#)"
on page 166.

- | | |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| "Linear" | The power level values are converted into linear units before 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 before 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
	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 411

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

Trace Labels

Access: "Overview" > "Analysis" > "Traces" > "Trace Label" tab

You can define a descriptive label to active traces instead of the default "Trace <x>" label.

Note: This function is not available in all applications.

The labels are displayed in the diagram area. The font color corresponds to the color of the particular trace (for example, yellow trace: yellow font).

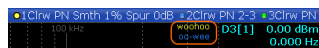


Figure 7-1: Example: the yellow and blue traces have a label

You can move the trace label to any position on the display by dragging it to the new position.

You can only configure labels for active traces and for traces whose "State" is enabled.

Traces	Export / Import	Copy Trace	Trace Math	Trace Label
	State Text			
Trace 1	<input checked="" type="checkbox"/>			Trace 1
Trace 2	<input checked="" type="checkbox"/>			Trace 2
Trace 3	<input type="checkbox"/>			Trace 3
Trace 4	<input type="checkbox"/>			Trace 4
Trace 5	<input type="checkbox"/>			Trace 5
Trace 6	<input type="checkbox"/>			Trace 6

Enable the state and enter a trace label.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe]` on page 408

`DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT` on page 408

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 182.

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 165.

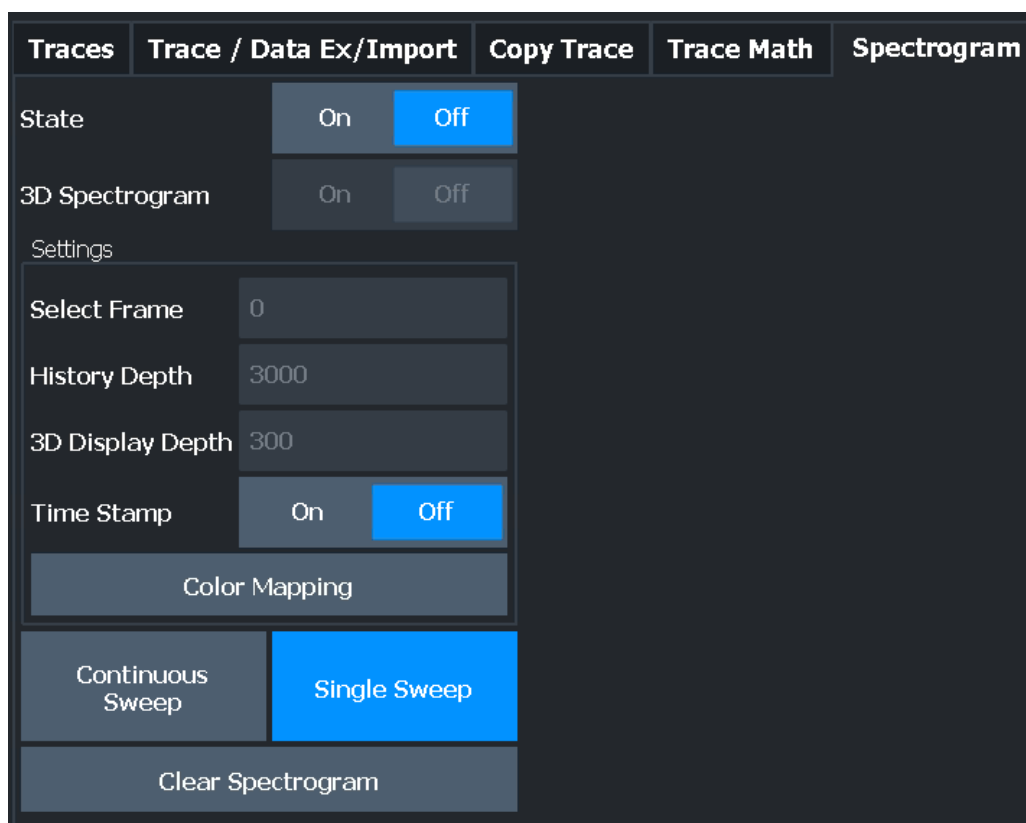
Search functions for spectrogram markers are described in [Chapter 7.4.2.2, "Marker search settings for spectrograms"](#), on page 196.

- [General spectrogram settings](#)..... 179
- [Color map settings](#)..... 182

7.2.1 General spectrogram settings

Access: [TRACE] > "Spectrogram Config"

This section describes general settings for spectrogram display.



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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 418

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 FSW User Manual.

Remote command:

[CALCulate<n>:SPECTrogram:THReedim\[:STATe\]](#) on page 419

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 FSW User Manual.

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:SElect](#) on page 417

History Depth

Sets the number of frames that the FSW stores in its memory.

The maximum number of frames depends on the "[Sweep Points](#)" on page 165.

For an overview of the maximum number of frames depending on the number of sweep points, see the FSW User Manual.

If the memory is full, the 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 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 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, "Continuous Sweep" and [RUN CONT] 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, "Continuous Sweep" 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, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the FSW base unit user manual.

Remote command:

[INITiate<n>:CONTinuous](#) on page 402

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, "Single Sweep" and [RUN SINGLE] are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, "Single Sweep" 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, [RUN SINGLE] 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 FSW base unit user manual.

Remote command:

`INITiate<n>[:IMMEDIATE]` on page 403

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 416

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.

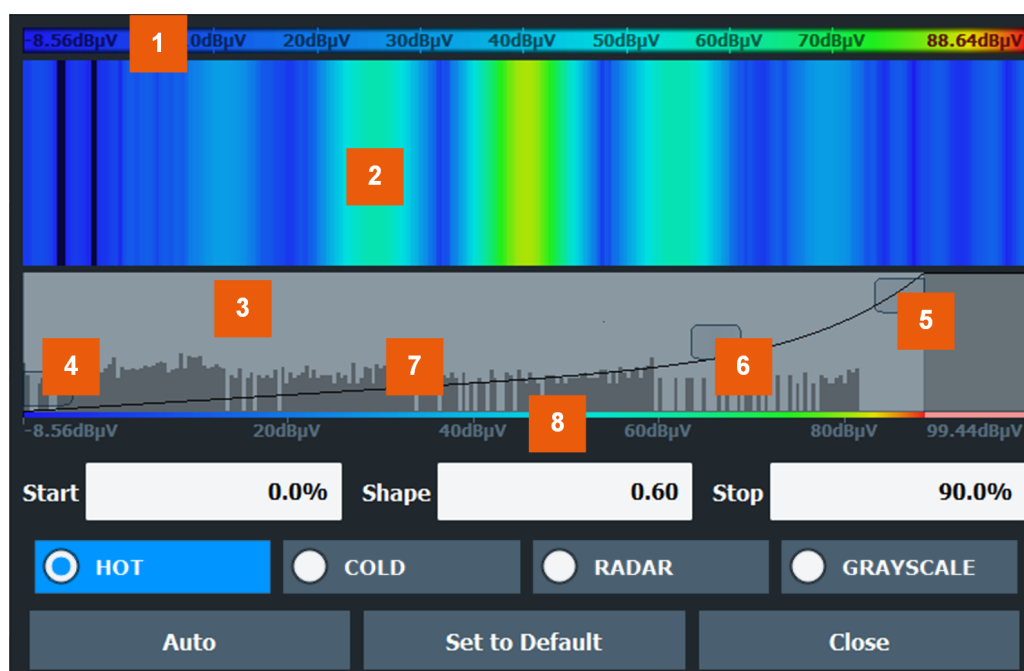


Figure 7-2: Color Mapping dialog box

- 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)

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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 422

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 421

Close

Saves the changes and closes the dialog box.

7.3 Trace / data export configuration



Access: "Save" > "Export" > "Export Configuration"

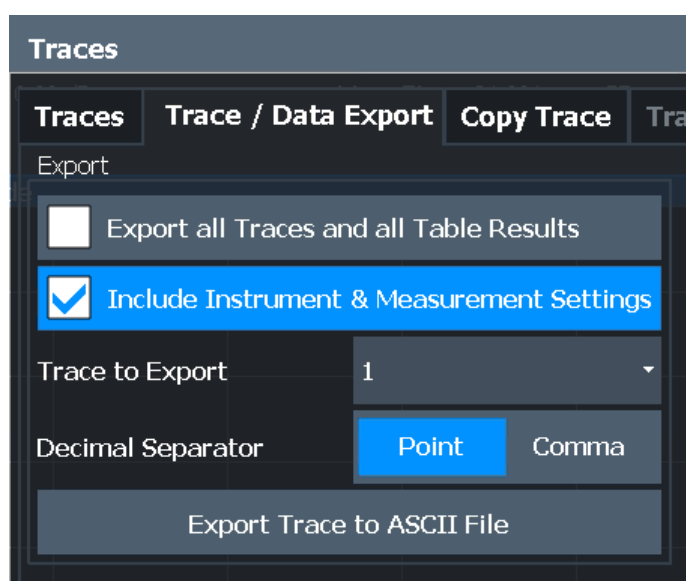
Or: [TRACE] > "Trace Config" > "Trace / Data Export"

The FSW provides various evaluation methods for the results of the performed measurements. However, if you want to evaluate the data with other, external applications, 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 FSW applications are not described here.

See the FSW base unit user manual for a description of the standard functions.



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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 481

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 481

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.

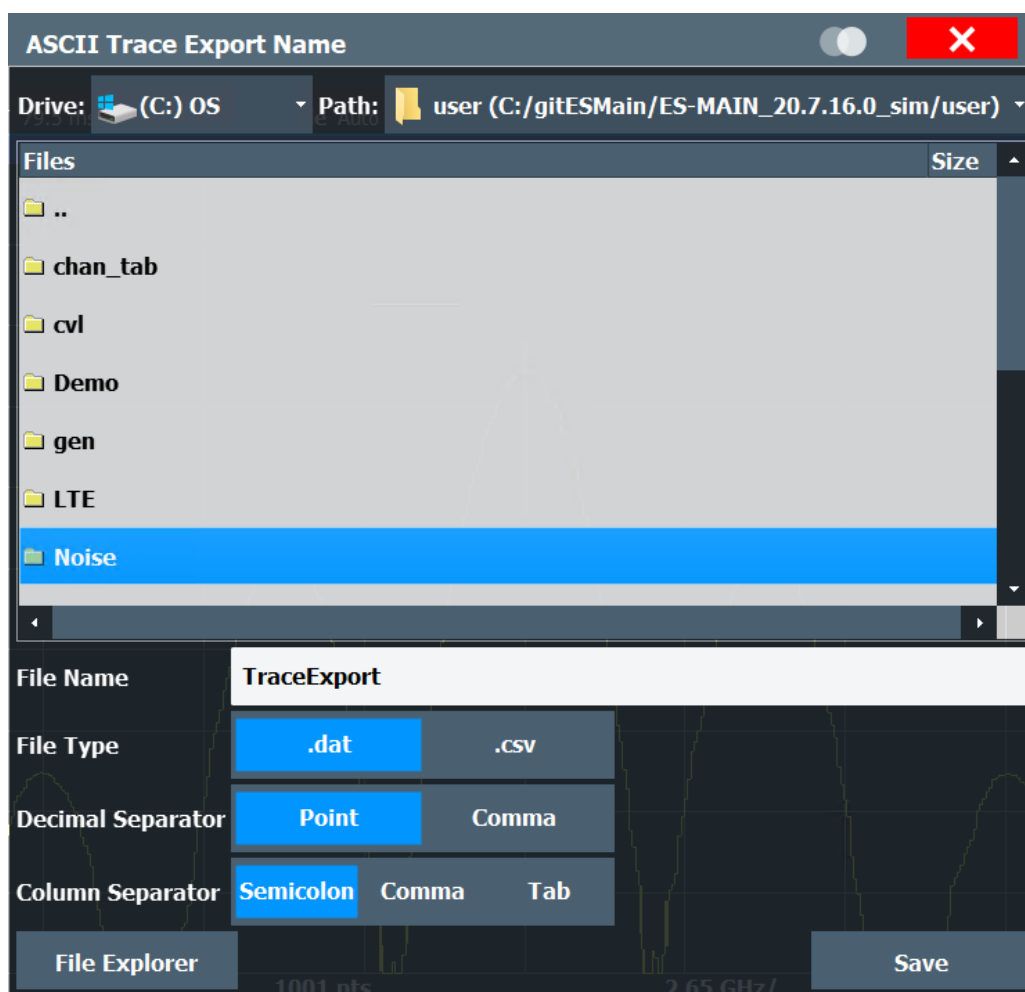
Remote command:

[FORMat:DEXPort:DSEParator](#) on page 480

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 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 FSW base unit user manual.

Remote command:

[MMEMory:STORE<n>:TRACe](#) on page 482

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 481

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 480

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;1.00;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSW13,  
Version,1.00,  
Date,01.Jan 3000,
```

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

```
Type      FSW13  
Version   1.00  
Date     01.Jan 3000
```

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

Remote command:

`FORMat:DEXPort:CSEParator` on page 480

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 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 FSW base unit user manual.

Remote command:

[MMEMoRY:STORe<n>:SPEcTrogram](#) on page 482

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 25).



Marker settings are now window-specific.

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- [Marker search settings and positioning functions](#)..... 193
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7.4.1 Marker settings

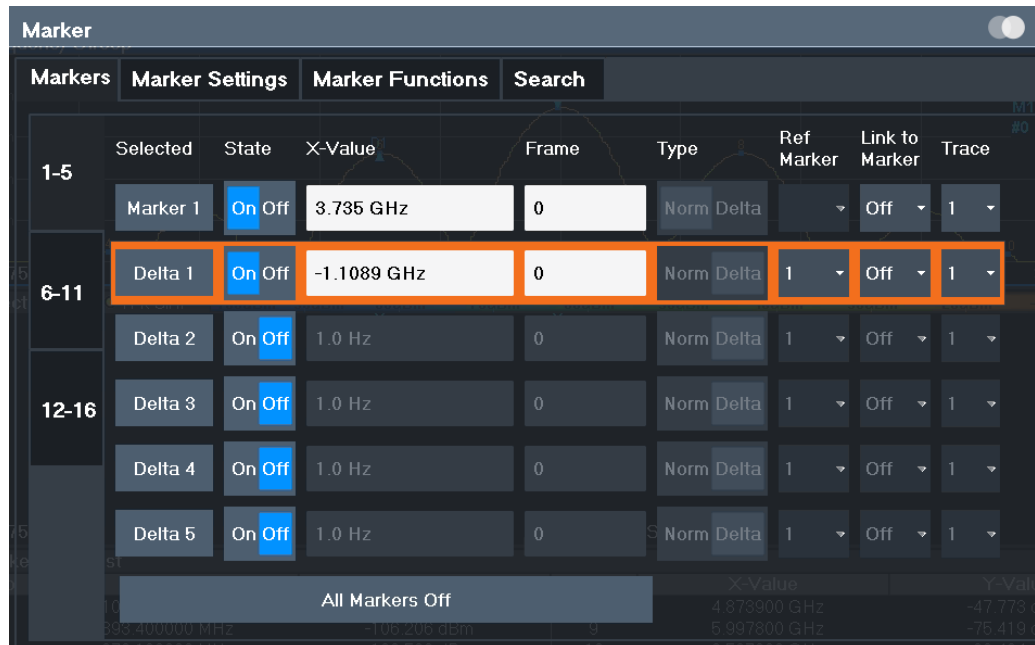
Or: [MKR] > "Marker Config"

The remote commands required to define these settings are described in [Chapter 11.7.3.1, "Setting up individual markers"](#), on page 423.

- [Individual marker setup](#).....188
- [General marker settings](#).....192

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.

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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 428

`CALCulate<n>:DELTAmarker<m>[:STATe]` on page 426

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.

To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the delta marker. Then link the delta marker to another marker using the [Linking to Another Marker](#) function.

Remote command:

[CALCulate<n>:MARKer<m>:X](#) on page 429

[CALCulate<n>:DELTAmarker<m>:X](#) on page 427

Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

Remote command:

[CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe](#) on page 437

[CALCulate<n>:DELTAmarker<m>:SPECTrogram:FRAMe](#) on page 441

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 428

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 426

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 426

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).

For linked delta markers, the x-value of the delta marker is 0 Hz by default. To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the linked delta marker.

Remote command:

[CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) on page 428

[CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>](#) on page 425

[CALCulate<n>:DELTamarker<m>:LINK](#) on page 424

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 429

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 428

[CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 426

All Markers Off

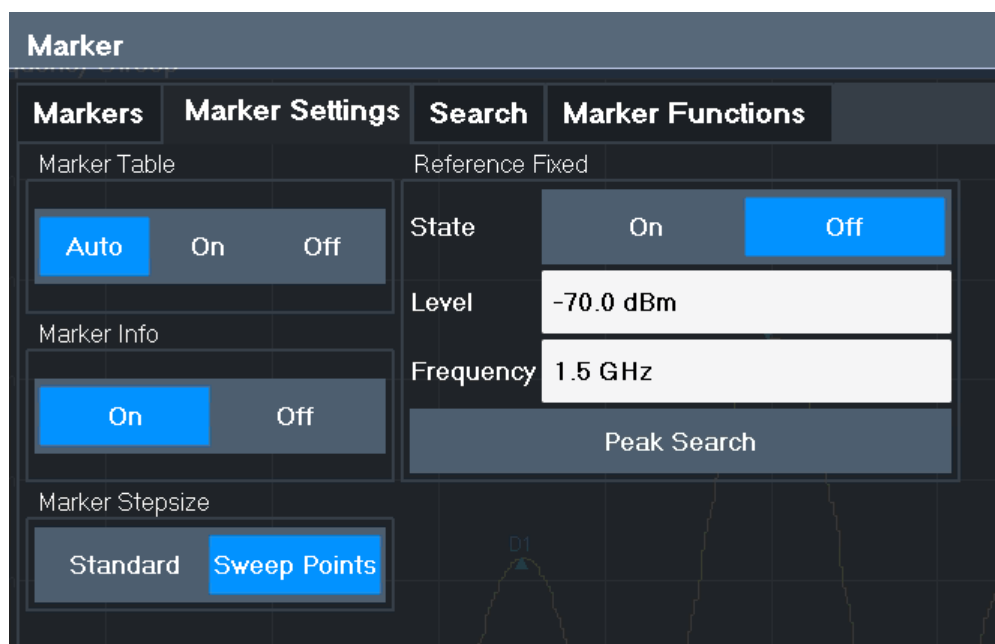
Deactivates all markers in one step.

Remote command:

`CALCulate<n>:MARKer<m>:AOFF` on page 427

7.4.1.2 General marker settings

Some general marker settings allow you to influence the marker behavior for all markers.



Marker Table Display.....	192
Marker Info.....	192
Marker Stepsize.....	193

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 430

Marker Info

Turns the marker information displayed in the diagram on and off.

1AP Clrw	
M1[1]	81.13 dBμV 177.610 MHz
D2[1]	-22.18 dB -28.980 MHz

Remote command:

`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 430

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 431

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 211.



In I/Q Analyzer mode, the search settings for "Real/Imag (I/Q)" evaluation include an additional parameter, see ["Branch for Peaksearch"](#) on page 196.

The remote commands required to define these settings are described in [Chapter 11.7.3.5, "Positioning the marker"](#), on page 444.

- [Marker search settings](#)..... 194
- [Marker search settings for spectrograms](#)..... 196
- [Positioning functions](#)..... 199

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 196.

Marker	
Markers	Marker Settings
Next Peak Mode	Left Absolute Right
Exclude LO	On Off
Peak Excursion	6.0 dB
Auto Max Peak	On Off
Auto Min Peak	On Off

Search	
Search Limits	
Left Limit	<input type="checkbox"/> 40.0 GHz
Right Limit	<input type="checkbox"/> 40.0 GHz
Threshold	<input type="checkbox"/> -120.0 dBm
Use Zoom Limits	On Off
Search Limits Off	

Search Mode for Next Peak.....	194
Exclude LO.....	195
Peak Excursion.....	195
Auto Max Peak Search / Auto Min Peak Search.....	195
Search Limits.....	195
L Search Limits (Left / Right).....	195
L Search Threshold.....	196
L Use Zoom Limits.....	196
L Search Limits Off.....	196
Branch for Peaksearch.....	196

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 11.7.3.5, "Positioning the marker"](#), on page 444

Exclude LO

If activated, restricts the frequency range for the marker search functions.

- "On" The minimum frequency included in the peak search range is $\geq 5 \times$ 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 431

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 211.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 432

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 445

[CALCulate<n>:MARKer<m>:MINimum:AUTO](#) on page 446

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 433

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 433

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 434

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. If enabled, only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold:STATe](#) on page 435

[CALCulate<n>:THReshold](#) on page 435

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 434

Search Limits Off ← Search Limits

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 433

[CALCulate<n>:THReshold:STATe](#) on page 435

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 432

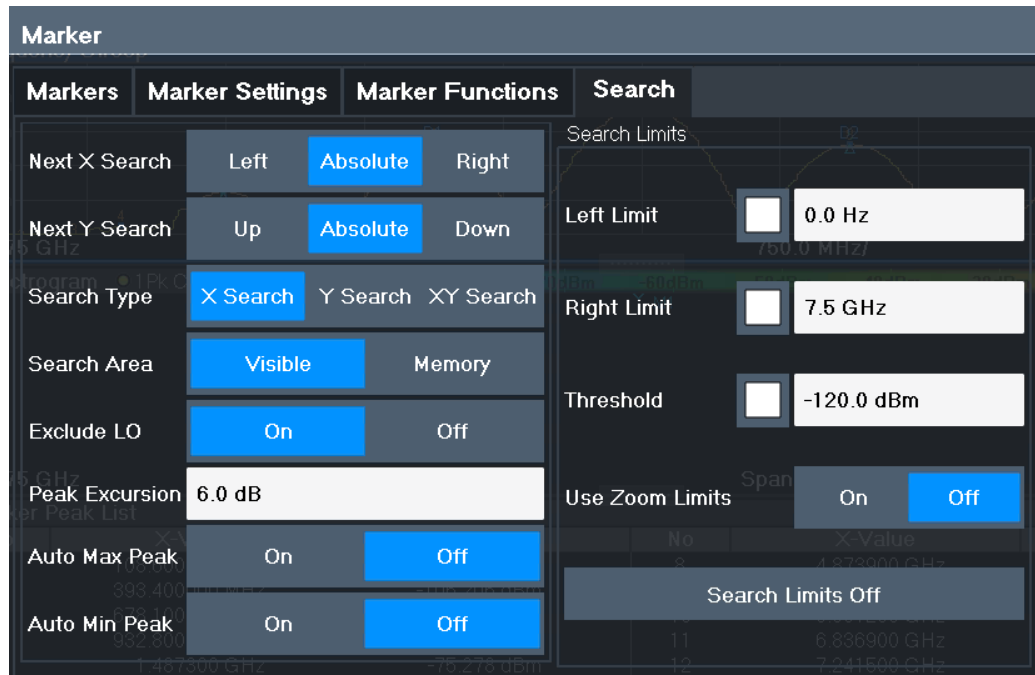
7.4.2.2 Marker search settings for spectrograms

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.....	197
Search Mode for Next Peak in Y-Direction.....	197
Marker Search Type.....	198
Marker Search Area.....	198
Peak Excursion.....	198
Search Limits.....	199
L Search Limits (Left / Right).....	199
L Search Threshold.....	199
L Use Zoom Limits.....	199
L Search Limits Off.....	199

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 11.7.3.5, "Positioning the marker"](#), on page 444

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 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:ABOVE](#)
on page 442

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:BELOW](#) on page 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:BELOW](#)
on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:NEXT](#) on page 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:NEXT](#) on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:ABOVE](#) on page 439

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:ABOVE](#)
on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:BELOW](#) on page 439

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELOW](#)
on page 444

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT](#) on page 440

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT](#) on page 444

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 11.7.3.4, "Marker search \(spectrograms\)"](#), on page 436

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 437

[CALCulate<n>:DELTamarker<m>:SPECTrogram:SARea](#) on page 442

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 211.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 432

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 433

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 433

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 434

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. If enabled, only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold:STATe](#) on page 435

[CALCulate<n>:THReshold](#) on page 435

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 434

Search Limits Off ← Search Limits

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 433

[CALCulate<n>:THReshold:STATe](#) on page 435

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	200
Search Next Peak	200
Search Minimum	200
Search Next Minimum	200
Center Frequency = Marker Frequency	200
Reference Level = Marker Level	200

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 446

[CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 449

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 446

[CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 446

[CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 445

[CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 449

[CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 449

[CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 448

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 447

[CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 450

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 447

[CALCulate<n>:MARKer<m>:MINimum:LEFT](#) on page 447

[CALCulate<n>:MARKer<m>:MINimum:RIGHT](#) on page 448

[CALCulate<n>:DELTamarker<m>:MINimum:NEXT](#) on page 450

[CALCulate<n>:DELTamarker<m>:MINimum:LEFT](#) on page 449

[CALCulate<n>:DELTamarker<m>:MINimum:RIGHT](#) on page 450

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 365

Reference Level = Marker Level

Sets the reference level to the selected marker level.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:REFerence on page 354

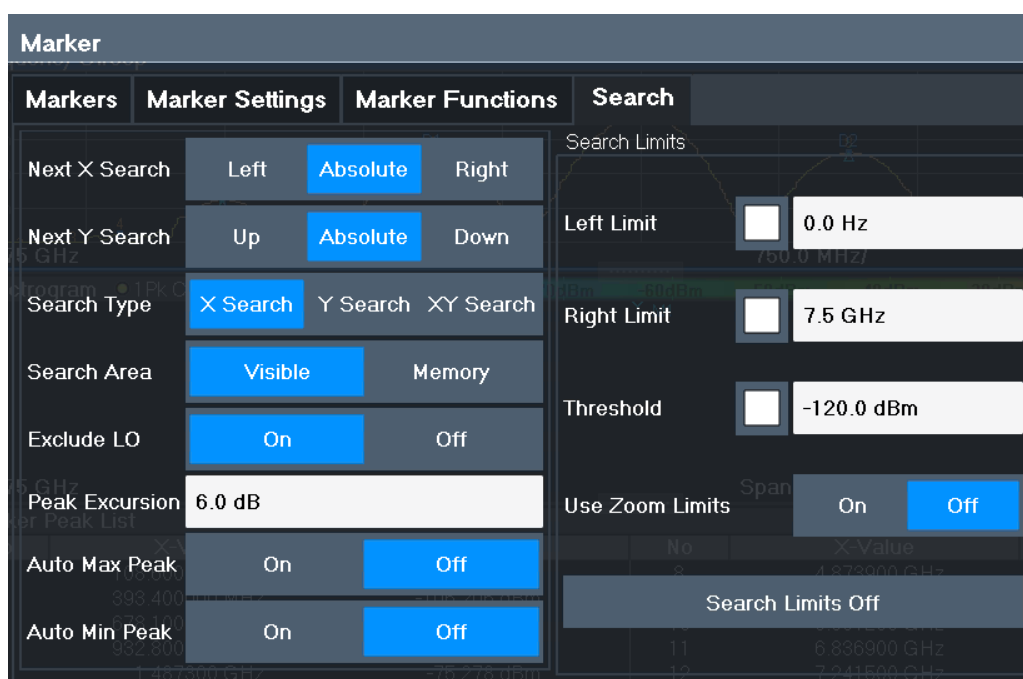
7.4.3 Marker search settings for spectrograms

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..... 201
- Search Mode for Next Peak in Y-Direction.....202
- Marker Search Type.....202
- Marker Search Area.....202
- Peak Excursion.....203
- Search Limits.....203
 - L Search Limits (Left / Right).....203
 - L Search Threshold.....203
 - L Use Zoom Limits.....203
 - L Search Limits Off.....203

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 11.7.3.5, "Positioning the marker"](#), on page 444

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 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:ABOVE](#)

on page 442

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:BELOW](#) on page 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:BELOW](#)

on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:NEXT](#) on page 438

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:NEXT](#) on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:ABOVE](#) on page 439

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:ABOVE](#)

on page 443

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:BELOW](#) on page 439

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELOW](#)

on page 444

[CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT](#) on page 440

[CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT](#) on page 444

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 11.7.3.4, "Marker search \(spectrograms\)"](#), on page 436

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 437

[CALCulate<n>:DELTAmarker<m>:SPECTrogram:SARea](#) on page 442

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 211.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 432

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 433

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 433

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 434

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. If enabled, only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold:STATe](#) on page 435

[CALCulate<n>:THReshold](#) on page 435

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 434

Search Limits Off ← Search Limits

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 433

[CALCulate<n>:THReshold:STATe](#) on page 435

7.4.4 Marker functions

Some special marker functions are available in the I/Q Analyzer application.

- [Measuring the power in a channel \(band power marker\)](#).....204
- [Time domain power measurement](#).....207
- [Marker peak list](#).....211
- [Deactivating all marker functions](#).....215

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]

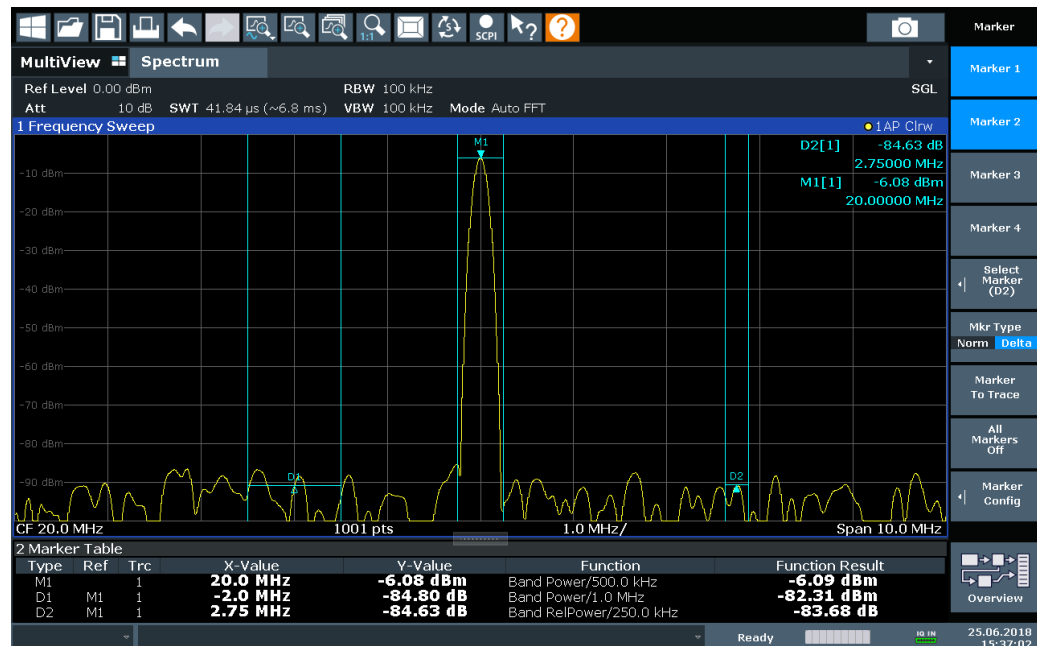
The measured power for the reference marker may be an absolute power at a single point (if the reference marker is not a band power marker), or the power in a band (if the reference marker is a band power marker itself).

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.

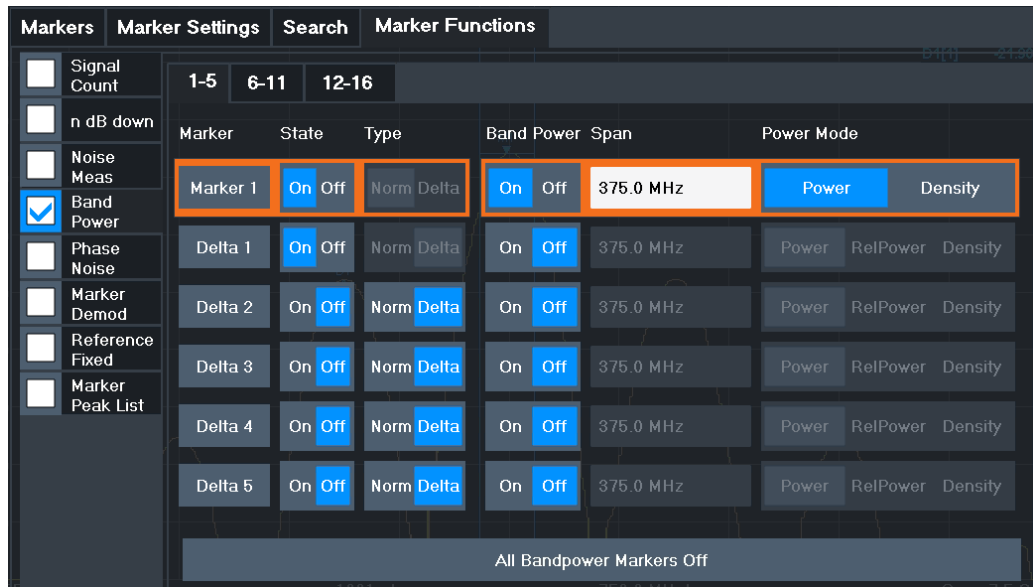
The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



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 188). 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 452

[CALCulate<n>:MARKer<m>:FUNCTION:BPOwer:RESult?](#) on page 451

[Band Power Measurement State](#)..... 206

[Span](#)..... 206

[Power Mode](#)..... 207

[Switching All Band Power Measurements Off](#)..... 207

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 204.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:BPOwer\[:STATe\]](#) on page 452

[CALCulate<n>:DELTamarker<m>:FUNCTION:BPOwer\[:STATe\]](#) on page 454

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 452

[CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER:SPAN](#) on page 454

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 190). The powers are subtracted logarithmically, so the result is a dB value. <i>[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]</i> For details see "Relative band power markers" on page 204
"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 451

[CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER:MODE](#) on page 453

Switching All Band Power Measurements Off

Deactivates band power measurement for all markers.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:BPOWER\[:STATe\]](#) on page 452

[CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER\[:STATe\]](#) on page 454

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](#).....207
- [Time domain power results](#).....208
- [Time domain power basics - range definition using limit lines](#).....209
- [Time domain power configuration](#).....209
- [How to measure powers in the time domain](#).....210

About the measurement

Using the Time Domain Power measurement function, the 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.

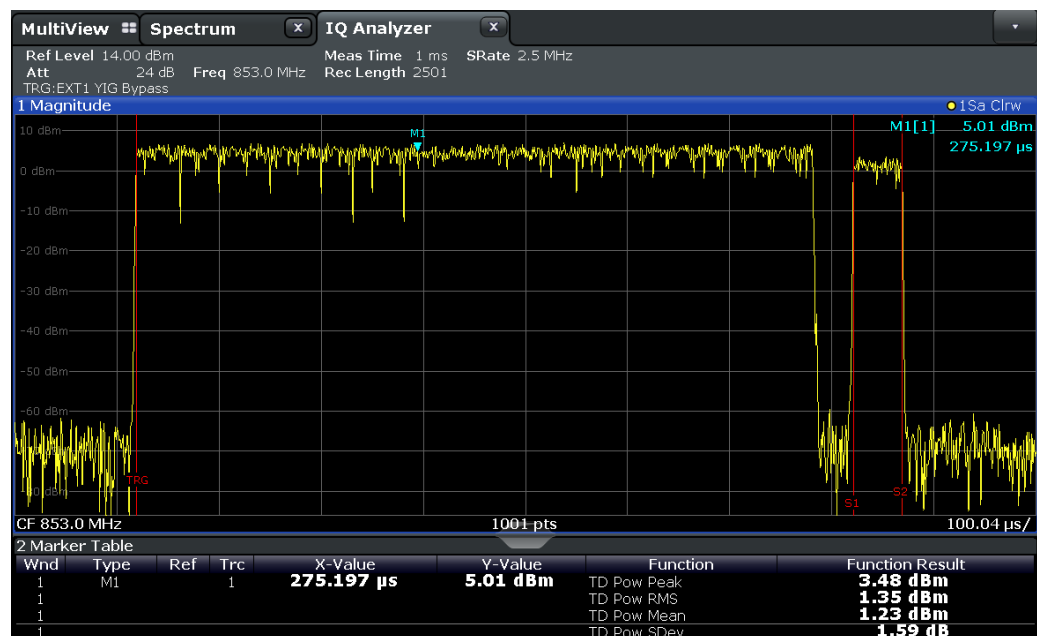
For this measurement, the sample detector is recommended. The sample detector is activated automatically if the detector is in auto mode.

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 11.7.3.8, "Measuring the time domain power"](#), on page 458.

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"

Time Domain Power
X

Results

Peak	On	Off
RMS	On	Off
Mean	On	Off
Std Dev	On	Off

Limits

State	On	Off
Left	-----	
Right	-----	

The remote commands required to perform these tasks are described in [Chapter 11.7.3.8, "Measuring the time domain power"](#), on page 458.

Results.....	210
Limit State.....	210
Left Limit / Right Limit.....	210

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 460

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?](#) on page 464

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS\[:STATe\]](#) on page 461

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:RESult?](#) on page 465

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN\[:STATe\]](#) on page 460

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:RESult?](#) on page 462

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 433

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 433

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 434

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 [MARK FUNC].
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 "Time Dom Power Config" 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 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, noise values are 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.

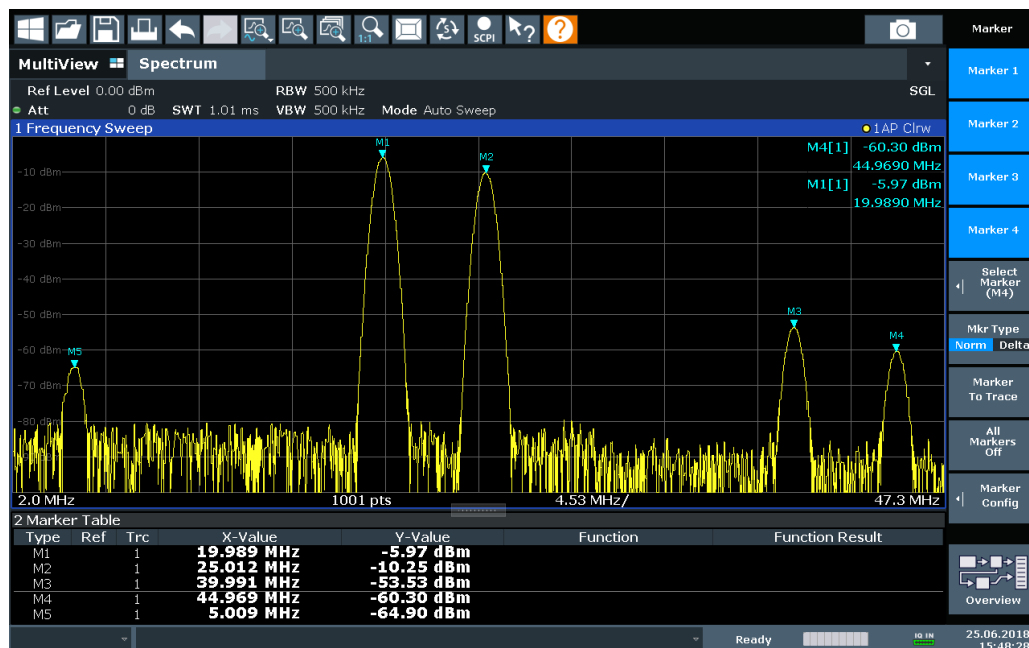


Figure 7-3: Trace example

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

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

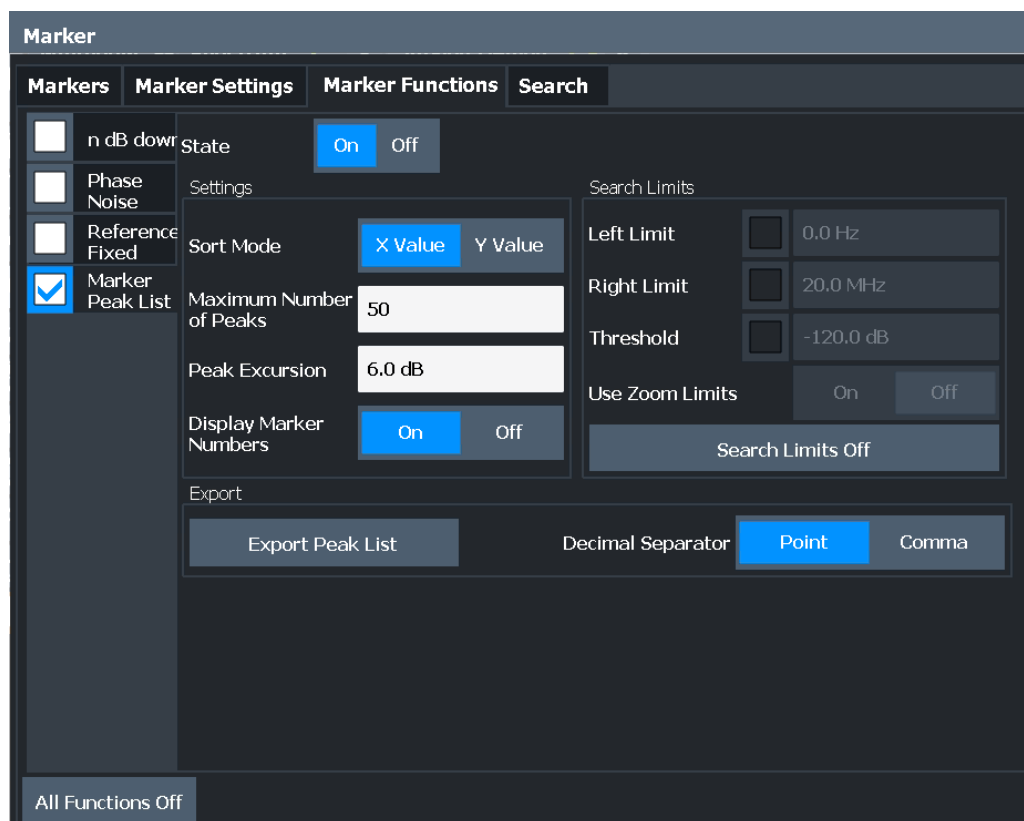
the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each sweep to keep the maximum value as the reference point for a phase noise measurement. Automatic peak search 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 457

TRAC? LIST,

See [TRACe<n>\[:DATA\]?](#) on page 477

Peak List State	214
Sort Mode	214
Maximum Number of Peaks	214

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Display Marker Numbers.....	214
Export Peak List.....	214

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 457

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 456

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 456

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 211.

Remote command:

`CALCulate<n>:MARKer<m>:PEXCursion` on page 432

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 can decrease readability; in this case, deactivate the marker number display.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:FPEaks:ANNotation:LABel[:STATe]`
on page 455

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 458

[FORMat:DEXPort:DSEParator](#) on page 480

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 primary application 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.

AL 10.0 ms

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.....	215
Show Line.....	216

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 467

[CALCulate<n>:RTMS:ALINE\[:VALue\]](#) on page 469

Show Line

Hides or displays the analysis line in the time-based windows. By default, the line is displayed.

Note: The window title bar always shows whether the currently defined line position lies within the analysis interval of the active secondary application, even if the analysis line display is disabled.

Remote command:

[CALCulate<n>:MSRA:ALINE:SHOW](#) on page 467

[CALCulate<n>:RTMS:ALINE:SHOW](#) on page 469

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.

- [How to perform measurements in the I/Q Analyzer application](#)..... 217
- [How to capture or output I/Q data via optional interfaces](#)..... 218
- [How to export and import I/Q data](#)..... 231

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 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 FSW MSRA/MSRT User Manual.

- [How to capture baseband \(I/Q\) data as RF input](#).....217
- [How to analyze data in the I/Q Analyzer](#).....218

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 FSW.

1. Select [MODE] and select the "I/Q Analyzer" application.
2. Select "Overview" to display the "Overview" for an I/Q Analyzer measurement.
3. Select "Input" to select and configure the "RF Input" signal source.
4. Select "Amplitude" to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.
5. Select "Frequency" to define the input signal's center frequency.
6. Optionally, select "Trigger" 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 "Bandwidth" 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 "Display Config" 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 [RUN SINGLE].

8.1.2 How to analyze data in the I/Q Analyzer

1. Select [MODE] and select the "I/Q Analyzer" application.
2. Select "Overview" to display the "Overview" for an I/Q Analyzer measurement.
3. Select "Display Config" 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 "Overview" to display the "Overview" again.
5. Select "Analysis" 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 FSW using the optional "Digital Baseband" interface (FSW-B17) or the "Analog Baseband" interface (FSW-B71).

- [How to capture data via the optional Digital Baseband interface](#).....219
- [How to capture analog baseband input via the optional Analog Baseband interface](#) 220
- [How to capture data from the optional analog baseband input connectors \(R&S FSW-B71\) as RF input](#)..... 221

- [How to capture analog baseband input via the Oscilloscope Baseband Input option \(R&S FSW-B2071\)](#).....222
- [How to capture data via the optional 2 GHz / 5 GHz bandwidth extension \(FSW-B2000/B5000\)](#).....224
- [How to output I/Q data via the optional Digital Baseband interface](#).....229
- [How to stream digital I/Q 40G output to an R&S IQW](#).....230

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 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 FSW.
2. Press [INPUT/OUTPUT] of the 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 [AMPT] to define the reference level manually. Select "Amplitude Config" to change the reference level offset or to set the level automatically only once.
8. Select "Frequency" to define the input signal's center frequency.
9. Optionally, select "Trigger" 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 "Bandwidth" 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 "Display Config" 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

Analog baseband signals can also be captured via the optional "Analog Baseband" interface, if installed.

1. Connect the device that provides analog baseband input to the "Baseband Input" connectors at the front of the 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 [INPUT/OUTPUT] of the FSW.
3. Select "Input Source Config".
4. Switch to the "Analog Baseband" tab to configure the "Analog Baseband" interface.
5. Set the state of the "Analog Baseband" signal source to "On".
6. Select the "I/Q Mode" depending on the signal at the input connectors, or how you want to interpret it.
7. 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.
8. 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.
9. Press [Ampt].
10. Select "Amplitude Config".

11. Define the reference level for the input. If a probe is connected, consider the probe's attenuation when defining the reference level.
12. 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.
13. Optionally, select "Trigger" 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.
14. Press [MEAS CONFIG].
15. 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 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)
 - 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 ("Swap I/Q").
16. Select "Display Config" 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.
17. Exit the SmartGrid mode.
18. 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 FSW.
2. Press [INPUT/OUTPUT] of the FSW.
3. Select "Input Source Config" 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 "Amplitude" to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.
7. Select "Frequency" to define the input signal's center frequency.
8. Optionally, select "Trigger" 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 "Bandwidth" 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 "Display Config" 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 58.)



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 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 [Setup] and select the "System" tab or "LXI" tab.
The current computer name is displayed.

To determine the oscilloscope's TCPIP address

1. Press [Setup] 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 FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope.
If the reference is supplied by the FSW, connect the "REF OUTPUT 10 MHz" connector of the FSW to the "REF IN" connector of the oscilloscope.
4. Press [INPUT/OUTPUT] of the 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 [Ampt] 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 "Trigger" 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 [MEAS CONFIG] 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 fil-

- ter and thus remains undistorted; this range can be used for accurate analysis by the 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 "Display Config" 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 capture data via the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000)

The optional 2 GHz / 5 GHz bandwidth extensions (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 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64).



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 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 [Setup] and select the "System" tab or "LXI" tab.

The current computer name is displayed.

To determine the oscilloscope's TCPIP address

1. Press [Setup] 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 FSW to the "Ch1" input on the front panel of the oscilloscope.
2. Connect the oscilloscope to the FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope. If the reference is supplied by the FSW, connect the "REF OUTPUT 10 MHz" connector of the FSW to the "REF IN" connector of the oscilloscope.
4. On the FSW, press [Input/Output].
5. Select "B5000 Config".
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 "ABC" 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 10-5](#) 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 FSW to the "Ch1" input on the front panel of the oscilloscope.
2. Connect the oscilloscope to the FSW via LAN.
3. Connect an external reference to the "REF IN" connector of the oscilloscope. If the reference is supplied by the FSW, connect the "REF OUTPUT 10 MHz" connector of the FSW to the "REF IN" connector of the oscilloscope.
4. On the FSW, press [Input/Output].
5. Select "B2000 Config".
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 "ABC" 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 FSW.
11. Select "Continue Alignment".
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 10-5](#) for possible solutions.
12. Remove the cable from the "Alignment signal source" on the FSW and connect it to the "IF OUT 2 GHz" connector.
13. Select "Continue".
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 FSW and the oscilloscope:
(For details see [Chapter 5.6.3, "Prerequisites and measurement setup"](#), on page 66.)
 - The "IF OUT 2 GHz/ IF OUT 5 GHz" connector of the FSW is connected to the "Ch1" input of the oscilloscope
 - An external reference (for example the "REF OUTPUT 10 MHz" connector of the FSW) is connected to the "REF IN" connector of the oscilloscope
 - The oscilloscope is connected to the FSW via LAN
 - Optionally, the "TRIG OUT" connector of the 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 FSW 2.30, the "**Ch3**" input on the oscilloscope must be used!
2. On the FSW, press [Input/Output].
3. Select "B2000/B5000 Config".
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 225.

If the green alignment message is displayed, the 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 217.
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 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 FSW via LAN.
4. Connect an external reference to the "REF IN" connector of the oscilloscope.
If the reference is supplied by the FSW, connect the "REF OUTPUT 10 MHz" connector of the FSW to the "REF IN" connector of the oscilloscope.
5. On the FSW, press [Input/Output].
6. Select "B5000 Config".
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 "ABC" 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 10-5](#) 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 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 FSW via LAN.
4. Connect an external reference to the "REF IN" connector of the oscilloscope. If the reference is supplied by the FSW, connect the "REF OUTPUT 10 MHz" connector of the FSW to the "REF IN" connector of the oscilloscope.
5. On the FSW, press [Input/Output].
6. Select "B2000 Config".
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 "ABC" 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 FSW.
13. Select "Continue Alignment".
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 10-5](#) for possible solutions.
14. Remove the cable from the "Alignment signal source" on the FSW and connect it to the "IF OUT 2 GHz" connector.
15. Select "Continue".

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 227 and ["How to align the B2000 power splitter"](#) on page 228.
2. Check the following connections on the FSW and the oscilloscope:

(For details see [Chapter 5.6.3, "Prerequisites and measurement setup"](#), on page 66.)

- The "IF OUT 2 GHz/ IF OUT 5 GHz" connector of the 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 FSW) is connected to the "REF IN" connector of the oscilloscope
 - The oscilloscope is connected to the FSW via LAN
 - Optionally, the "TRIG OUT" connector of the FSW (or any other trigger signal) is connected to the "EXT TRIGGER INPUT" connector of the oscilloscope
3. On the FSW, press [Input/Output].
 4. Select "B2000/B5000 Config".
 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 227 and ["How to align the B2000 power splitter"](#) on page 228.
If the green alignment message is displayed, the 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 217.
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.

8.2.6 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 FSW.
2. Press [INPUT/OUTPUT].

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 [MEAS CONFIG] and select "Data Acquisition" to change the "Sample Rate" setting.
6. Select "Frequency" to define the center frequency for the measurement.
7. Optionally, select "Trigger" 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 "Display Config" 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.

8.2.7 How to stream digital I/Q 40G output to an R&S IQW

The Digital I/Q 40G Streaming Output options (FSW-B517/-B1017) provide raw, unprocessed I/Q data to the QSFP+ connector on the rear panel of the FSW. You can connect an R&S IQW to the FSW to process the I/Q data further.

See also [Chapter 5.7, "Digital I/Q 40G streaming output"](#), on page 73.

1. Connect the R&S IQW to the QSFP+ connector at the rear of the FSW.
2. Press [INPUT/OUTPUT].
3. Select "Output Config" and switch to the "Digital I/Q 40G" tab to configure the 40G streaming output.
Information on the detected R&S IQW is shown under "Connected Instrument".
4. Select [MEAS CONFIG] > "Data Acquisition" > "Sample Rate".
5. Set the sample rate to a value between 100.1 MHz and 600 MHz (for B517) or 1200 MHz (for B1017).
6. Select [TRIG] > "Trigger Source" > "Trigger Source" > "I/Q Power".
7. Set the "Trigger Level" for data acquisition to -20 dBm.
8. Select [AUTO SET] > "Auto Level" to set the optimal reference level.
9. Set the state of the "Dig I/Q 40G Streaming Out" to "On".



The "Connection established" icon is displayed in the status bar.

The captured data is written to the QSFP+ connector continuously.


10. Display the "I/Q 40G Recording" window to insert a marker at any time:
 - a) Select [MEAS] to open SmartGrid mode.
 - b) Select "I/Q 40G Recording" and drag it to a suitable position in the display.
 - c) Exit the SmartGrid mode.
11. Select "Insert marker" in the "I/Q 40G Recording" window to insert a marker in the output data.

8.3 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 [PRESET].
2. Press [MODE] and select the I/Q Analyzer application or any other application that supports I/Q data.
3. Configure the data acquisition.
4. Press [RUN SINGLE] to perform a single sweep measurement.
5. Select the  "Save" icon in the toolbar.
6. Select "I/Q Export".
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.

The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

Importing I/Q data

1. Press [MODE] 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 [RUN SINGLE].
3. Select the  "Open" icon in the toolbar.
4. Select "I/Q Import".

5. Select the storage location and the file name.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.
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.

xzy.xml (of .iq.tar file)

Description	
Saved by	FSV IQ Analyzer
Comment	Here is a comment
Date & Time	2011-03-03 14:33:05
Sample rate	6.5 MHz
Number of samples	65000
Duration of signal	10 ms
Data format	complex, float32
Data filename	xzy.complex.1ch.float32
Scaling factor	1 V

Channel 1

Comment	Channel 1 of 1
Power vs time y-axis: 10 dB /div x-axis: 1 ms /div	
Spectrum y-axis: 20 dB /div x-axis: 500 kHz /div	

E-mail: info@rohde-schwarz.com
 Internet: <http://www.rohde-schwarz.com>
 Fileformat version: 1

9 Measurement example: Providing I/Q data to a signal generator

A typical application of the I/Q Analyzer is to capture I/Q data from a connected antenna out in the field, record the data on a recording device such as the R&S IQW, then play back the signal using a signal generator in the lab.

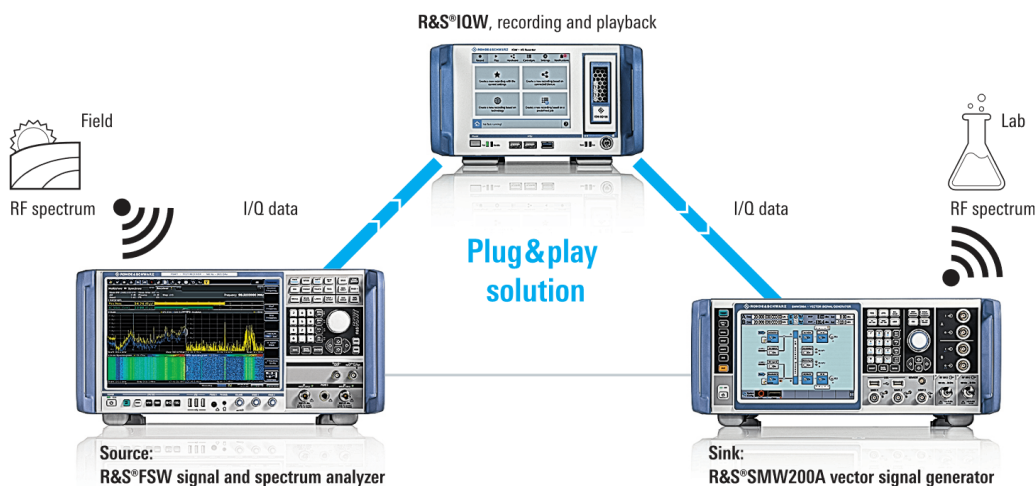


Figure 9-1: Providing I/Q data from the I/Q Analyzer to a signal generator

In this measurement example, we demonstrate how to set up such a scenario. For details on the settings in the connected instruments, see the R&S IQW and the signal generator documentation.

Required options

To provide digital I/Q data output, one of the following options must be installed **on the FSW**:

- FSW-B17: for analysis bandwidths up to 160 MHz
- FSW-B517: for analysis bandwidths from 100.1 MHz to 512 MHz
- FSW-B1017 for analysis bandwidths from 100.1 MHz to 1000 MHz

To record and replay wideband I/Q data, the following options must be installed **on the R&S IQW**:

- R&S IQW100 for bandwidths up to 100 MHz
- R&S IQW-K200 for bandwidths up to 200 MHz (for R&S IQW100 only)
- R&S IQW for bandwidths up to 512 MHz
- R&S IQW1000 for bandwidths up to 1000 MHz
- R&S IQW-K110 (to export I/Q data)
- R&S IQW-B40G (for highspeed export/import)

To receive and generate wideband I/Q data, the following options must be installed **on the R&S SMW**:

- R&S SMW-B9 Wideband Baseband Generator
- R&S SMW-B13XT Wideband baseband main module
- R&S SMW-B1007 (frequency extension to output RF data)

To connect the instruments for data recording

1. Connect the antenna to the "RF Input" connector on the front panel of the FSW.
2. Connect the available digital I/Q output connector on the FSW to the R&S IQW using the provided connection cables.

Table 9-1: Data recording connectors for different options and instruments

FSW option	FSW	R&S IQW
FSW-B17	"DIGITAL BASEBAND OUTPUT"	"Dig. IQ Input"
FSW-B517 FSW-B1017	QSFP+ (possibly under metal cover on rear panel of the FSW)	"HS Dig. IQ 40G A" / "HS Dig. IQ 40G B"



Figure 9-2: QSFP+ connector on FSW

To connect the instruments for data replay

1. Connect the required digital I/Q output connector on the R&S IQW to the corresponding digital I/Q input connector on the signal generator using the provided connection cables.

Table 9-2: Data replay connectors for different options and instruments

R&S IQW	Signal generator
"Dig. IQ Output"	("Coder:;) "Dig I/Q In Out"
"HS Dig. IQ 40G A" / "HS Dig. IQ 40G B"	("Coder:;) "HS Dig I/Q In Out"

2. Connect an antenna to the "RF" output connector on the signal generator.

To configure the FSW for signal measurement

The antenna is connected to the FSW.

1. Configure the I/Q measurement of the RF data from the antenna as described in [Chapter 8.1, "How to perform measurements in the I/Q Analyzer application"](#), on page 217.
2. Configure the digital I/Q output as described for the available connector, see [Chapter 8.2.6, "How to output I/Q data via the optional Digital Baseband interface"](#), on page 229 and [Chapter 8.2.7, "How to stream digital I/Q 40G output to an R&S IQW"](#), on page 230.

Note: The sample rate is automatically adapted to the maximum supported sample rate for the connector, if necessary.

To configure the R&S IQW for recording

The FSW is connected to the R&S IQW.

1. In the R&S IQW start screen, from the main menu, select "Record".
2. Select "Create a new recording based on connected devices".
A configuration wizard with 5 steps is displayed.
3. From the source selection, select the connected FSW.
4. In the "Device Configuration", the name of the connected instrument is indicated.
5. In the "General Parameters", define the trigger that starts and the trigger that stops data recording on the R&S IQW.
To start and stop recording manually, select "Manual".
6. In the "Storage Options", define the file name and storage location for the stored data.
7. Optionally, define tags to describe the data recording file.
8. In the "Overview", select "Go to Recording".
9. Select "Start Recording".
10. For manual triggering, select "Start" to start data recording.
For automatic triggering, the recording is started as soon as the data stream is provided by the FSW.
11. After the measurement, for manual triggering, select "Stop" to stop data recording.
For automatic triggering, the recording is stopped as soon as a data stream is no longer provided by the FSW.
12. Select "Stop Recording".
The recorded data is stored to the specified file.
13. Select "Close" to close the recording dialog.

If necessary, you can process the signal data further, e.g. using Matlab, to compensate for or simulate special effects in the signal.

To configure the R&S IQW for data replay

The R&S IQW is connected to the signal generator.

1. In the R&S IQW start screen, from the main menu, select "Play".
A list with all record files, including recording date and time, is displayed.
2. Select one or more files to play on the signal generator.
3. Select "Start" to start the "Replay" wizard.
4. In the "Sink Selection", select the connected signal generator.
5. In the "Device Configuration", the name of the connected instrument and the center frequency (as specified in the data recording) is indicated.
6. In the "General Parameters", define the trigger that starts data replay to the signal generator.
7. In the "Overview", select one of the following:
 - "Loop Replay": the recording is continuously repeated from the beginning when the end is reached.
 - "Replay": single playback
8. Select "Start" to start data replay.

The digital I/Q data is provided at the output connector of the R&S IQW.

To configure the signal generator to input the signal

The R&S IQW is connected to the signal generator.

1. On the signal generator, select "BB Input" > "Baseband Input Settings"
2. Select "General" > "Interface" > "Dig I/Q" or "HS Dig I/Q".
3. Select the "Sample Rate Source", which is the digital interface used to estimate the sample rate.
4. Select ("Coder 1:") "BB Input > On".

If the connection between the two instruments is properly established and signal transmission is active, information on the R&S IQW is displayed in the "Baseband Input Settings" ("Connected device").

The data is input from the R&S IQW to the signal generator.

To configure the signal generator to output the signal

The signal generator is connected to the antenna.

1. Select ("Level" >) "RF ON" > "On" to enable the RF output.

The I/Q data is output to the antenna.

2. If necessary, adapt the signal level and frequency of the output signal on the generator as required. The original values of the measured signal are provided with the recording data.

Now you can perform a test in the lab using the measured data from the field.

10 Troubleshooting the measurement

If errors or problems occur, try the following methods to correct the measurement.

10.1 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 11.11.2, "STATUS:QUESTIONABLE:DIQ register"](#), on page 490.

The following tables describe the most common errors and possible solutions.

Table 10-1: 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!"	<ul style="list-style-type: none"> Reduce the sample rate Increase the input sample rate (See Table 5-22)
"Sample rate too low in respect to input sample rate!"	<ul style="list-style-type: none"> Increase the sample rate Reduce the input sample rate (See Table 5-22)
"Number of IQ Capture samples too high!"	<ul style="list-style-type: none"> 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"	<ul style="list-style-type: none"> 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"	<ul style="list-style-type: none"> Re-establish the Digital I/Q connection after the clock from the input device has been restored

Table 10-2: 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!"	<ul style="list-style-type: none"> Reduce the sample rate
Keyword: "FIFO OVLD"	The sample rate on the connected instrument is higher than the input sample rate setting on the FSW. <ul style="list-style-type: none"> Reduce the sample rate on the connected instrument Increase the input sample rate setting on the FSW

Table 10-3: Errors using the optional Analog Baseband interface and possible solutions

Message	Possible solutions
"Check Cable for High Accuracy Timing"	<p>For FSW models with a serial number lower than 103000 only:</p> <p>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.</p> <p>Unless it is explicitly deactivated, the high accuracy timing setting remains active.</p> <p>The error message is cleared when one of the following occurs:</p> <ul style="list-style-type: none"> • Analog Baseband input is deactivated (see "Analog Baseband Input State" on page 117) • High accuracy timing is deactivated (see "High Accuracy Timing Trigger - Baseband - RF" on page 118) • The cable was successfully detected
"High Accuracy Timing inactive"	Activation of High Accuracy Timing failed.

Table 10-4: Errors using the optional Oscilloscope Baseband Input bandwidth extension (FSW-B2071) and possible solutions

Message	Possible solutions
"Unsupported capturing device"	Connected oscilloscope is not supported by the option (see specifications document)
"Oscilloscope LAN connection failed"	<ul style="list-style-type: none"> • Check the LAN connection between 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 119)
"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 specifications document), 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 120)
"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 120). 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 120).
"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.
"B2071: Waiting for trigger"	<p>The oscilloscope is waiting for an external trigger signal at its external analog trigger input connector on the rear panel.</p> <ul style="list-style-type: none"> • Provide a trigger signal to the oscilloscope, either from an external device such as a signal generator, or from the FSW by connecting the "TRIG OUT" connector of the FSW to the external analog trigger input connector of the oscilloscope. • Use a trigger other than External Analog on the FSW.

Message	Possible solutions
"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 10-5: Errors using the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) and possible solutions

Message	Possible solutions
"Unsupported capturing device"	<p>Connected oscilloscope is not supported by the option (see specifications document)</p> <p>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)</p>
"Oscilloscope LAN connection failed"	<ul style="list-style-type: none"> Check the LAN connection between FSW and oscilloscope Check the IP address of the oscilloscope defined in the B2000/B5000 settings dialog box (see Chapter 6.3.1.7, "Settings for 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000)", on page 123)
"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 124)
"Alignment failed"	<ul style="list-style-type: none"> Check the connection from the "Alignment signal source output" connector (B2000) or "IF OUT" connector (B5000) on the 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 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 125).
"Oscilloscope is not aligned"	Perform the initial alignment on the oscilloscope (see "Alignment" on page 125).
"Oscilloscope communication failed"	An error occurred during communication, e.g. a timeout. Start a new sweep.
"B2000: Waiting for trigger"	<p>The oscilloscope is waiting for an external trigger signal at its "Ch3" input.</p> <ul style="list-style-type: none"> Provide a trigger signal to the oscilloscope, either from an external device such as a signal generator, or from the FSW by connecting the "TRIG OUT" connector of the FSW to the "Ch3" input connector of the oscilloscope <p>Note: In previous firmware versions, the external trigger was connected to the "CH2" input on the oscilloscope. As of firmware version FSW 2.30, the "Ch3" input on the oscilloscope must be used!</p> <ul style="list-style-type: none"> Use a trigger other than External Channel 3 on the FSW

Message	Possible solutions
"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 .ac1 file or no conversion loss table are assigned. Assign a special conversion loss table for large bandwidths (.b2g or .b5g file).



Oscilloscope is inoperable

As soon as the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) is activated (see "[B2000/B5000 State](#)" on page 124), the FSW takes control of the oscilloscope. The display on the oscilloscope is turned off to improve performance during data export. As soon as the 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 344).

10.2 Troubleshooting I/Q noise cancellation

If I/Q noise cancellation fails, the main cause is failed synchronization. Check the following possible issues.



Error status bit

If an error occurs during I/Q noise cancellation, bit 7 in the `STATus:QUESTionable:SYNC:CONDition` status register is set (`BIT_K575_FAILED`).

See [STATus:QUESTionable:SYNC:CONDition?](#) on page 488.

Capture length is too short	242
The EVM is too high	243
Frequency offset too large	243
Sample rate error too large	243
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Capture length is too short

Increase the capture length. If no trigger is used, try a capture length that is longer than twice the signal length.

The EVM is too high

Check the signal description to ensure the reference signal is estimated correctly. If the EVM is close to or exceeds the defined limits, I/Q noise cancellation may not be possible.

You can detect exceeded limits as red entries in the "Result Summary".

PPDUs:	Min	Mean	Limit
EVM All Carriers	11.40	11.42*	7.94
	-18.86	-18.85*	-22.00

Frequency offset too large

If the frequency offset is too large, I/Q noise cancellation may not be possible.

You can detect exceeded center frequency error limits as red entries in the "Result Summary".

Center Freq Error	100094....	100095....	±25000....	100095....	±25000....
Symbol Clock Error	46.04	46.04*	±25.00	46.04*	±25.00

Sample rate error too large

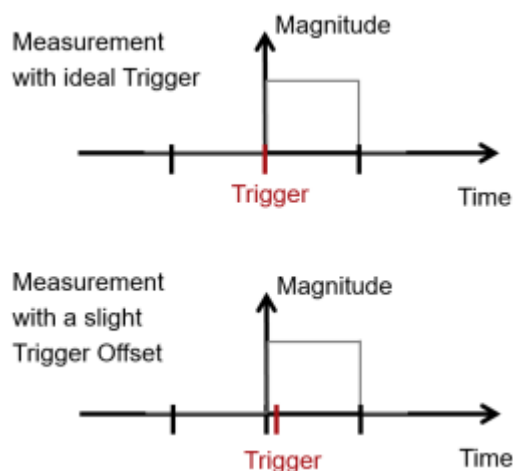
Check the signal capture settings to ensure the input sample rate is defined correctly. If possible, synchronize the FSW and the DUT using an external reference.

If the sample rate error is too large, I/Q noise cancellation may not be possible.

You can detect exceeded sample rate (symbol clock) error limits as red entries in the "Result Summary".

Trigger uncertainty

Due to trigger uncertainty, a trigger can occur after the first relevant sample. You can define a negative trigger offset so the measurement includes pretrigger samples and thus, the full signal.



Previous application warnings

If the application shows messages in the status bar before the I/Q noise cancellation has even started, it may not be possible.

For example, if the payload is too short (less than 5 symbols), the EVM results are not reliable and I/Q noise cancellation may not be possible.

Short payload (<5 symbols). EVM results not reliable

Check the status bar for errors or messages.

11 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 (FSW-B17) in a remote environment. The 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 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 FSW User Manual.

The following tasks specific to the I/Q Analyzer application are described here:

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• Common suffixes	250
• Activating I/Q Analyzer measurements	251
• Configuring I/Q Analyzer measurements	257
• Configuring the result display	392
• Capturing data and performing sweeps	400
• I/Q Analysis	407
• Configuring I/Q noise cancellation	470
• Retrieving results	473
• Importing and exporting I/Q data and results	485
• Querying the status registers	487
• Programming examples	493
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11.1 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, usually, 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, they 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 FSW.



Remote command examples

Note that some remote command examples mentioned in this general introduction are possibly not supported by this particular application.

11.1.1 Conventions used in descriptions

The following conventions are 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 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.

11.1.2 Long and short form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in uppercase letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

11.1.3 Numeric suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you do not quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

11.1.4 Optional keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.



If an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

```
[SENSe:]FREQuency:CENTer is the same as FREQuency:CENTer
```

With a numeric suffix in the optional keyword:

```
DISPlay[:WINDow<1...4>]:ZOOM:STATe
```

DISPlay:ZOOM:STATe ON enables the zoom in window 1 (no suffix).

DISPlay:WINDow4:ZOOM:STATe ON enables the zoom in window 4.

11.1.5 Alternative keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

```
[SENSe:]BANDwidth|BWIDth[:RESolution]
```

In the short form without optional keywords, BAND 1MHZ would have the same effect as BWID 1MHZ.

11.1.6 SCPI parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, they are separated by a comma.

Example:

```
LAYout:ADD:WINDow Spectrum,LEFT,MTABLE
```

Parameters can have different forms of values.

- [Numeric values](#)..... 248
- [Boolean](#)..... 249
- [Character data](#)..... 250
- [Character strings](#)..... 250
- [Block data](#)..... 250

11.1.6.1 Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. For 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. for 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. Sometimes, you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. For physical quantities, it applies the basic unit (e.g. Hz for 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`

Sometimes, numeric values are 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 if errors occur.

11.1.6.2 Boolean

Boolean parameters represent two states. The "on" state (logically true) is represented by "ON" or the numeric value 1. The "off" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying Boolean parameters

When you query Boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

11.1.6.3 Character data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information, see [Chapter 11.1.2, "Long and short form"](#), on page 247.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

11.1.6.4 Character strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELeTe 'Spectrum'`

11.1.6.5 Block data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. The data bytes follow. During the transmission of these data bytes, all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

11.2 Common suffixes

In the I/Q Analyzer application, the following common suffixes are used in remote commands:

Table 11-1: 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

11.3 Activating I/Q Analyzer measurements

I/Q Analyzer measurements require a special channel on the 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 256).

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 primary application*) 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 FSW User Manual.

<code>CALCulate<n>:IQ:MODE</code>	252
<code>INSTrument:CREate:DUPLicate</code>	252
<code>INSTrument:CREate[:NEW]</code>	252
<code>INSTrument:CREate:REPLace</code>	253
<code>INSTrument:DELeTe</code>	253

INSTrument:LIST?.....	254
INSTrument:REName.....	255
INSTrument[:SElect].....	256
SYSTem:PRESet:CHANnel[:EXEC].....	256
TRACe:IQ:EVAL.....	256
TRACe:IQ[:STATe].....	257

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 secondary applications in multistandard mode (not the MSRA primary application).

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

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.

Is not available if the MSRA/MSRT primary 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>

Adds a 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 254.
- <ChannelName> String containing the name of the channel.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds a spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>, <ChannelType>,
<ChannelName2>

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 254.
- <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 254).
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>

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 to delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Setting only

INSTrument:LIST?

Queries all active channels. The query is useful to obtain the names of the existing channels, which are required to replace or delete the channels.

Return values:

<ChannelType>, For each channel, the command returns the channel type and
<ChannelName> 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 11-2: 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
Bluetooth (R&S FSW-K8)	BTO	Bluetooth
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
HRP UWB (R&S FSW-K149)	UWB	HRP UWB
I/Q Analyzer	IQ	IQ Analyzer
LTE (R&S FSW-K10x)	LTE	LTE

*) 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*)
Multi-Carrier "Group Delay" (R&S FSW-K17)	MCGD	MC "Group Delay"
NB-IoT (R&S FSW-K106)	NIOT	NB-IoT
Noise (R&S FSW-K30)	NOISE	Noise
5G NR (R&S FSW-K144)	NR5G	5G NR
OFDM VSA (R&S FSW-K96)	OFDMVSA	OFDM VSA
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>

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. If you do, an error occurs.
 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>

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 252

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see [INSTrument:LIST?](#) on page 254.

<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 [Chapter 11.4.5, "Configuring data acquisition"](#), on page 379), use [TRACe:IQ\[:STATE\]](#) on page 257.

```
INST 'MyIQSpectrum'
```

Selects the channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

SYSTem:PRESet:CHANnel[:EXEC]

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:PRESet:CHAN:EXEC
```

Restores the factory default settings to the "Spectrum2" channel.

Usage:

Event

Manual operation: See ["Preset Channel"](#) on page 93

TRACe:IQ:Eval <State>

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>

Activates the simple I/Q data acquisition mode (see ["Different remote modes available"](#) on page 251).

Executing this command also has the following effects:

- The sweep, amplitude, input and trigger settings from the measurement are retained.
- All measurements are turned off.
- All traces are set to "Blank" mode.
- The I/Q data analysis mode is turned off (`TRAC:IQ:EVAL OFF`).

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 256).

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
```

11.4 Configuring I/Q Analyzer measurements

The following commands configure the I/Q Analyzer measurements.

- [Configuring the data input and output](#).....258
- [Configuring the vertical axis \(amplitude, scaling\)](#).....354
- [Frequency](#).....365
- [Triggering](#).....367
- [Configuring data acquisition](#).....379
- [Adjusting settings automatically](#).....389

11.4.1 Configuring the data input and output

The following commands are required to configure data input and output.

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• Configuring the 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000).....	344
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11.4.1.1 RF input

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INPut:TYPE.....	262
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INPut:UPORt[:VALue].....	263

INPut:ATTenuation:PROTection:RESet

Resets the attenuator and reconnects the RF input with the input mixer for the 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 99.

Example: `INP:ATT:PROT:RES`

INPut:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

If an external frontend is active, the connector is automatically set to `RF`.

Parameters:

<ConnType> **RF**
RF input connector

RFProbe
Active RF probe

*RST: RF

Example:

INP:CONN RF
Selects input from the RF input connector.

Manual operation: See "[Input Connector](#)" on page 102

INPut:COUPling <CouplingType>

Selects the coupling type of the RF input.

The command is not available for measurements with the optional "Digital Baseband" interface.

If an external frontend is active, the coupling is automatically set to `AC`.

Parameters:

<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example:

INP:COUP DC

Manual operation: See "[Input Coupling](#)" on page 100

INPut:DPATH <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

If an external frontend is active, the direct path is always used.

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 101

INPut:FILTer:HPASs[:STATe] <State>

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

Requires an additional high-pass filter hardware option.

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

Parameters:

<State> ON | OFF | 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 101

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

Enables or disables the YIG filter.

Parameters:

<State> ON | OFF | 0 | 1

Example: INP:FILT:YIG OFF
 Deactivates the YIG-preselector.

Manual operation: See "[YIG-Preselector](#)" on page 101

INPut:IMPedance <Impedance>

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.

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, primary only)

*RST: 50 Ω
Default unit: OHM

Example: INP:IMP 75

Manual operation: See "[Impedance](#)" on page 100
See "[Unit](#)" on page 137

INPut:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for RF input.

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 100

INPut:SElect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the FSW.

If no additional input options are installed, only RF input or file input is supported.

For FSW85 models with two RF input connectors, you must select the input connector to configure first using [INPut:TYPE](#).

Parameters:

<Source> **OBB**
Oscilloscope Baseband signal
For details on Oscilloscope Baseband Input see the FSW I/Q Analyzer User Manual.
Not available for Input2.

RF
Radio Frequency ("RF INPUT" connector)

FIQ

I/Q data file

(selected by `INPut:FILE:PATH` on page 263)

Not available for Input2.

DIQ

Digital IQ data (only available with optional "Digital Baseband" interface)

For details on I/Q input see the FSW I/Q Analyzer User Manual.

Not available for Input2.

AIQ

Analog Baseband signal (only available with optional "Analog Baseband" interface)

For details on Analog Baseband input, see [Chapter 5.3, "Processing data from the Analog Baseband interface"](#), on page 51.

Not available for Input2.

`*RST: RF`**Example:**`INP:TYPE INP1`

For 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 99See ["I/Q Input File State"](#) on page 103See ["Digital I/Q Input State"](#) on page 115See ["Analog Baseband Input State"](#) on page 117**INPut:TYPE** <Input>

The command selects the input path.

Parameters:

<Input>

INPUT1

Selects RF input 1.

1 mm [RF Input] connector

INPUT2

Selects RF input 2.

For 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 99

INPut:UPORt:STATe <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This SUB-D male connector is located on the rear panel of the FSW.

See the FSW Getting Started manual for details.

Parameters:

<State> **ON | 1**
User port is switched to INPut

OFF | 0
User port is switched to OUTPut

*RST: 1

INPut:UPORt[:VALue]

Queries the control lines of the user ports.

For details see [OUTPut:UPORt\[:VALue\]](#) on page 352.

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.
```

11.4.1.2 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 5.5, "Basics on input from I/Q data files"](#), on page 63.

Useful commands for retrieving results described elsewhere:

- [INPut:SElect](#) on page 261

Remote commands exclusive to input from I/Q data files:

INPut:FILE:PATH	263
MMEMory:LOAD:IQ:STReam	264
MMEMory:LOAD:IQ:STReam:AUTO	265
MMEMory:LOAD:IQ:STReam:LIST?	265
TRACe:IQ:FILE:REPetition:COUNT	265

INPut:FILE:PATH <FileName>[, <AnalysisBW>]

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](#).

Parameters:

<FileName>	String containing the path and name of the source file. The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be <code>.iq.tar</code> . For <code>.mat</code> files, Matlab® v4 is assumed.
<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:SWEp:TIME 0.001001
//Start the measurement
INIT:IMM
```

Manual operation: See "[Select I/Q data file](#)" on page 103

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 104

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 104

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 104

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 104

11.4.1.3 Remote commands for external frontend control

The following commands are available and required only if the external frontend control option (R&S FSW-K553) is installed.

Further commands for external frontend control described elsewhere:

- `INPut:SElect RF`; see `INPut:SElect` on page 261
- `[SENSe:]FREQuency:CENTer` on page 365
- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RLEVel` on page 355
- `INPut:ATTenuation:AUTO` on page 357
- `INPut:ATTenuation` on page 356
- `INPut:SANalyzer:ATTenuation:AUTO` on page 359
- `Commands for initial configuration`.....266
- `Commands for test, alignment, and diagnosis`.....276
- `Commands for external devices`.....278
- `Format of selftest result file`.....282
- `Programming example: Configuring an external frontend`.....287
- `Programming example 2: Configuring an external frontend with a connected amplifier`.....288

Commands for initial configuration

The following commands are required when you initially set up an external frontend.

<code>[SENSe:]EFRontend:CONNection[:STATe]</code>	267
<code>[SENSe:]EFRontend:CONNection:CONFig</code>	267
<code>[SENSe:]EFRontend:CONNection:CSTate?</code>	268
<code>[SENSe:]EFRontend:FREQuency:BAND:COUNT?</code>	268
<code>[SENSe:]EFRontend:FREQuency:BAND:LOWer?</code>	268
<code>[SENSe:]EFRontend:FREQuency:BAND:UPPer?</code>	269
<code>[SENSe:]EFRontend:FREQuency:BCONfig:AUTO</code>	269
<code>[SENSe:]EFRontend:FREQuency:BCONfig:LIST?</code>	270
<code>[SENSe:]EFRontend:FREQuency:BCONfig:SElect</code>	270
<code>[SENSe:]EFRontend:FREQuency:IFRequency:MAXimum?</code>	271
<code>[SENSe:]EFRontend:FREQuency:IFRequency:MINimum?</code>	271
<code>[SENSe:]EFRontend:FREQuency:IFRequency:SIDeband?</code>	271
<code>[SENSe:]EFRontend:FREQuency:IFRequency[:VALue]?</code>	272
<code>[SENSe:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?</code>	272
<code>[SENSe:]EFRontend:FREQuency:LOSCillator:MODE</code>	272
<code>[SENSe:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?</code>	273
<code>[SENSe:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe</code>	273
<code>[SENSe:]EFRontend:FREQuency:REFerence</code>	274
<code>[SENSe:]EFRontend:FREQuency:REFerence:LIST?</code>	274
<code>[SENSe:]EFRontend:IDN?</code>	274
<code>[SENSe:]EFRontend:NETWork</code>	274
<code>[SENSe:]EFRontend[:STATe]</code>	275

[SENSe:]EFRontend:CONNection[:STATe] <State>

Queries the external frontend connection state in the firmware.

Note: to query the physical connection state of the external frontend, use [\[SENSe:\]EFRontend:CONNection:CSTate?](#) on page 268.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The connection to the frontend is deactivated temporarily. The frontend is thus available for use elsewhere, for example by a signal generator. The measurement settings on the FSW remain untouched.

ON | 1
Frontend connection enabled.
The frontend is reserved for exclusive use by the FSW.

*RST: 0

Example:

```
//Global activation of external frontend
EFR ON
//Configure frontend
EFR:CONN:CONF "FE44S", "123.456.789"
//Activate exclusive use of frontend by FSW.
EFR:CONN ON
```

Manual operation: See ["External Frontend Connection State"](#) on page 106

[SENSe:]EFRontend:CONNection:CONFig <Type>, <IPAddress>[, <DeviceID>, <SymbolicName>]

Configures the connection to the external frontend.

Parameters:

<Type> | "FE44S" | "FE50DTR" | "FE170SR" | "FE110SR"
String in double quotes containing the type of frontend to be connected.

<IPAddress> string in double quotes
The IP address or computer name of the frontend connected to the FSW via LAN. The IP address and computer name are indicated on the electronic ink display on the side panel of the frontend.

<DeviceID> string in double quotes
Unique device ID consisting of <type>-<serialnumber>
Not required or relevant for the FSW.

<SymbolicName> string in double quotes
Symbolic name of the external frontend.
Not required or relevant for the FSW.

Example:

```
//Global activation of external frontend
EFR ON
//Configure frontend
EFR:CONN:CONF "FE44S", "123.456.789"
//Activate exclusive use of frontend by FSW.
EFR:CONN ON
```

Manual operation: See ["Frontend Type"](#) on page 106
See ["IP Address/ Computer Name"](#) on page 106

[SENSe:]EFRontend:CONNECTION:CState?

Queries the status of the physical connection to the external frontend.

Return values:

<State> ON | OFF | 0 | 1
OFF | 0
 Frontend not connected; connection error
ON | 1
 Frontend connected

Usage: Query only

Manual operation: See ["External Frontend Connection State"](#) on page 106

[SENSe:]EFRontend:FREQUENCY:BAND:COUNT?

Queries the number of frequency bands provided by the selected frontend.

Return values:

<NoBands> integer
 Number of frequency bands

Example:

```
//Query number of frequency bands
EFR:FREQ:BAND:COUN?
//Result: 2
```

Usage: Query only

Manual operation: See ["Frequency Band"](#) on page 108

[SENSe:]EFRontend:FREQUENCY:BAND:LOWer?

Queries the start of the frequency range supported by the selected frontend frequency band.

Suffix:

 1..n
 Band for multi-band frontends
 Use [\[SENSe:\]EFRontend:FREQUENCY:BAND:COUNT?](#)
 on page 268 to determine the number of available bands.

Return values:

<StartFreq> Start frequency of the specified band

Example:

```
//Query start frequency of second band
EFR:FREQ:BAND2:LOW?
//Result: 24000000000
```

Usage:

Query only

Manual operation: See "[Frequency Band](#)" on page 108

[SENSe:]EFRontend:FREQuency:BAND:UPPer?

Queries the end of the frequency range supported by the selected frontend frequency band.

Suffix:

 1..n
Band for multi-band frontends
Use [\[SENSe:\]EFRontend:FREQuency:BAND:COUNT?](#)
on page 268 to determine the number of available bands.

Return values:

<StopFreq> End frequency of the specified band

Example:

```
//Query end frequency of second band
EFR:FREQ:BAND2:UPP?
//Result: 44000000000
```

Usage:

Query only

Manual operation: See "[Frequency Band](#)" on page 108

[SENSe:]EFRontend:FREQuency:BCONfig:AUTO <State>

Determines whether the frequency band of the external frontend is configured automatically or manually.

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Uses the frequency band configured by [\[SENSe:\]EFRontend:FREQuency:BCONfig:SElect](#) on page 270.
ON | 1
Configures the frequency band automatically
Currently, auto mode always applies the "IF Low" range.
*RST: 1

Example:

```
//Configures the use of the IF high band manually.
EFR:FREQ:BCON:AUTO 0
EFR:FREQ:BCON:SEL "IF HIGH"
```

Manual operation: See "[Frequency Band Configuration](#)" on page 107

[SENSe:]EFRontend:FREQUENCY:BCONfig:LIST?

Returns the intermediate frequency (output) range of the external frontend.

Return values:

<BandConfigs>	string
	"IF LOW"
	(Not for R&S FE170SR/R&S FE110SR frontends.) A higher intermediate frequency is used on the external frontend, resulting in a higher input frequency at the FSW.
	"IF HIGH"
	(Not for R&S FE170SR/R&S FE110SR frontends.) A lower intermediate frequency is used on the external frontend, resulting in a lower input frequency at the FSW.
	"Spur Optimized"
	The selected IF range avoids unwanted spurious effects.
	"EVM Optimized"
	The selected IF range provides an optimal EVM result.

Example:

```
EFR:FREQ:BCON:LIST?
//Result: "IF HIGH", "IF LOW"
EFR:FREQ:BCON:SEL "IF HIGH"
```

Usage: Query only

Manual operation: See ["Frequency Band Configuration"](#) on page 107

[SENSe:]EFRontend:FREQUENCY:BCONfig:SElect <BandConfig>

Defines the intermediate frequency (output) range of the external frontend.

Parameters:

<BandConfig>	"IF HIGH"
	(R&S FE44S/ R&S FE50DTR) A higher intermediate frequency is used on the external frontend, resulting in a higher input frequency at the FSW.
	"IF LOW"
	(R&S FE44S/ R&S FE50DTR) A lower intermediate frequency is used on the external frontend, resulting in a lower input frequency at the FSW.
	"Spur Optimized"
	(R&S FE170SR/R&S FE110SR only) The selected IF range avoids unwanted spurious effects.
	"EVM Optimized"
	(R&S FE170SR/R&S FE110SR only) The selected IF range provides an optimal EVM result.

"Shared LO"

(R&S FE170SR/R&S FE110SR only)

Ensures that multiple external frontends (R&S FE170SR/R&S FE170ST or R&S FE110SR/R&S FE110ST) use the same LO frequencies for upconversion and downconversion.

Example:

```
EFR:FREQ:BCON:LIST?
//Result: "IF HIGH", "IF LOW"
EFR:FREQ:BCON:SEL "IF HIGH"
```

Manual operation: See ["Frequency Band Configuration"](#) on page 107

[SENSe:]EFRontend:FREQuency:IFRequency:MAXimum?

Queries the maximum used intermediate frequency (IF) for frequency conversion for a frequency span.

Return values:

<IFFrequency> numeric

Example: EFR:FREQ:IFR:MAX?

Usage: Query only

Manual operation: See ["Intermediate Frequency"](#) on page 109

[SENSe:]EFRontend:FREQuency:IFRequency:MINimum?

Queries the minimum used intermediate frequency (IF) for frequency conversion for a frequency span.

Return values:

<IFFrequency> numeric

Example: EFR:FREQ:IFR:MIN?

Usage: Query only

Manual operation: See ["Intermediate Frequency"](#) on page 109

[SENSe:]EFRontend:FREQuency:IFRequency:SIDeband?

Queries the currently used sideband for frequency conversion.

Return values:

<Sideband> "USB" | "LSB"
"USB"
 Upper sideband
"LSB"
 Lower sideband

Example:

```
EFR:FREQ:IFR?
EFR:FREQ:IFR:SID?
```

Usage: Query only

Manual operation: See "[Intermediate Frequency](#)" on page 109

[SENSe:]EFRontend:FREQuency:IFRequency[:VALue]?

Queries the currently used intermediate frequency (IF) for frequency conversion.

To query the maximum and minimum IF for the selected frequency range, use [\[SENSe:\]EFRontend:FREQuency:IFRequency:MAXimum?](#) on page 271 and [\[SENSe:\]EFRontend:FREQuency:IFRequency:MINimum?](#) on page 271.

Return values:

<IFFrequency> numeric

Example: EFR:FREQ:IFR?

Usage: Query only

Manual operation: See "[Intermediate Frequency](#)" on page 109

[SENSe:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?

Queries the frequency of the LO input for [\[SENSe:\]EFRontend:FREQuency:LOSCillator:MODE](#) EXT.

Return values:

<LOInFreq> Default unit: Hz

Example: The external frontend uses the external LO provided at the "LO IN" connector.

```
EFR:FREQ:LOSC:MODE EXT
```

Query the frequency that the external LO must be provided at.

```
EFR:FREQ:LOSC:INP:FREQ?
```

```
//Result: 10615000000
```

Usage: Query only

Manual operation: See "[Mandatory LO IN Frequency](#)" on page 110

[SENSe:]EFRontend:FREQuency:LOSCillator:MODE <Type>

Determines whether the external frontend uses its internal LO or an external LO.

Parameters:

<Type> EXTernal | INTernal

EXTernal

Uses the external LO provided at the LO input connector of the external frontend. Query the frequency at which the LO must be input to the external frontend using [\[SENSe:\]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?](#) on page 272.

INTernal

Uses the internal LO.

***RST:** EXTernal**Example:**

```
EFR:FREQ:LOSC:MODE EXT
EFR:FREQ:LOSC:INP:FREQ?
//Result: 10615000000
```

Manual operation: See "[LO Mode](#)" on page 109**[SENSe:]EFRontend:FREQUENCY:LOSCillator:OUTPut:FREQUENCY?**Queries the frequency of the LO output for [\[SENSe:\]EFRontend:FREQUENCY:LOSCillator:OUTPut:STATe](#) ON.**Return values:**

<LOOutFreq> Default unit: Hz

Example:

The external frontend uses the internal LO and provides it as output to the "LO OUT" connector.

```
EFR:FREQ:LOSC:MODE INT
EFR:FREQ:LOSC:OUTP:STAT ON
Query the frequency of the LO output.
EFR:FREQ:LOSC:OUTP:FREQ?
//Result: 10615000000
```

Usage:

Query only

Manual operation: See "[LO OUT Frequency](#)" on page 110**[SENSe:]EFRontend:FREQUENCY:LOSCillator:OUTPut:STATe <State>**Enables or disables output of the LO by the external frontend. The output frequency is returned by [\[SENSe:\]EFRontend:FREQUENCY:LOSCillator:OUTPut:FREQUENCY?](#) on page 273.**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

***RST:** 0**Example:**

The external frontend provides the LO as output at the "LO OUT" connector.

```
EFR:FREQ:LOSC:OUTP:STAT ON
Query the frequency of the LO output.
EFR:FREQ:LOSC:OUTP:FREQ?
//Result: 10615000000
```

Manual operation: See "[LO Out State](#)" on page 109

[SENSe:]EFRontend:FREQUENCY:REfERENCE <Frequency>

Sets the reference frequency that is used for frequency conversion on the frontend. Depending on the connected type of frontend, different values are available. To determine which reference levels are available, use [\[SENSe:\]EFRontend:FREQUENCY:REfERENCE:LIST?](#) on page 274.

Parameters:

<Frequency> Default unit: HZ

Example: `//Query the available reference levels`
`EFR:FREQ:REF:LIST?`
`//Result: 10000000,640000000,1000000000`
`//Use 640 MHz reference`
`EFR:FREQ:REF 640000000`

Manual operation: See ["Reference Frequency"](#) on page 108

[SENSe:]EFRontend:FREQUENCY:REfERENCE:LIST?

Queries the available reference signals for the connected frontend type.

Return values:

<References> 10000000 | 640000000 | 1000000000

Example: `//Query the available reference levels`
`EFR:FREQ:REF:LIST?`
`//Result: 10000000,640000000,1000000000`
`//Use 640 MHz reference`
`EFR:FREQ:REF 640000000`

Usage: Query only

Manual operation: See ["Reference Frequency"](#) on page 108

[SENSe:]EFRontend:IDN?

Queries the device identification information (*IDN?) of the frontend.

Return values:

<DevInfo> string without quotes
Rohde&Schwarz,<device type>,<part number>/<serial number>,<firmware version>

Example: `EFR:IDN?`
`//Result: Rohde&Schwarz,FE44S,`
`1234.5678K00/123456,0.8.0`

Usage: Query only

[SENSe:]EFRontend:NETWork <IPAddress>, <Subnet>, <DHCP State>

Sets or queries the network information for the frontend.

This information is also indicated on the electronic paper display on the side panel of the device.

Beware that if you change the network setting to DHCP = ON, the connection is aborted and you must re-establish a connection to the frontend (see [\[SENSe:\]EFRontend:CONNECTION\[:STATe\]](#) on page 267).

Parameters:

<IPAddress>	string in double quotes IP address of the frontend
<Subnet>	string in double quotes Subnet mask of the frontend
<DHCP State>	ON OFF 0 1 Indicates whether a DHCP server is used. OFF 0 DHCP off ON 1 DHCP on *RST: 0

Example: `EFR:NETW?
//Result: "123.456.78.90", "255.255.255.0", ON`

Manual operation: See ["IP Address"](#) on page 112
See ["Subnet Mask"](#) on page 112
See ["DHCP"](#) on page 112
See ["Apply Network Settings"](#) on page 112

[SENSe:]EFRontend[:STATe] <State>

Enables or disables the general use of an external frontend for the application.

Parameters:

<State>	ON OFF 0 1 OFF 0 The frontend is disconnected. The application adapts the measurement settings to the common settings supported by the FSW. ON 1 The FSW allows you to configure and connect an external frontend for the application. The application adapts the available measurement settings to the connected frontend. The channel bar indicates "Inp: ExtFe". *RST: 0
---------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Example: `EFR ON`

Manual operation: See ["Global activation"](#) on page 105

Commands for test, alignment, and diagnosis

The following commands are required to test and optimize the connection after it has initially been set up.

[SENSe:]EFRontend:ALIGnment<ch>:FILE.....	276
[SENSe:]EFRontend:ALIGnment<ch>:STATe.....	276
[SENSe:]EFRontend:FWUPdate.....	277
[SENSe:]EFRontend<fe>:SELFtest?.....	277
[SENSe:]EFRontend<fe>:SELFtest:RESult?.....	277

[SENSe:]EFRontend:ALIGnment<ch>:FILE <File>

Selects or queries the touchstone file that contains correction data to compensate for signal losses in the cable occurring at different IF signal frequencies.

Suffix:

<ch> 1..n
 Currently irrelevant

Parameters:

<File> string in double quotes
 Path and file name of the correction data file. The file must be in s2p format.
 If the specified file is not found or does not have the correct format, an error message is returned (-256, "File name not found", -150, "String data error").

Example: EFR:ALIG:FILE "FE44S.s2p"

Manual operation: See "[Load Cable Correction S2P File](#)" on page 110

[SENSe:]EFRontend:ALIGnment<ch>:STATe <State>

Activates correction of the IF signal due to cable loss from the frontend to the analyzer. Specify the file with correction data using [SENSe:]EFRontend:ALIGnment<ch>:FILE on page 276.

Suffix:

<ch> 1..n
 Currently irrelevant

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on
 *RST: 0

Manual operation: See "[Correction State](#)" on page 110

[SENSe:]EFRontend:FWUPdate

Updates the firmware on the external frontend. Note that this process can take some time.

Usage: Event

Manual operation: See "[FW Update](#)" on page 106

[SENSe:]EFRontend<fe>:SELFtest?

Performs a selftest on the frontend to compare the current performance and characteristic values with the specified values for the frontend.

As a result, the success is returned.

Suffix:

<fe> 1
Connected frontend

Return values:

<Result> 0
No error
>0
Error
*RST: 0

Example: EFR:SELF?
//Result: 0

Usage: Query only

Manual operation: See "[Start Selftest](#)" on page 111

[SENSe:]EFRontend<fe>:SELFtest:RESult?

Queries the results of the selftest on the frontend.

Suffix:

<fe> 1
Connected frontend

Return values:

<Result> string containing xml data in double quotes
For details, see "[Format of selftest result file](#)" on page 282.

Example: EFR:SELF:RES?
For details, see "[Format of selftest result file](#)" on page 282.

Usage: Query only

Manual operation: See "[Selftest Results](#)" on page 111

Commands for external devices

You can insert additional external devices in the signal path between the DUT and the external frontend, such as preamplifiers or filters. The external frontend must then consider the additional gain or correction values.

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE.....	278
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe.....	278
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?.....	279
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?.....	279
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFResh.....	280
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?.....	280
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?.....	281
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?.....	281
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?.....	281
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?.....	282

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE <File>

Defines the correction file to compensate for signal losses by the external devices occurring at different IF signal frequencies.

To query whether the loaded file is valid or not, use [SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid? on page 279.

Suffix:

<ch>	1..n For future use.
<di>	1..n irrelevant

Parameters:

<File>

Example: SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p'
 SENS:EFR:CHAN:EXTD:CORR:STAT ON
 SENS:EFR:CHAN:EXTD:CORR:FILE:VAL?

Manual operation: See "Load S2P File" on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe <State>

Enables or disables the use of a correction file for the connected external devices. The file is defined by [SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE on page 278.

Suffix:

<ch>	1..n For future use.
------	-------------------------

<di> 1..n
irrelevant

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 0

Example: SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p'
SENS:EFR:CHAN:EXTD:CORR:STAT ON

Manual operation: See "[Correction State](#)" on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?

Queries whether the loaded correction file for an external device is valid or not.

Suffix:

<ch> 1..n
For future use.

<di> 1..n
irrelevant

Return values:

<Result> ON | OFF | 0 | 1
OFF | 0
File is valid.
ON | 1
File is not valid.

Example: SENS:EFR:CHAN:EXTD:CORR:STAT ON
SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p'
SENS:EFR:CHAN:EXTD:CORR:VAL?

Usage: Query only

Manual operation: See "[Load S2P File](#)" on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?

Queries the names of all detected connected devices at the external frontend.

Suffix:

<ch> 1..n
For future use.

<di> 1..n
irrelevant

Return values:

<Devices> Comma-separated list of the names of the devices.

Example:

```
:SENSe1:EFRontend1:CHANnel1:EXTDevice1:LIST?
//Result:
//"fe170_z50", "fe170_z01"
```

Usage: Query only

Manual operation: See ["Name"](#) on page 113

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFresh

Scans the ports of the external frontend and refreshes the display with detected information on connected devices. This function is useful after connecting a new device to the frontend.

Suffix:

<ch> 1..n
For future use.

<di> 1..n
irrelevant

Example: SENSe1:EFRontend1:CHANnel:EXTDevice1:REFresh

Usage: Event

Manual operation: See ["Refresh External Devices"](#) on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?

Queries the upper limit of the supported frequency range of the connected device.

Suffix:

<ch> 1..n
For future use.

<di> 1..n
Connected external device

Return values:

<RFFrequency> numeric value
Maximum frequency
Default unit: Hz

Example:

```
SENS:EFR:EXTD1:FREQ:MAX?
//Result:
1700000000000
```

Usage: Query only

Manual operation: See ["Frequency Range"](#) on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQUENCY:MINimum?

Queries the lower limit of the supported frequency range of the connected device.

Suffix:

<ch>	1..n For future use.
<di>	1..n Connected external device

Return values:

<RFFrequency>	numeric value Minimum frequency Default unit: Hz
---------------	--------------------------------------------------------

Example:

```
SENS:EFR:EXTD1:FREQ:MIN?
//Result:
1100000000000
```

Usage: Query only

Manual operation: See "[Frequency Range](#)" on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?

Queries the gain provided by a connected external amplifier.

Suffix:

<ch>	1..n For future use.
<di>	1..n Connected external device

Return values:

<Gain>	numeric value Default unit: dB
--------	-----------------------------------

Example:

```
SENSe1:EFRontend1:CHANnel1:EXTDevice1:GAIN?
//Result:
//10
```

Usage: Query only

Manual operation: See "[Gain](#)" on page 114

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?

Queries the name of the external device for reference.

Suffix:

<ch>	1..n For future use.
------	-------------------------

<di> 1..n
Connected external device

Return values:

<Type> string

Example: SENS:EFR:CHAN:EXTD1:NAME?
//Result:
//'fe170_z50'

Usage: Query only

Manual operation: See "Name" on page 113

[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?

Queries the type of the detected device for reference.

Suffix:

<ch> 1..n
For future use.

<di> 1..n
Connected external device

Return values:

<Type> 'Amplifier' | 'Filter'

Example: SENSE1:EFRontend1:CHANnel1:EXTDevice1:TYPE?
//Result:
//'Filter'

Usage: Query only

Manual operation: See "Type" on page 114

Format of selftest result file

As a result of the selftest, an XML file with test details is created. It contains the following information in the specified order. Mandatory elements and attributes are indicated in bold font.

Element	Attributes	Description
<Sequence>		Main element
	Name	="Selftest"
	Description	Optional description of the test process
	FirmwareVersion	Firmware version of the controlling instrument (FSW)
	FrontendLibrary-Version	Version of the control.dll with the format x.y.z
	FrontendServerVersion	Version of the RRH server with the format x.y.z (FE44A only)

Element	Attributes	Description
	Date	Date the selftest was performed, with the format dd/mm/yyyy
	Time	Time the selftest was performed, with the format hh:mm:ss
	State	Test result state, combined result of all <SequenceCategory>s: "PASSED"/ "FAILED"
	Version	For internal use.
	Comment	Optional comment on the test process
<SequenceCategory>		Set of test steps
	Name	Name of the test sequence, e.g. "Frontend voltages"
	Description	Optional description of the test sequence
	State	Test sequence result state, combined result of all <SequenceStep>s: "PASSED"/ "FAILED"
	Version	For internal use.
	Comment	Optional comment on the test sequence
<SequenceStep>		Subelement of <SequenceCategory> for an individual test step
	Name	Name of the individual test step, e.g. FE1_3V3
	Description	Optional description of the test step
	LimitLow	Optional: lower limit to be checked
	LimitHigh	Optional: upper limit to be checked
	MeasValue	Optional: measured value
	Unit	Optional: unit of the measured value
	State	Test step result state: "PASSED"/ "FAILED"
	Version	For internal use.
	Comment	Optional comment on the test step

Example for selftest result xml file

```
<?xml version="1.0" encoding="UTF-8"?>
<Sequence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="SelfTest_Schema.xsd">
  <Name>DeviceCheck</Name>
  <FirmwareVersion>1.50-21.1.1.0 Beta</FirmwareVersion>
  <FrontendLibraryVersion>0.8.0</FrontendLibraryVersion>
  <Date>15/01/2021</Date>
  <Time>08:51:35</Time>
  <State>FAILED</State>
  <Version>1.0.0</Version>
  <SequenceCategory>
    <Name>Frontend Voltages</Name>
    <Description>test description</Description>
```

```

<State>FAILED</State>
<Version>1.0.0</Version>
<Type>Diagnose</Type>
<SequenceStep>
  <Name>FE1_3V3</Name>
  <LimitLow>3.000</LimitLow>
  <LimitHigh>3.600</LimitHigh>
  <MeasValue>3.311</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>FE1_5V</Name>
  <LimitLow>4.250</LimitLow>
  <LimitHigh>5.750</LimitHigh>
  <MeasValue>5.027</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>FE1_6V5</Name>
  <LimitLow>6.000</LimitLow>
  <LimitHigh>7.000</LimitHigh>
  <MeasValue>5.893</MeasValue>
  <State>FAILED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>FE1_M3V3</Name>
  <LimitLow>-3.600</LimitLow>
  <LimitHigh>-3.000</LimitHigh>
  <MeasValue>3.347</MeasValue>
  <State>FAILED</State>
  <Version>1.0.0</Version>
</SequenceStep>
</SequenceCategory>
<SequenceCategory>
  <Name>Frontend Temperature</Name>
  <Description>test description</Description>
  <State>PASSED</State>
  <Version>1.0.0</Version>
  <Type>Diagnose</Type>
  <SequenceStep>
    <Name>TEMP_FE1</Name>
    <LimitLow>0.000</LimitLow>
    <LimitHigh>60.000</LimitHigh>
    <MeasValue>39.300</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>

```



```

</SequenceCategory>
<SequenceCategory>
  <Name>Synthesizer Voltage</Name>
  <Description>test description</Description>
  <State>PASSED</State>
  <Version>1.0.0</Version>
  <Type>Diagnose</Type>
  <SequenceStep>
    <Name>SYNTH_3V4</Name>
    <LimitLow>3.200</LimitLow>
    <LimitHigh>3.910</LimitHigh>
    <MeasValue>3.576</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>
  <SequenceStep>
    <Name>SYNTH_5V4_SYN</Name>
    <LimitLow>4.860</LimitLow>
    <LimitHigh>5.940</LimitHigh>
    <MeasValue>5.405</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>
  <SequenceStep>
    <Name>SYNTH_5V4_YIG</Name>
    <LimitLow>4.860</LimitLow>
    <LimitHigh>5.940</LimitHigh>
    <MeasValue>5.438</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>
  <SequenceStep>
    <Name>SYNTH_M5V</Name>
    <LimitLow>-5.500</LimitLow>
    <LimitHigh>-4.500</LimitHigh>
    <MeasValue>-4.948</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>
  <SequenceStep>
    <Name>SYNTH_REF5V</Name>
    <LimitLow>4.500</LimitLow>
    <LimitHigh>5.500</LimitHigh>
    <MeasValue>5.031</MeasValue>
    <State>PASSED</State>
    <Version>1.0.0</Version>
  </SequenceStep>
</SequenceCategory>
<SequenceCategory>
  <Name>Supply Voltage</Name>

```

```
<Description>test description</Description>
<State>PASSED</State>
<Version>1.0.0</Version>
<Type>Diagnose</Type>
<SequenceStep>
  <Name>SUPPLY_12V</Name>
  <LimitLow>10.800</LimitLow>
  <LimitHigh>13.200</LimitHigh>
  <MeasValue>11.909</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>SUPPLY_3V3D</Name>
  <LimitLow>2.970</LimitLow>
  <LimitHigh>3.630</LimitHigh>
  <MeasValue>3.318</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>SUPPLY_4V</Name>
  <LimitLow>3.650</LimitLow>
  <LimitHigh>4.460</LimitHigh>
  <MeasValue>4.053</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>SUPPLY_6V</Name>
  <LimitLow>5.400</LimitLow>
  <LimitHigh>6.600</LimitHigh>
  <MeasValue>6.076</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
<SequenceStep>
  <Name>SUPPLY_M5V</Name>
  <LimitLow>-6.050</LimitLow>
  <LimitHigh>-4.950</LimitHigh>
  <MeasValue>-5.507</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
</SequenceStep>
</SequenceCategory>
</Sequence>
```

Programming example: Configuring an external frontend

The following example describes how to configure RF frontend settings in remote operation.

```
// Prepare the instrument
// Preset
*RST
// Create new IQ-Analyzer channel
:INST:SEL IQ
// Enable 640MHz Reference
:ROSC:O640 ON

//Enable general use of external frontend
SENSE:EFRontend:STATe ON
//Configure connection to ext. FE named "FE44S-1000826"
SENSE:EFRontend:CONNECTION:CONFig "FE44S","FE44S-1000826"
//Activate exclusive use of frontend by FSW.
SENSE:EFRontend:CONNECTION:STATe ON

//For demonstration purposes only: assign a static IP address
SENSE:EFRontend:NETWork "123.456.7.8", "255.255.255.00", OFF

// Query information about the connected RF frontend.
SENSE:EFRontend:CONNECTION:CSTATe?
// Response: 1 (connected)
SENSE:EFRontend:IDN?
////Result: Rohde&Schwarz,FE44S,1234.5678K00/123456,0.8.0

// Specify frontend settings
//Query available intermediate frequency bands
SENSE:EFRontend:FREQuency:BCONfig:LIST?
//Result: "IF HIGH", "IF LOW"
//Use high IF
SENSE:EFRontend:FREQuency:BCONfig:SElect "IF HIGH"
//Query used intermediate frequency
SENSE:EFRontend:FREQuency:IFREquency?
//Result: 8.595000000

//Query available reference frequencies
SENSE:EFRontend:FREQuency:REFerence:LIST?
//Result: 10000000,640000000,1000000000
//Use 640 MHz reference
SENSE:EFRontend:FREQuency:REFerence 640000000

// Query ranges of the operating frequency band.
SENSE:EFRontend:FREQuency:BAND1:LOWer?
// Response in Hz: "24000000000" (= 24 GHz)
SENSE:EFRontend:FREQuency:BAND1:UPPer?
// Response in Hz: "44000000000" (= 44 GHz)
```

```

// Add cable correction data by loading an *.s2p file.
SENSe:EFRontend:ALIGnment:FILE "C:\R_S\Instr\user\external_frontends\FE44S\
touchstonefiles\if_default_cable_1347_7552_00.s2p"
SENSe:EFRontend:ALIGnment:STATe ON

//Update FW version on frontend (only available if external frontend firmware
//is incompatible to FSW firmware)
SENSe:EFRontend:FWUPdate
//Perform a selftest on the frontend and query results
SENSe:EFRontend:SELftest?
//Result: 0 (no errors)
SENSe:EFRontend:SELftest:RESult?
//Result: "<?xml version="1.0" encoding="UTF-8"?>
//<Sequence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
//xsi:noNamespaceSchemaLocation="
//<Name>DeviceCheck</Name>
//<FirmwareVersion>1.50-21.1.1.0 Beta</FirmwareVersion>
//..."

```

Programming example 2: Configuring an external frontend with a connected amplifier

The following example demonstrates how to configure an R&S FE170SR external frontend with a connected amplifier.

Some commands may not be necessary as they reflect the default settings; however, they are included to demonstrate the command usage.

```

// Prepare the instrument
// Preset
*RST
// Create new IQ-Analyzer channel
:INST:SEL IQ
// Enable 640MHz Reference
:ROSC:O640 ON

//Enable general use of external frontend
SENSe:EFRontend:STATe ON
//Configure connection to ext. FE named "FE170SR-123456"
SENSe:EFRontend:CONNection:CONFig "FE170SR","FE170SR-123456"
//Activate exclusive use of frontend by FSW.
SENSe:EFRontend:CONNection:STATe ON

// Query information about the connected RF frontend.
SENSe:EFRontend:CONNection:CSTATe?
// Response: 1 (connected)
SENSe:EFRontend:IDN?
////Result: Rohde&Schwarz,FE170SR,1234.5678K00/123456,0.8.0

// Specify frontend settings
//Query available intermediate frequency bands
SENSe:EFRontend:FREQuency:BCONfig:LIST?

```

```

//Result: "Spur Optimized","EVM Optimized"
//Use spur optimized
SENSe:EFRontend:FREQuency:BCONfig:SElect "Spur Optimized"
//Query used intermediate frequency
SENSe:EFRontend:FREQuency:IFRequency?
//Result: 9940000000

//Query available reference frequencies
SENSe:EFRontend:FREQuency:REFeRence:LIST?
//Result: 10000000,640000000,1000000000
//Use 1 GHz reference
SENSe:EFRontend:FREQuency:REFeRence 1000000000

// Query ranges of the operating frequency band.
SENSe:EFRontend:FREQuency:BAND1:LOWer?
// Response in Hz: "110000000000" (= 110 GHz)
SENSe:EFRontend:FREQuency:BAND1:UPPer?
// Response in Hz: "170000000000" (= 170 GHz)

// Add cable correction data by loading an *.s2p file.
SENSe:EFRontend:ALIGnment:FILE "C:\R_S\Instr\user\external_frontends\FE170SR\
touchstonefiles\if_default_cable_1348_3850_00.s2p"
SENSe:EFRontend:ALIGnment:STATe ON

//Configure external amplifier named "fe170_z50" connected to frontend
//Refresh and query the list of detected external devices
SENSe:EFRontend:EXTDevice:REFresh
SENSe:EFRontend:EXTDevice:LIST?
//Result:
//"fe170_z50"
//Query the type of the external device
SENSe:EFRontend:EXTDevice:TYPE?
//Result:
//'Amplifier'
//Query the supported frequency range of the amplifier
SENSe:EFRontend:EXTDevice1:FREQuency:MINimum?
//Result:
//110000000000
SENSe:EFRontend:EXTDevice1:FREQuency:MAXimum?
//Result:
//170000000000
//Query the gain of the amplifier
SENSe:EFRontend:EXTDevice1:GAIN?
//Result:
//10
//Only for demonstration purposes:
//Load and enable a correction file for the amplifier.
//The correction file is automatically considered if the IX cable is used to connect
//the external device to the frontend.
SENSe:EFRontend:EXTDevice1:CORRection:FILE 'C:\temp\ExtDev_Corr.s2p'
SENSe:EFRontend:EXTDevice1:CORRection:STATe ON

```

```
//Check if the loaded file is valid
SENSe:EFFrontend:EXTDevice1:CORRection:VALid?
```

11.4.1.4 Configuring digital I/Q input and output

Useful commands for digital I/Q data described elsewhere:

- `INP:SEL DIQ` (see `INPut:SElect` on page 261)
- `TRIGger[:SEquence]:LEVel:BBPower` on page 370
- `TRACe:IQ:DIQFilter` on page 383

Remote commands exclusive to digital I/Q data input and output

<code>INPut:DIQ:CDEvice</code>	290
<code>INPut:DIQ:RANGe:COUPling</code>	290
<code>INPut:DIQ:RANGe[:UPPer]</code>	291
<code>INPut:DIQ:RANGe[:UPPer]:AUTO</code>	291
<code>INPut:DIQ:RANGe[:UPPer]:UNIT</code>	291
<code>INPut:DIQ:SRATe</code>	291
<code>INPut:DIQ:SRATe:AUTO</code>	292
<code>OUTPut:DIQ[:STATe]</code>	292
<code>OUTPut<up>:DIQ:CDEvice?</code>	292

`INPut:DIQ:CDEvice`

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 FSW I/Q Analyzer User Manual.

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 116

`INPut:DIQ:RANGe:COUPling` <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0
 *RST: 0

Manual operation: See "[Adjust Reference Level to Full Scale Level](#)" on page 116

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<Level> Range: 1 μ V to 7.071 V
 *RST: 1 V
 Default unit: DBM

Manual operation: See "[Full Scale Level](#)" on page 116

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0
 *RST: 0

Manual operation: See "[Full Scale Level](#)" on page 116

INPut: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.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<Level> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere
 *RST: Volt

Manual operation: See "[Full Scale Level](#)" on page 116

INPut:DIQ:SRATe <SampleRate>

Specifies or queries the sample rate of the input signal from the optional "Digital Baseband" interface.

(See "[Input Sample Rate](#)" on page 115).

Note: the final user sample rate of the FSW can differ and is defined using TRAC:IQ:SRAT (see [TRACe:IQ:SRATe](#) on page 386).

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 115

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

Is only available if the optional "Digital Baseband" interface is installed.

Parameters:

<State> ON | OFF | 1 | 0
*RST: 0

Manual operation: See ["Input Sample Rate"](#) on page 115

OUTPut:DIQ[:STATe] <State>

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 49.

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 132

OUTPut<up>:DIQ:CDEVice?

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 132 See "Connected Instrument" on page 132

11.4.1.5 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 51.

For a programming example, see [Chapter 11.12.6, "Data acquisition via the optional Analog Baseband interface"](#), on page 499.

Useful commands for Analog Baseband data described elsewhere:

- `INP:SEL AIQ` (see `INPut:SElect` on page 261)
- `[SENSe:]FREQuency:CENTer` on page 365

Commands for the Analog Baseband calibration signal are described in the FSW User Manual.

Remote commands exclusive to Analog Baseband data input and output

<code>INPut:IQ:BALanced[:STATe]</code>	294
<code>INPut:IQ:FULLscale:AUTO</code>	294
<code>INPut:IQ:FULLscale[:LEVel]</code>	295
<code>INPut:IQ:IMPedance</code>	295
<code>INPut:IQ:IMPedance:PTYPE</code>	296
<code>INPut:IQ:TYPE</code>	296
<code>CALibration:AIQ:DCOFFset:I</code>	296
<code>CALibration:AIQ:DCOFFset:Q</code>	297
<code>CALibration:AIQ:HATiming[:STATe]</code>	297
<code>TRACe:IQ:APCon[:STATe]</code>	297
<code>TRACe:IQ:APCon:A</code>	298
<code>TRACe:IQ:APCon:B</code>	298
<code>TRACe:IQ:APCon:RESult?</code>	298

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

Defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 single-ended lines.

Parameters:

<State> ON | OFF | 1 | 0
 ON | 1
 Differential
 OFF | 0
 Single ended
 *RST: 1

Example: `INP:IQ:BAL OFF`

Manual operation: See ["Input Configuration"](#) on page 118

`INPut:IQ:FULLscale:AUTO` <State>

Defines whether the full scale level (i.e. the maximum input power on the Baseband Input connector) is defined automatically according to the reference level, or manually.

Parameters:

<State> **ON | 1**
 Automatic definition

OFF | 0

Manual definition according to `INPut:IQ:FULLscale[:LEVel]` on page 295

*RST: 1

Example: `INP:IQ:FULL:AUTO OFF`

Manual operation: See "[Full Scale Level Mode / Value](#)" on page 144

INPut:IQ:FULLscale[:LEVel] <PeakVoltage>

Defines the peak voltage at the Baseband Input connector if the full scale level is set to manual mode (see `INPut:IQ:FULLscale:AUTO` on page 294).

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 144

INPut:IQ:IMPedance <Impedance>

Selects the nominal input impedance of the analog baseband input.

Not available for input from the optional "Digital Baseband" interface.

For input from the RF input, use the `INPut:IMPedance` command.

Parameters:

<Impedance> 50 | 75

numeric value

User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)

User-defined values are only available for:

Spectrum application

I/Q Analyzer

MSRA mode, primary application only

*RST: 50

Default unit: OHM

Example: `INP:IQ:IMP 75`

Manual operation: See "[Impedance](#)" on page 100

INPut:IQ:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for analog baseband input.

For RF input, use the `INPut:IQ:IMPedance:PTYPe` command.

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 100

INPut:IQ:TYPE <DataType>

Defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ

The input signal is filtered and resampled to the sample rate of the application.

Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I

The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the in-phase component of the input signal is down-converted first (Low IF I).

Q

The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example:

```
INP:IQ:TYPE Q
```

Manual operation: See "[I/Q Mode](#)" on page 117

CALibration:AIQ:DCOffset:I <Offset>

Defines a DC offset of the I input from the "Analog Baseband" interface (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>

Defines a DC offset of the Q input from the "Analog Baseband" interface (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 54.

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 118

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 298.

For details see [Chapter 5.3.6, "Average power consumption"](#), on page 58.

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 58.

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 58.

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 58.

Return values:

<Average> numeric value
 Default unit: W

Usage: Query only

11.4.1.6 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 FSW.

INPut:IQ:OSC:BA ^L anced[:STATe].....	299
INPut:IQ:OSC:CONState?.....	299
INPut:IQ:OSC:COUPling.....	300
INPut:IQ:OSC:FULLscale[:LEVel].....	300
INPut:IQ:OSC:IDN?.....	301
INPut:IQ:OSC:IMPedance.....	301
INPut:IQ:OSC:IMPedance:PTYPE.....	301
INPut:IQ:OSC:SKEW:I.....	302
INPut:IQ:OSC:SKEW:I:INVerted.....	302
INPut:IQ:OSC:SKEW:Q.....	302
INPut:IQ:OSC:SKEW:Q:INVerted.....	302
INPut:IQ:OSC:SRATe.....	303
INPut:IQ:OSC[:STATe].....	303
INPut:IQ:OSC:TCPip.....	303
INPut:IQ:OSC:TYPE.....	304
INPut:IQ:OSC:VDEVice?.....	304
INPut:IQ:OSC:VFIRmware?.....	304

INPut:IQ:OSC:BA^Lanced[:STATe] <State>

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Single ended
 ON | 1
 Differential
 *RST: 1

Example: INP:IQ:OSC:BA^L OFF

Manual operation: See "Input Configuration" on page 121

INPut:IQ:OSC:CONState?

Returns the state of the LAN connection to the oscilloscope for the optional Oscilloscope Baseband Input.

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 FSW and the oscilloscope, and make sure the IP address of the oscilloscope has been defined (see [INPut:IQ:OSC:TCPIP](#) on page 303).

Usage: Query only

INPut:IQ:OSC:COUPling <Coupling>

Determines the coupling of the oscilloscope to the FSW.

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 121

INPut: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.

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 144

INPut:IQ:OSC:IDN?

Returns the identification string of the oscilloscope connected to the FSW.

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 120

INPut:IQ:OSC:IMPedance <Impedance>

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:IMPedance](#) command.

For analog baseband input without an oscilloscope, use the [INPut:IQ:IMPedance](#) command.

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, primary application 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 100

INPut: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:IMPedance:PTYPe](#) command.

For analog baseband input without an oscilloscope, use the [INPut:IQ:IMPedance:PTYPe](#) command.

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 100

INPut:IQ:OSC:SKEW:I <Value>

Compensates for skewed values in the positive I path, e.g. due to different input cables.

Parameters:

<Value> Default unit: S

Example: INP:IQ:OSC:SKEW:I 0.2

Manual operation: See "[I/Q Skew](#)" on page 122

INPut:IQ:OSC:SKEW:I:INVerted <Value>

Compensates for skewed values in the negative I path, e.g. due to different input cables.

Parameters:

<Value> Default unit: S

Example: INP:IQ:OSC:SKEW:I:INV 0.2

Manual operation: See "[I/Q Skew](#)" on page 122

INPut:IQ:OSC:SKEW:Q <Value>

Compensates for skewed values in the positive Q path, e.g. due to different input cables.

Parameters:

<Value> Default unit: S

Example: INP:IQ:OSC:SKEW:Q 0.2

Manual operation: See "[I/Q Skew](#)" on page 122

INPut:IQ:OSC:SKEW:Q:INVerted <Value>

Compensates for skewed values in the negative Q path, e.g. due to different input cables.

Parameters:

<Value> Default unit: S

Example:

INP:IQ:OSC:SKEW:Q:INV 0.2

Manual operation:See "[I/Q Skew](#)" on page 122**INPut:IQ:OSC:SRATe** <SampleRate>

Returns the used oscilloscope acquisition sample rate, which depends on the used I/Q mode (see [INPut:IQ:OSC:TYPE](#) on page 304).

Parameters:

<SampleRate> 10 GHz | 20 GHz
10 GHz
 differential mode
20 GHz
 single-ended mode
 Default unit: Hz

Example:

INP:IQ:OSC:SRAT?

INPut:IQ:OSC[:STATe] <State>

Activates or deactivates Oscilloscope Baseband Input from a connected oscilloscope. This input requires optional firmware.

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:SElect](#) on page 261.

Manual operation:See "[Oscilloscope Baseband Input State](#)" on page 120**INPut:IQ:OSC:TCPIp** <Tcpip>

Defines the TCPIP address or computer name of the oscilloscope connected to the FSW via LAN.

Note: The IP address is maintained after a [PRESET], and is transferred between applications.

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 120

INPut:IQ:OSC:TYPE <Type>

Defines the format of the input signal.

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 121

INPut:IQ:OSC:VDEvice?

Queries whether the connected instrument is supported for Oscilloscope Baseband Input.

For details see the specifications document.

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 120

INPut:IQ:OSC:VFIRmware?

Queries whether the firmware on the connected oscilloscope is supported for Oscilloscope Baseband Input.

For details see the specifications document.

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 120

11.4.1.7 Using external mixers

The commands required to work with external mixers in a remote environment are described here. Note that these commands require the FSW to have an external mixer option installed and an external mixer to be connected to the FSW.

In MSRA/MSRT mode, external mixers are not supported.

For details on working with external mixers see the FSW User Manual.

- [Basic settings](#)..... 305
- [Mixer settings](#)..... 306
- [Conversion loss table settings](#)..... 312
- [Programming example: working with an external mixer](#)..... 316

Basic settings

The basic settings concern general usage of an external mixer.

[SENSe:]MIXer<x>[:STATe]	305
[SENSe:]MIXer<x>:BIAS:HIGH	306
[SENSe:]MIXer<x>:BIAS[:LOW]	306
[SENSe:]MIXer<x>:LOPower	306

[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

[SENSe:]MIXer<x>:BIAS:HIGH <BiasSetting>

Defines the bias current for the high (last) range.

Is only available if the external mixer is active (see [SENSe:]MIXer<x>[:STATe] on page 305).

Suffix:

<x> 1..n
irrelevant

Parameters:

<BiasSetting> *RST: 0.0 A
Default unit: A

[SENSe:]MIXer<x>:BIAS[:LOW] <BiasSetting>

Defines the bias current for the low (first) range.

Is only available if the external mixer is active (see [SENSe:]MIXer<x>[:STATe] on page 305).

Suffix:

<x> 1..n
irrelevant

Parameters:

<BiasSetting> *RST: 0.0 A
Default unit: A

[SENSe:]MIXer<x>:LOPower <Level>

Specifies the LO level of the external mixer's LO port.

Suffix:

<x> 1..n
irrelevant

Parameters:

<Level> Range: 13.0 dBm to 17.0 dBm
Increment: 0.1 dB
*RST: 15.5 dBm
Default unit: DBM

Example: MIX:LOP 16.0dBm

Mixer settings

The following commands are required to configure the band and specific mixer settings.

[SENSe:]MIXer<x>:FREQuency:HANdOver.....	307
[SENSe:]MIXer<x>:FREQuency:STARt.....	307
[SENSe:]MIXer<x>:FREQuency:STOP.....	307

[SENSe:]MIXer<x>:HARMonic:BAND:PRESet.....	308
[SENSe:]MIXer<x>:HARMonic:BAND.....	308
[SENSe:]MIXer<x>:HARMonic:HIGH:STATe.....	309
[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue].....	309
[SENSe:]MIXer<x>:HARMonic:TYPE.....	309
[SENSe:]MIXer<x>:HARMonic[:LOW].....	310
[SENSe:]MIXer<x>:IF?.....	310
[SENSe:]MIXer<x>:LOSS:HIGH.....	310
[SENSe:]MIXer<x>:LOSS:TABLE:HIGH.....	310
[SENSe:]MIXer<x>:LOSS:TABLE[:LOW].....	311
[SENSe:]MIXer<x>:LOSS[:LOW].....	311
[SENSe:]MIXer<x>:PORTs.....	312
[SENSe:]MIXer<x>:RFOVerrange[:STATe].....	312

[SENSe:]MIXer<x>:FREQuency:HANDOver <Frequency>

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.

Is only available if the external mixer is active (see [SENSe:]MIXer<x>[:STATe] on page 305).

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.

[SENSe:]MIXer<x>:FREQuency:STARt

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.

[SENSe:]MIXer<x>:FREQuency:STOP

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.

[SENSe:]MIXer<x>:HARMonic:BAND:PRESet

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:PRESet
Presents the selected waveguide band.

[SENSe:]MIXer<x>:HARMonic:BAND <Band>

Selects the external mixer band. The query returns the currently selected band.

Is only available if the external mixer is active (see [SENSe:]MIXer<x>[:STATe] on page 305).

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.

Table 11-3: 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
G	140.0	220.0

*) The band formerly referred to as "A" is now named "KA".

Band	Frequency start [GHz]	Frequency stop [GHz]
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>

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

[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue] <HarmOrder>

Specifies the harmonic order to be used for the high (second) range.

Suffix:

<x> 1..n
irrelevant

Parameters:

<HarmOrder> Range: 2 to 128 (USER band); for other bands: see band definition

Example: MIX:HARM:HIGH:STAT ON
MIX:HARM:HIGH 3

[SENSe:]MIXer<x>:HARMonic:TYPE <OddEven>

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

[SENSe:]MIXer<x>:HARMonic[:LOW] <HarmOrder>

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

[SENSe:]MIXer<x>:IF?

Queries the intermediate frequency currently used by the external mixer.

Suffix:

<x> 1..n
irrelevant

Example: MIX:IF?

Example: See ["Programming example: working with an external mixer"](#) on page 316.

Usage: Query only

[SENSe:]MIXer<x>:LOSS:HIGH <Average>

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

[SENSe:]MIXer<x>:LOSS:TABLE:HIGH <FileName>

Defines the conversion loss table to be used for the high (second) 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 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: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'
```

[SENSe:]MIXer<x>:LOSS:TABLE[:LOW] <FileName>

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 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'
```

[SENSe:]MIXer<x>:LOSS[:LOW] <Average>

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
```

[SENSe:]MIXer<x>:PORTs <PortType>

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

[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

Conversion loss table settings

The following settings are required to configure and manage conversion loss tables.

[SENSe:]CORRection:CVL:BAND.....	313
[SENSe:]CORRection:CVL:BIAS.....	313
[SENSe:]CORRection:CVL:CATalog?.....	313
[SENSe:]CORRection:CVL:CLEar.....	314
[SENSe:]CORRection:CVL:COMMeNt.....	314
[SENSe:]CORRection:CVL:DATA.....	314
[SENSe:]CORRection:CVL:HARMonic.....	314
[SENSe:]CORRection:CVL:MIXer.....	315
[SENSe:]CORRection:CVL:PORTs.....	315
[SENSe:]CORRection:CVL:SElect.....	315
[SENSe:]CORRection:CVL:SNUMber.....	316

[SENSe:]CORRection:CVL:BAND <Band>

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).

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 11-3).
 *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).
```

[SENSe:]CORRection:CVL:BIAS <BiasSetting>

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).

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
```

[SENSe:]CORRection:CVL:CATalog?

Queries all available conversion loss tables saved in the C:\R_S\INSTR\USER\cv1\ directory on the instrument.

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

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).

Is only available with option B21 (External Mixer) installed.

Example: CORR:CVL:SEL 'LOSS_TAB_4'
 Selects the conversion loss table.
 CORR:CVL:CLE

[SENSe:]CORRection:CVL:COMMeNt <Text>

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).

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'

[SENSe:]CORRection:CVL:DATA {<Freq>, <Level>}...

Defines the reference values of the selected conversion loss tables. The values are entered as a set of frequency/level pairs. You can define a maximum of 500 frequency/level pairs. Before this command can be performed, you must select the conversion loss table (see [\[SENSe:\]CORRection:CVL:SELEct](#) on page 315).

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

[SENSe:]CORRection:CVL:HARMonic <HarmOrder>

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).

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
```

[SENSe:]CORRection:CVL:MIXer <Type>

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).

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'
```

[SENSe:]CORRection:CVL:PORTs <PortType>

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).

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
```

[SENSe:]CORRection:CVL:SElect <FileName>

Selects the conversion loss table with the specified file name. If <file_name> is not available, a new conversion loss table is created.

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'

[SENSe:]CORRection:CVL:SNUMber <SerialNo>

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).

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'
```

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 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? TRACel

```

11.4.1.8 Setting up probes

Modular probes can be connected to the RF input connector of the FSW.

For details see the FSW User Manual.

Probes can also be connected to the optional "Baseband Input" connectors, if the "Analog Baseband" interface (option FSW-B71) is installed.

[SENSe:]PROBe<pb>:ID:PARTnumber?	318
[SENSe:]PROBe<pb>:ID:SRNumber?	319
[SENSe:]PROBe<pb>:SETup:ATTRatio	319
[SENSe:]PROBe<pb>:SETup:CMOFset	320
[SENSe:]PROBe<pb>:SETup:DMOFset	320
[SENSe:]PROBe<pb>:SETup:MODE	321
[SENSe:]PROBe<pb>:SETup:NAME?	321
[SENSe:]PROBe<pb>:SETup:NMOFset	321
[SENSe:]PROBe<pb>:SETup:PMODE	322
[SENSe:]PROBe<pb>:SETup:PMOFset	322
[SENSe:]PROBe<pb>:SETup:STATe?	323
[SENSe:]PROBe<pb>:SETup:TYPE?	323

[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

[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

[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

[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 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 the FSW User Manual.

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

[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 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 the FSW User Manual.

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

[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.

[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

[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 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 the FSW User Manual.

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

[SENSe:]PROBe<pb>:SETup:PMODE <Mode>

Determines the mode of a multi-mode modular probe.

For details see the FSW User Manual.

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.

[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 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 the FSW User Manual.

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

[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:SElect](#) on page 261).

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

11.4.1.9 External generator control

External generator control commands are available if the FSW External Generator Control option (R&S FSW-B10) 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 the FSW User Manual.

- [Measurement configuration](#).....324
- [Interface configuration](#).....327
- [Source calibration](#)..... 330
- [Programming example for external generator control](#).....332

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	324
SOURce<si>:EXTernal<gen>:FREQuency:COUPling[:STATe]	324
SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:DENominator	325
SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:NUMerator	325
SOURce<si>:EXTernal<gen>:FREQuency:OFFSet	326
SOURce<si>:EXTernal<gen>:POWer[:LEVel]	326
SOURce<si>:EXTernal<gen>[:STATe]	327
SOURce<si>:POWer[:LEVel][:IMMediate]:OFFSet	327

SOURce<si>:EXTernal<gen>:FREQuency <Frequency>

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

SOURce<si>:EXTernal<gen>:FREQuency:COUPling[:STATe] <State>

Couples the frequency of the external generator output to the 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 FSW. The RF frequency range covers the currently defined span of the 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

SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:DENominator <Value>

Defines the denominator of the factor with which the analyzer frequency is multiplied 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

SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:NUMerator <Value>

Defines the numerator of the factor with which the analyzer frequency is multiplied 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:

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

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

SOURce<si>:EXTernal<gen>:FREQuency:OFFSet <Offset>

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:

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

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

SOURce<si>:EXTernal<gen>:POWer[:LEVel] <Level>

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

SOURce<si>:EXTernal<gen>[:STATe] <State>

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

SOURce<si>:POWER[:LEVel][:IMMediate]:OFFSet <Offset>

Suffix:

<si> irrelevant

Parameters:

<Offset> Range: -200 dB to +200 dB
 *RST: 0dB
 Default unit: DB

Example: SOUR:POW:OFFS -10dB

Interface configuration

The following commands are required to configure the interface for the connection to the external generator.

SOURce<si>:EXTernal<gen>:ROSCillator[:SOURce].....	328
SYSTem:COMMunicate:GPIB:RDEVice:GENerator<gen>:ADDRess.....	328
SYSTem:COMMunicate:RDEVice:GENerator<gen>:INTerface.....	328
SYSTem:COMMunicate:RDEVice:GENerator<gen>:LINK.....	329
SYSTem:COMMunicate:RDEVice:GENerator<gen>:TYPE.....	329
SYSTem:COMMunicate:TCPip:RDEVice:GENerator<gen>:ADDRess.....	329

SOURce<si>:EXTernal<gen>:ROSCillator[:SOURce] <Source>

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
```

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
```

SYSTem:COMMunicate:RDEvice:GENerator<gen>:INTerface <Type>

Defines the interface used for the connection to the external generator.

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
```

SYSTem:COMMunicate:RDEvice:GENerator<gen>:LINK <Type>

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. During GPIB operation, each frequency to be set is transmitted to the generator separately. If the TTL interface is also used, a whole frequency list can be programmed in one go. Frequencies can then be switched per TTL handshake, which speeds up the process considerably.

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.

SYSTem:COMMunicate:RDEvice:GENerator<gen>:TYPE <Type>

Selects the type of external generator.

For a list of the available generator types, see the specifications document.

Suffix:

<gen>

Parameters:

<Name>

<Generator name as string value>

*RST: SMU02

Example:

```
//Select an external generator
```

```
SYST:COMM:RDEV:GEN:TYPE 'SMW06'
```

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

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\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:Y\[:SCALe\]:RPOSition](#) on page 364

Remote commands exclusive to source calibration:

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue	330
[SENSe:]CORRection:COLLect[:ACQuire]	330
[SENSe:]CORRection:METhod	331
[SENSe:]CORRection:RECall	331
[SENSe:]CORRection[:STATe]	332
[SENSe:]CORRection:TRANsducer:GENerate	332

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

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> Default unit: DB

Example:

DISP:TRAC:Y:RVAL 0
 Sets the value assigned to the reference position to 0 Hz

[SENSe:]CORRection:COLLect[:ACQuire] <MeasType>

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 331).

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.

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

[SENSe:]CORRection:METHod <Type>

Selects the type of measurement to be performed with the generator.

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".
```

[SENSe:]CORRection:RECall

Restores the measurement configuration used for calibration.

Is only available if external generator control is active (see [SOURCE<si>:EXTERNAL<gen>\[:STATe\]](#) on page 327).

Example: CORR:REC

[SENSe:]CORRection[:STATe] <State>

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 330.

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.

[SENSe:]CORRection:TRANsducer:GENerate <Name>

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 FSW > Working with Transducers" section in the FSW User Manual.

Parameters:

<Name> '<name>'

Example:

CORR:TRAN:GEN 'MyGenerator'
 Creates the transducer file
`C:\r_s\instr\trd\MyGenerator.trd`.

Programming example for external generator control

The following example demonstrates how to work with an external generator in a remote environment.

It assumes that a signal generator of the type SMW06 is connected to the FSW, including TTL synchronization, as described in the 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
```

11.4.1.10 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 specifications document.

- [Configuring power sensors](#)..... 334
- [Configuring power sensor measurements](#)..... 335
- [Triggering with power sensors](#)..... 342

Configuring power sensors

[SYSTem:COMMunicate:RDEvice:PMETer<p>:CONFigure:AUTO\[:STATe\]](#)..... 334
[SYSTem:COMMunicate:RDEvice:PMETer<p>:COUNT?](#)..... 335
[SYSTem:COMMunicate:RDEvice:PMETer<p>:DEFine](#)..... 335

SYSTem:COMMunicate:RDEvice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

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?

Queries the number of power sensors currently connected to the 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>

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.....	336
CALCulate<n>:PMETer<p>:RELative[:MAGNitude].....	336
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE.....	336
CALCulate<n>:PMETer<p>:RELative:STATe.....	337
FETCh:PMETer<p>?.....	337
READ:PMETer<p>?.....	337

[SENSe:]PMETer<p>:DCYClE[:STATe].....	337
[SENSe:]PMETer<p>:DCYClE:VALue.....	338
[SENSe:]PMETer<p>:FREQuency.....	338
[SENSe:]PMETer<p>:FREQuency:LiNK.....	338
[SENSe:]PMETer<p>:MTIME.....	339
[SENSe:]PMETer<p>:MTIME:AVERAge:COUNt.....	339
[SENSe:]PMETer<p>:MTIME:AVERAge[:STATe].....	340
[SENSe:]PMETer<p>:ROFFset[:STATe].....	340
[SENSe:]PMETer<p>:SOFFset.....	340
[SENSe:]PMETer<p>[:STATe].....	340
[SENSe:]PMETer<p>:UPDate[:STATe].....	341
UNIT<n>:PMETer<p>:POWer.....	341
UNIT<n>:PMETer<p>:POWer:RATio.....	341

CALibration:PMETer<p>:ZERO:AUTO ONCE

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>

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

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>

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>?

Queries the results of power sensor measurements.

Suffix:
 <p> Power sensor index
Usage: Query only

READ:PMETer<p>?

Initiates a power sensor measurement and queries the results.

Suffix:
 <p> Power sensor index
Usage: Query only

[SENSe:]PMETer<p>:DCYClE[:STATe] <State>

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>

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>

Defines the frequency of the power sensor.

Suffix:
<p> Power sensor index

Parameters:
<Frequency> The available value range is specified in the specifications document 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>

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>

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>

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>

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>

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:SOFF 0.001

[SENSe:]PMETer<p>[:STATe] <State>

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>

Turns continuous update of power sensor measurements on and off.

If on, the results are updated 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>

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>

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.....	342
[SENSe:]PMETer<p>:TRIGger:HOLDoff.....	342
[SENSe:]PMETer<p>:TRIGger:HYSTeresis.....	343
[SENSe:]PMETer<p>:TRIGger:LEVel.....	343
[SENSe:]PMETer<p>:TRIGger:SLOPe.....	343
[SENSe:]PMETer<p>:TRIGger[:STATe].....	344

[SENSe:]PMETer<p>:TRIGger:DTIME <Time>

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>

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>

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 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>

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>

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>

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

11.4.1.11 Configuring the 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000)

The following commands are required to use the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000).

For details on prerequisites and restrictions see [Chapter 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64.

See also the command for configuring triggers while using the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000):

- [TRIGger\[:SEQuence\]:OSCilloscope:COUPling](#) on page 349

Remote commands exclusive to configuring the 2 GHz / 5 GHz bandwidth extensions:

EXPort:WAVeform:DISPlayoff	344
SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe]	345
SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP<st>[:STATe]	345
SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE	346
SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:FALignment	346
SYSTem:COMMunicate:RDEVice:OSCilloscope:IDN	346
SYSTem:COMMunicate:RDEVice:OSCilloscope:LEDState	347
SYSTem:COMMunicate:RDEVice:OSCilloscope:PSMMode[:STATe]	347
SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe	348
SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip	348
SYSTem:COMMunicate:RDEVice:OSCilloscope:VDEVice?	348
SYSTem:COMMunicate:RDEVice:OSCilloscope:VFIRmware?	349
TRIGger[:SEQuence]:OSCilloscope:COUPling	349

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 (FSW-B2000/B5000).

Note that this command is **only executable by the oscilloscope**, not by the FSW.

As soon as the FSW-B2000/B5000 is activated, the display on the oscilloscope is turned off to improve performance during data export. As soon as the 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 (FSW-B2000/B5000), see 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 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 124

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 (FSW-B2000/B5000). The correction data for the oscilloscope (including the connection cable between the 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 FSW
- A new cable is used between the "IF OUT 2 GHz/ IF OUT 5 GHz" connector of the FSW and the oscilloscope
- A power splitter is inserted between the "IF OUT 2 GHz/ IF OUT 5 GHz" connector of the FSW and the oscilloscope

- New firmware is installed on the oscilloscope or the 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 126

SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGment: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 (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:ALIG:DATE?
//Result: 2014-02-28
```

Manual operation: See "[Alignment](#)" on page 126

SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGment:FALignment <State>

Performs a self-alignment on the oscilloscope before the B2000/B5000 alignment on the 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 126

SYSTem:COMMunicate:RDEvice:OSCilloscope:IDN <IDString>

Returns the identification string of the oscilloscope connected to the 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 124**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 (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 FSW and the oscilloscope, and make sure the IP address of the oscilloscope has been defined (see [SYSTem:COMMunicate:RDEvice:OSCilloscope:TCPIP](#) on page 348).

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 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 5.6.8, "Power splitter mode"](#), on page 72.

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 125

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 125

SYSTem:COMMunicate:RDEvice:OSCilloscope:TCPIp <Address>

Defines the TCPIP address or computer name of the oscilloscope connected to the 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 124

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 5.6.3, "Prerequisites and measurement setup"](#), on page 66.

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

DCDirect connection with 50 Ω termination, passes both DC and AC components of the trigger signal.**CDLimit**Direct connection with 1 M Ω 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 154**11.4.1.12 Configuring the outputs**

The following commands are required to provide output from the FSW.



Configuring trigger input/output is described in [Chapter 11.4.4.2, "Configuring the trigger output"](#), on page 374.

Configuring the Digital I/Q 40G Streaming Output option (FSW-B517) is described in [Chapter 11.4.1.13, "Digital I/Q 40G streaming output commands"](#), on page 353.

DIAGnostic:SERVice:NSource	350
OUTPut:IF:SBANd?	350
OUTPut:IF[:SOURce]	351
OUTPut:IF:IFFRequency	351
OUTPut:UPORt:STATe	352
OUTPut:UPORt[:VALue]	352
SYSTem:SPEaker:VOLume	352

DIAGnostic:SERVice:NSource <State>

Turns the 28 V supply of the BNC connector labeled [noise source control] on the 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 131

OUTPut:IF:SBANd?

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.

Is available only if the output is configured for IF2 (see [OUTPut:IF\[:SOURce\]](#) on page 351).

For more information and prerequisites see [Chapter 5.8, "IF and video signal output"](#), on page 76.

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:IF[:SOURce] <Source>

Defines the type of signal available at one of the output connectors of the FSW.

For restrictions and more information see [Chapter 5.8, "IF and video signal output"](#), on page 76.

Parameters:

<Source>

IF

The measured IF value is available at the IF/VIDEO/DEMODO output connector.

The frequency at which the IF value is provided is defined using the `OUTPut: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 (FSW-B2000/B5000) is available.

It is automatically set if the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000) is installed and active.

For details see [Chapter 5.6, "Basics on the R&S FSW bandwidth extensions \(R&S FSW-B2000/B5000 options\)"](#), on page 64.

VIDeo

The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMODO 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/DEMODO output connector.

Manual operation: See ["Data Output"](#) on page 130

OUTPut:IF:IFFrequency <Frequency>

Defines the frequency for the IF output of the FSW. The IF frequency of the signal is converted accordingly.

Is available in the time domain and if the IF/VIDEO/DEMODO output is configured for IF.

If the [IF WIDE OUTPUT] connector is used (`TRACe:IQ:WBAND ON`, see [TRACe:IQ:WBAND\[:STATE\]](#) on page 387), 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 5.8, "IF and video signal output"](#), on page 76.

Parameters:

<Frequency> *RST: 50.0 MHz
 Default unit: HZ

Manual operation: See "[Data Output](#)" on page 130

OUTPut:UPORt:STATe <State>

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 FSW.

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:UPORt[:VALue] <Value>

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:UPORt:STATe](#) on page 263), the output value is temporarily stored.

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>

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.

11.4.1.13 Digital I/Q 40G streaming output commands

The following commands are only available if the Digital I/Q 40G Streaming Output option (FSW-B517/-B1017) is installed.

For details see [Chapter 5.7, "Digital I/Q 40G streaming output"](#), on page 73.

OUTPut:IQHS:CDEvice?	353
OUTPut:IQHS:MARKer	353
OUTPut:IQHS:SRATe?	353
OUTPut:IQHS[:STATe]	354

OUTPut:IQHS:CDEvice?

Returns a comma-separated list of information on the instrument connected to the QSFP+ connector, if available.

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 134

OUTPut:IQHS: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.

Usage:

Event

Manual operation: See ["I/Q 40G Recording"](#) on page 21
See ["Insert Marker"](#) on page 133

OUTPut:IQHS:SRATe?

Returns the currently used sample rate to transfer data via the Digital I/Q 40G Streaming Output interface.

Usage:

Query only

Manual operation: See "Output Settings Information" on page 134

OUTPut:IQHS[:STATe] <State>

Enables or disables a digital output stream to the optional QSFP+ connector, if available.

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 133

11.4.2 Configuring the vertical axis (amplitude, scaling)

The following commands are required to configure the amplitude and vertical axis settings in a remote environment.

- [Amplitude settings](#).....354
- [Configuring the attenuation](#).....356
- [Configuring a preamplifier](#).....360
- [Scaling the Y-axis](#).....362

11.4.2.1 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	354
UNIT<n>:POWer	355
CALCulate<n>:UNIT:POWer	355
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel	355
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet	356

CALCulate<n>:MARKer<m>:FUNction:REFerence

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 200**UNIT<n>:POWer** <Unit>**CALCulate<n>:UNIT:POWer** <Unit>

Selects the power unit.

The unit applies to all power-based measurement windows with absolute values.

In addition, the unit of the reference level is adapted to the same unit.

Suffix:

<n> irrelevant

Parameters:

<Unit> *RST: dBm

Example:

CALC:UNIT:POW DBM

Sets the power unit to dBm.

Manual operation: See "Unit" on page 137**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel**
<ReferenceLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset $\neq 0$, the value range of the reference level is modified by the offset.**Suffix:**

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.

Range: see specifications document

*RST: 0 dBm

Default unit: DBM

Example:

DISP:TRAC:Y:RLEV -60dBm

Manual operation: See "Reference Level" on page 136

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet
 <Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n>	irrelevant
<w>	subwindow Not supported by all applications
<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 137

11.4.2.2 Configuring the attenuation

INPut:ATTenuation.....	356
INPut:ATTenuation:AUTO.....	357
INPut:ATTenuation:AUTO:MODE.....	357
INPut:EATT.....	358
INPut:EATT:AUTO.....	358
INPut:EATT:STATe.....	358
INPut:SANalyzer:ATTenuation.....	359
INPut:SANalyzer:ATTenuation:AUTO.....	359
[SENSe:]IQ:WBANd.....	360

INPut:ATTenuation <Attenuation>

Defines the total attenuation for RF input.

If an electronic attenuator is available and active, the command defines a mechanical attenuation (see [INPut:EATT:STATe](#) on page 358).

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.

If an external frontend is active (see [\[SENSe:\]EFRontend\[:STATe\]](#) on page 275), you can configure the attenuation of the external frontend and the analyzer separately. See also [INPut:SANalyzer:ATTenuation:AUTO](#) on page 359 and [INPut:SANalyzer:ATTenuation](#) on page 359.

Is not available if the optional "Digital Baseband" interface is active.

Parameters:

<Attenuation> Range: see specifications document
 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 ["External Frontend Attenuation"](#) on page 138
 See ["Attenuation Mode / Value"](#) on page 138

INPut:ATTenuation:AUTO <State>

Couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

If an external frontend is active (see [\[SENSe:\]EFRontend\[:STATe\]](#) on page 275), you can configure the attenuation of the external frontend and the analyzer separately. See also [INPut:SANalyzer:ATTenuation:AUTO](#) on page 359 and [INPut:SANalyzer:ATTenuation](#) on page 359.

Is not available if the optional "Digital Baseband" interface is active.

Parameters:

<State> ON | OFF | 0 | 1
 *RST: 1

Example:

INP:ATT:AUTO ON
 Couples the attenuation to the reference level.

Manual operation: See ["External Frontend Attenuation"](#) on page 138
 See ["Attenuation Mode / Value"](#) on page 138

INPut:ATTenuation:AUTO:MODE <OptMode>

Selects the priority for signal processing *after* the RF attenuation has been applied.

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 139

INPut:EATT <Attenuation>

Defines an electronic attenuation manually. Automatic mode must be switched off (INP:EATT:AUTO OFF, see INPut:EATT:AUTO on page 358).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Requires the electronic attenuation hardware option.

It is not available if the optional "Digital Baseband" interface is active.

Parameters:

<Attenuation> attenuation in dB
 Range: see specifications document
 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 140

INPut:EATT:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Requires the electronic attenuation hardware option.

It is not available if the optional "Digital Baseband" interface is active.

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 140

INPut:EATT:STATe <State>

Turns the electronic attenuator on and off.

Requires the electronic attenuation hardware option.

It is not available if the optional "Digital Baseband" interface is active.

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 140

INPut:SANalyzer:ATTenuation <Attenuation>

Configures attenuation at the analyzer input for an active external frontend manually.

Parameters:

<Attenuation> Range: see specifications document
 Increment: 1 dB
 Default unit: DB

Manual operation: See ["Attenuation Mode / Value"](#) on page 138

INPut:SANalyzer:ATTenuation:AUTO <State>

Enables or disables automatic configuration of attenuation at the analyzer input for an active external frontend.

By default, the attenuation settings are applied at the input of the external frontend.

See [INPut:ATTenuation:AUTO](#) on page 357 and [INPut:ATTenuation](#) on page 356.

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Auto mode for analyzer attenuation is disabled. Allows you to configure attenuation at the analyzer using [INPut:SANalyzer:ATTenuation](#) on page 359.
ON | 1
 Auto mode for analyzer attenuation is enabled. No attenuation is configured at the analyzer.
 *RST: 0

Example:

```
//Enable external frontend
EFR ON
//Query the currently configured RF attenuation
INP:ATT?
//Result: 10 dB
//Disable auto mode for analyzer attenuation
INP:SAN:ATT:AUTO OFF
//Configure 10 dB attenuation at the analyzer
INP:SAN:ATT 10
//Query the currently configured RF attenuation at the ext. FE
INP:ATT?
//Result: 0 dB
```

Manual operation: See "[Attenuation Mode / Value](#)" on page 138

[SENSe:]IQ:WBANd <State>

Selects the signal path for signal processing.

For details and restrictions, see "[Signal Path](#)" on page 139.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The narrowband signal path is used.

ON | 1
The wideband signal path is used.

*RST: 0

Example: SENS:IQ:WBAN ON

Manual operation: See "[Signal Path](#)" on page 139

11.4.2.3 Configuring a preamplifier

INPut:EGAIN[:]STATe]	360
INPut:GAIN:STATe]	361
INPut:GAIN[:]VALue]	362

INPut:EGAIN[:]STATe] <State>

Before this command can be used, the external preamplifier must be connected to the FSW. See the preamplifier's documentation for details.

When activated, the 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 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.

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 141

INPut:GAIN:STATe <State>

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.

Is not available for input from the optional "Digital Baseband" interface.

For FSW85 models, no preamplifier is available.

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.

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 140

INPut:GAIN[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (INP:GAIN:STAT ON, see INPut:GAIN:STATe on page 361).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> For all FSW models except for FSW85, the following settings are available:
15 dB and 30 dB
All other values are rounded to the nearest of these two.
30 dB
For older FSW43/FSW50/FSW67 models, the input signal is always amplified by about 30 dB when the preamplifier is active.
For FSW85 models, no preamplifier is available.
Default unit: DB

Example: INP:GAIN:STAT ON
INP:GAIN:VAL 30
Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 140

11.4.2.4 Scaling the Y-axis

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe].....	362
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE.....	363
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE.....	363
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision.....	363
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition.....	364
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing.....	364

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe] <Range>

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
<w> subwindow
Not supported by all applications
<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 145
See "Y-Axis Max" on page 145

DISPlay[:WINDow<n>][:SUBWindow<w>]: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>

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 145

**DISPlay[:WINDow<n>][:SUBWindow<w>]: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
<w> subwindow
Not supported by all applications
<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>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition
 <Position>

Defines the vertical position of the reference level on the display grid (for all traces).

The 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](#)
 <w> subwindow
 Not supported by all applications
 <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 "[Ref Level Position](#)" on page 145

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing <ScalingType>

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 145

11.4.3 Frequency

<code>CALCulate<n>:MARKer<m>:FUNction:CENTer</code>	365
<code>[SENSe:]FREQuency:CENTer</code>	365
<code>[SENSe:]FREQuency:CENTer:STEP</code>	366
<code>[SENSe:]FREQuency:CENTer:STEP:AUTO</code>	366
<code>[SENSe:]FREQuency:OFFSet</code>	366

`CALCulate<n>:MARKer<m>:FUNction:CENTer`

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 200

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

Defines the center frequency.

Parameters:<Frequency> For the allowed range and f_{max} , refer to the specifications document.*RST: $f_{max}/2$

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 119
See ["Center Frequency"](#) on page 146

[SENSe:]FREQuency:CENTer:STEP <StepSize>

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 365.

Parameters:

<StepSize> For f_{max} , refer to the specifications document.
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 146

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

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>

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 147.

Note: In MSRA/MSRT mode, the setting command is only available for the MSRA/MSRT primary application. For MSRA/MSRT secondary 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 147

11.4.4 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 147.



*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.

- [Configuring the triggering conditions](#).....367
- [Configuring the trigger output](#).....374
- [Configuring I/Q gating](#)..... 377

11.4.4.1 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 349

Remote commands exclusive to configuring triggers:

<code>TRIGger[:SEquence]:CTPis</code>	368
<code>TRIGger[:SEquence]:DTIME</code>	368
<code>TRIGger[:SEquence]:HOLDoff[:TIME]</code>	369
<code>TRIGger[:SEquence]:IFPower:HOLDoff</code>	369
<code>TRIGger[:SEquence]:IFPower:HYSteresis</code>	369
<code>TRIGger[:SEquence]:LEVel:BBPower</code>	370
<code>TRIGger[:SEquence]:LEVel[:EXternal<port>]</code>	370
<code>TRIGger[:SEquence]:LEVel:IFPower</code>	370
<code>TRIGger[:SEquence]:LEVel:IQPower</code>	371
<code>TRIGger[:SEquence]:LEVel:RFPower</code>	371
<code>TRIGger[:SEquence]:SLOPe</code>	371
<code>TRIGger[:SEquence]:SOURce</code>	372
<code>TRIGger[:SEquence]:TIME:RINTerval</code>	374

TRIGger[:SEQuence]:CTPis <State>

The trigger event is set to the actual trigger point within the sample (TPIS). See also [TRACe:IQ:TPISample?](#) on page 386.

This setting is available for all trigger sources except "Free Run".

This setting only becomes effective for the next new measurement.

TPIS correction is not supported if user frequency response correction (R&S FSW-K544) is active. If you activate frequency response correction, TPIS correction is automatically deactivated in all channels.

For details see frequency response correction in the FSW user manual.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on
 *RST: 0

Example:

```
// Query the current trigger offset within the sample
TRAC:IQ:TPIS?
//Result: 0.000002
//Correct the trigger event
TRIG:CTP ON
//Start a new measurement
INIT:IMM; *WAI
//Query the trigger offset within the sample again
TRAC:IQ:TPIS?
//Result: 0.000000
```

Manual operation: See ["Correct TPIS"](#) on page 155

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 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 154

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 154

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

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 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 155

TRIGger[:SEQuence]:IFPower:HYSteresis <Hysteresis>

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 155

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

Sets the level of the baseband power trigger.

Is available for the optional "Digital Baseband" interface.

Is available for 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 153

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

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 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 153

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

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.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths, see the specifications document.

*RST: -20 dBm
Default unit: DBM

Example: TRIG:LEV:IFP -30DBM

Manual operation: See "[Trigger Level](#)" on page 153

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

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 153

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

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 specifications document.

*RST: -20 dBm
Default unit: DBM

Example: TRIG:LEV:RFP -30dBm

Manual operation: See "[Trigger Level](#)" on page 153

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 155

TRIGger[:SEQUence]:SOURce <Source>

Selects the trigger source.

For details on trigger sources, see "[Trigger Source](#)" on page 149.

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 that 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 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 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 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 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 "Analog Baseband" interface.

Not available for input from the optional "Digital 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.

TIME

Time interval

VIDeo

Video mode is available in the time domain and only in the Spectrum application.

BBPower

Baseband power

For input from the optional "Analog Baseband" interface.

For input from the optional "Digital 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 149
 See ["Free Run"](#) on page 149
 See ["External Trigger 1/2/3"](#) on page 149
 See ["External Channel 3"](#) on page 150
 See ["External Analog"](#) on page 150
 See ["IF Power"](#) on page 150
 See ["Baseband Power"](#) on page 151
 See ["I/Q Power"](#) on page 151
 See ["Digital I/Q"](#) on page 152
 See ["RF Power"](#) on page 152
 See ["Power Sensor"](#) on page 153
 See ["Time"](#) on page 153

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

Defines the repetition interval for the time trigger.

Parameters:

<Interval> numeric value
 Range: 2 ms to 5000 s
 *RST: 1.0 s
 Default unit: S

Example:

TRIG:SOUR TIME
 Selects the time trigger input for triggering.
 TRIG:TIME:RINT 5
 The sweep starts every 5 s.

Manual operation: See ["Repetition Interval"](#) on page 153

11.4.4.2 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 FSW.

OUTPut:TRIGger<tp>:DIRection	374
OUTPut:TRIGger<tp>:LEVel	375
OUTPut:TRIGger<tp>:OTYPe	375
OUTPut:TRIGger<tp>:PULSe:IMMediate	376
OUTPut:TRIGger<tp>:PULSe:LENGth	376

OUTPut:TRIGger<tp>:DIRection <Direction>

Selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:
 <tp> Selects the used trigger port.
 2 = trigger port 2 (front)
 (Not available for 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 156

OUTPut:TRIGger<tp>:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with [OUTPut:TRIGger<tp>:OTYPe](#).

Suffix:
 <tp> 1..n
 Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 (Not available for 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 157

OUTPut:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

Suffix:
 <tp> 1..n
 Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 (Not available for FSW85 models with two RF input connectors.)
 3 = trigger port 3 (rear)

Parameters:
 <OutputType>

DEvice
 Sends a trigger signal when the FSW has triggered internally.

TARMed
 Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
 Sends a user-defined trigger signal. For more information, see [OUTPut:TRIGger<tp>:LEVel](#).

*RST: DEvice

Manual operation: See "[Output Type](#)" on page 156

OUTPut:TRIGger<tp>:PULSe:IMMediate

Generates a pulse at the trigger output.

Suffix:
 <tp> 1..n
 Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 (Not available for FSW85 models with two RF input connectors.)
 3 = trigger port 3 (rear)

Manual operation: See "[Send Trigger](#)" on page 157

OUTPut:TRIGger<tp>:PULSe:LENGth <Length>

Defines the length of the pulse generated at the trigger output.

Suffix:
 <tp> Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 (Not available for 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 157

11.4.4.3 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.

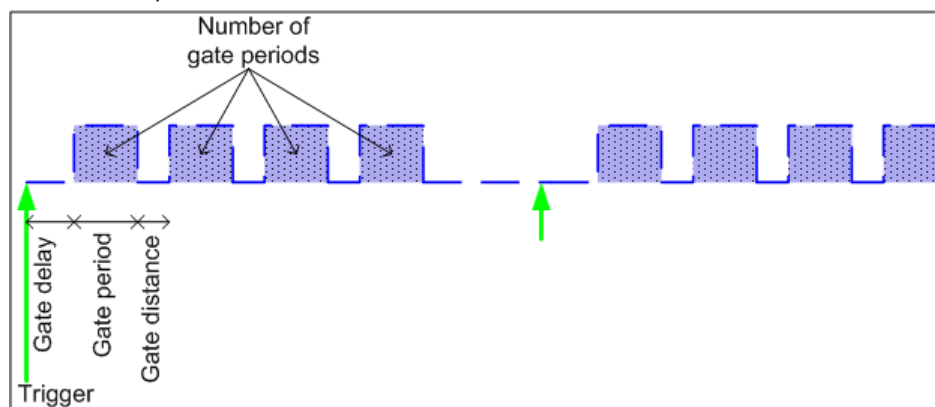


I/Q gating is only available using remote commands; manual configuration is not possible.

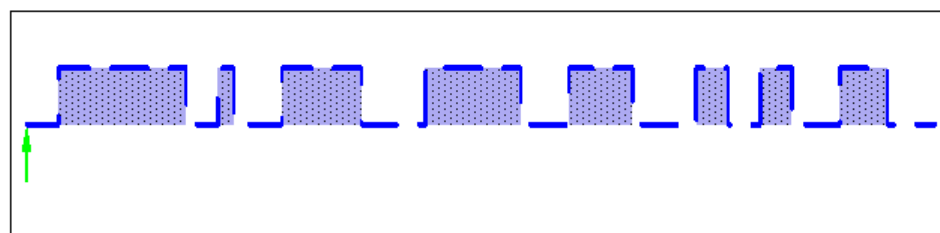
It is only possible up to a bandwidth of 28 MHz.

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 384) for all available trigger sources, except for "Free Run".

TRACe:IQ:EGATe[:STATE] <State>

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>

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>

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 11.4.4.3, "Configuring I/Q gating"](#), on page 377.

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>

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>

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> **LEVeI**
 EDGE
 *RST: EDGE

Example: TRAC:IQ:EGAT:TYPE LEV

11.4.5 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 primary 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 11.7.4, "Configuring an analysis interval and line \(MSRA mode only\)"](#), on page 466.

For more commands related to the MSRT operating mode see [Chapter 11.7.5, "Configuring an analysis interval and line \(MSRT mode only\)"](#), on page 469.

Useful commands for I/Q data acquisition described elsewhere

- [SENSe:]SWEep:COUNT on page 405
- [SENSe:]SWEep[:WINDow<n>]:POINTs on page 406
- [SENSe:]SWEep:TIME on page 406

Remote commands exclusive to I/Q data acquisition

[SENSe:]IQ:BANDwidth:MODE.....	380
[SENSe:]IQ:BWIDth:MODE.....	380
[SENSe:]IQ:BANDwidth:RESolution.....	380
[SENSe:]IQ:BWIDth:RESolution.....	380
[SENSe:]IQ:FFT:ALGorithm.....	381
[SENSe:]IQ:FFT:LENGth.....	381
[SENSe:]IQ:FFT:WINDow:LENGth.....	381
[SENSe:]IQ:FFT:WINDow:OVERlap.....	382
[SENSe:]IQ:FFT:WINDow:TYPE.....	382
[SENSe:]SWAPiq.....	383
TRACe:IQ:BWIDth.....	383
TRACe:IQ:DIQFilter.....	383
TRACe:IQ:M9933:STATe.....	384

TRACe:IQ:RLENgth.....	384
TRACe:IQ:SET.....	384
TRACe:IQ:SRATe.....	386
TRACe:IQ:TPISample?.....	386
TRACe:IQ:WBANd[:STATe].....	387
TRACe:IQ:WBANd:MBWIdth.....	387
TRACe:IQ:WFILter.....	388

[SENSe:]IQ:BANDwidth:MODE <Mode>

[SENSe:]IQ:BWIDth:MODE <Mode>

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 162

[SENSe:]IQ:BANDwidth:RESolution <Bandwidth>

[SENSe:]IQ:BWIDth:RESolution <Bandwidth>

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 5.11.4, "Frequency resolution of FFT results - RBW"](#), on page 84.

Parameters:

<Bandwidth> refer to specifications document

*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 162

[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 163

[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 163

[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 4096
 *RST: record length

Example: IQ:FFT:WIND:LENG 500

Manual operation: See "[Window Length](#)" on page 164

[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 164

[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 164

[SENSe:]SWAPiq <State>

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 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 162

TRACe:IQ:BWIDth

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 25.

Default unit: HZ

Manual operation: See "[Analysis Bandwidth](#)" on page 159

TRACe:IQ:DIQFilter <State>

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:DIQ:SRATe](#) on page 291).

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 161

TRACe:IQ:M9933:STATe <State>

Enables the optional analysis bandwidth extensions B6001/B8001, if available, for a center frequency of 9.993 GHz.

Note the restrictions described in "[Bandwidth extension options B6001 / B8001 at CF 9.933 GHz](#)" on page 44.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on
 *RST: 0

Example: FREQuency:CENTer 9933000
 TRACe:IQ:M9933:STATe ON

Manual operation: See "[9.933 GHz Mode](#)" on page 161

TRACe:IQ:RLENgth <NoOfSamples>

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 25.
 For digital input via the "Digital Baseband" interface (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 48.
 *RST: 1001

Example: TRAC:IQ:RLEN 256

Manual operation: See "[Record Length](#)" on page 162

TRACe:IQ:SET <NORM>, <0>, <SampleRate>, <TriggerMode>, <TriggerSlope>, <PretriggerSamp>, <NumberSamples>

Sets up the FSW for I/Q measurements.

If you do not use this command to set up I/Q measurements, the 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 147. You can set the trigger level with `TRIGger[:SEquence]:LEVel:IFPower`. For details on trigger parameters see [Chapter 11.4.4, "Triggering"](#), on page 367.

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 25. For digital input via the "Digital Baseband" interface (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 48. *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 162

TRACe:IQ:SRATe <SampleRate>

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 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 25.

In order to ensure a minimum usable I/Q bandwidth use the [TRACe:IQ:WBANd:MBWidth](#) on page 387 command.

Parameters:

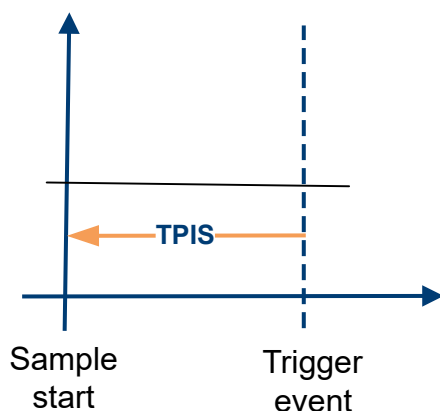
<SampleRate> The valid sample rates are described in [Chapter 5.1.1, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 25.

*RST: 32 MHz
Default unit: HZ

Manual operation: See "[Sample Rate](#)" on page 159

TRACe:IQ:TPISample?

Queries the time offset from the sample start to the trigger event (trigger point in sample = TPIS). Since the 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 (downsampled) data in the application. Thus, the TPIS indicates the offset from the sample start to the actual trigger event.



This value can only be determined in triggered measurements using external or IFPower triggers, otherwise the value is 0.

Is not available if the "Digital Baseband" interface (FSW-B17) is active.

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 μ s (the duration of 1 sample).

Usage:

Query only

TRACe:IQ:WBAND[:STATE] <State>

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 160

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 25).

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 25).
`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 160

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 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 161

11.4.6 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 168.



MSRA operating mode

In MSRA operating mode, settings related to data acquisition (measurement time, hysteresis) can only be adjusted automatically in the MSRA primary application, not in the MSRA secondary applications.

[SENSe:]ADJust:ALL.....	389
[SENSe:]ADJust:CONFigure:LEVel:DURation.....	389
[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE.....	390
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer.....	390
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer.....	391
[SENSe:]ADJust:CONFigure:TRIGger.....	391
[SENSe:]ADJust:FREQuency.....	391
[SENSe:]ADJust:LEVel.....	392

[SENSe:]ADJust:ALL

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 169

[SENSe:]ADJust:CONFigure:LEVel:DURation <Duration>

To determine the ideal reference level, the 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 \(Meas Time Manual\)"](#) on page 170

[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the FSW performs a measurement on the current input data. This command selects the way the FSW determines the length of the measurement .

Parameters:

<Mode>

AUTO

The FSW determines the measurement length automatically according to the current input data.

MANual

The FSW uses the measurement length defined by [\[SENSe:\]ADJust:CONFigure:LEVel:DURation](#) on page 389.

*RST: AUTO

Manual operation: See ["Resetting the Automatic Measurement Time \(Meas Time Auto\)"](#) on page 170
See ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 170

[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. 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 is only adjusted when the signal level falls below 18 dBm.

Manual operation: See ["Lower Level Hysteresis"](#) on page 170

[SENSe:]ADJust:CONFigure:HYSTerisis: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. 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 is only adjusted when the signal level rises above 22 dBm.

Manual operation: See "[Upper Level Hysteresis](#)" on page 170

[SENSe:]ADJust:CONFigure:TRIGger <State>

Defines the behavior of a triggered measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

See "[Adjusting settings automatically during triggered measurements](#)" on page 169.

Parameters:

<State> ON | OFF | 0 | 1
 ON | 1
 (default:) The measurement for adjustment waits for the next trigger.
 OFF | 0
 The measurement for adjustment is performed without waiting for a trigger (corresponds to "Continue" in manual operation).
 *RST: 0

Example:

```
//Use default ref level at 0.00 dBm.
//Define an RF power trigger at -20 dBm
:TRIG:SEQ:SOUR RFP
:TRIG:SEQ:LEV:RFP -20
//Perform adjustment measurement without waiting for trigger
SENS:ADJ:CONF:TRIG OFF
//Perform auto level adjustment
:SENS:ADJ:LEV;*WAI
```

[SENSe:]ADJust:FREQuency

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 169

[SENSe:]ADJust:LEVel

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The FSW is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

Example: ADJ:LEV

Manual operation: See ["Setting the Reference Level Automatically \(Auto Level\)"](#) on page 137

11.5 Configuring the result display

The commands required to configure the screen display in a remote environment are described here.

- [General window commands](#).....392
- [Working with windows in the display](#).....393

11.5.1 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\[:SELection\]](#) on page 256).

DISPlay:FORMat	392
DISPlay[:WINDow<n>]:SIZE	393

DISPlay:FORMat <Format>

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>

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 397).

Suffix:

<n> [Window](#)

Parameters:

<Size>

LARGE

Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALI

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: SMALI

Example:

DISP:WIND2:SIZE LARG

11.5.2 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 256).

LAYout:ADD[:WINDow]?	393
LAYout:CATalog[:WINDow]?	395
LAYout:IDENtify[:WINDow]?	395
LAYout:MOVE[:WINDow]	396
LAYout:REMove[:WINDow]	396
LAYout:REPLace[:WINDow]	396
LAYout:SPLitter	397
LAYout:WINDow<n>:ADD?	398
LAYout:WINDow<n>:IDENtify?	399
LAYout:WINDow<n>:REMove	399
LAYout:WINDow<n>:REPLace	399
LAYout:WINDow<n>:TYPE	400

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel.

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 <code>LAYout:CATalog[:WINDow]?</code> 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 "[Phase vs. Time](#)" on page 20
 See "[Marker Table](#)" on page 20
 See "[Marker Peak List](#)" on page 21

Table 11-4: <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"
PHASe	"Phase vs. time"
RECORDing	"I/Q 40G Recording" window providing "Insert Marker" function
RIMAG	"Real/Imag (I/Q)"
VECT	"I/Q Vector"

Parameter value	Window type
Frequency and time domain measurements:	
DIAGram	"Diagram"
MTABle	"Marker table"
PEAKlist	"Marker peak list"
RSUMmary	"Result summary"

LAYout:CATalog[:WINDow]?

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>

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:IDEN:WIND? '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>

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>

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 393 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>

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 does not work, but does not return an error.

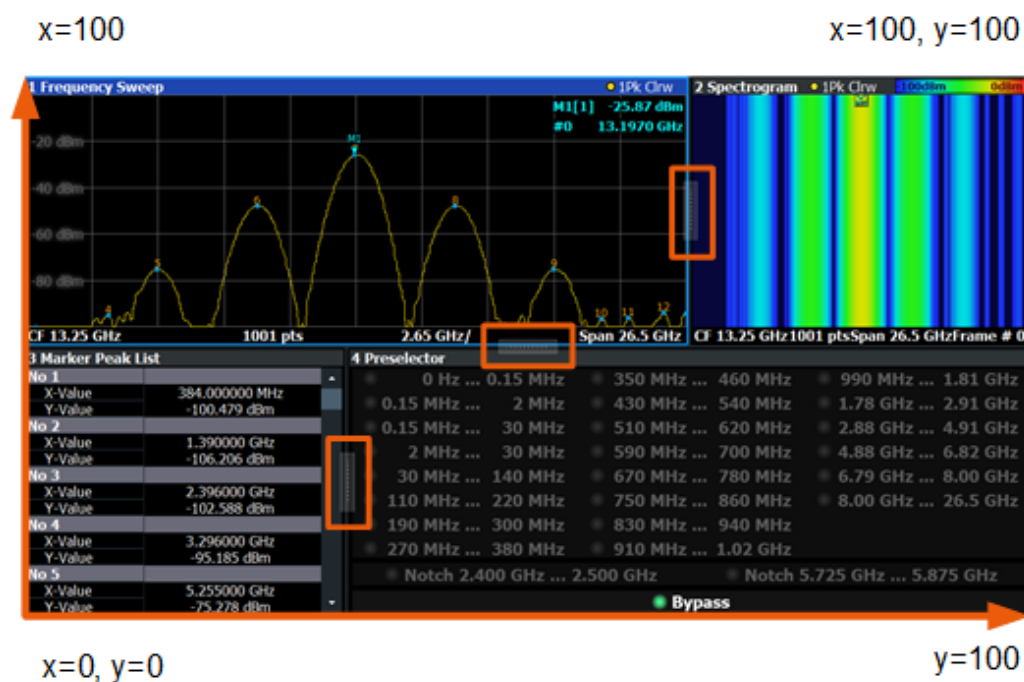


Figure 11-1: SmartGrid coordinates for remote control of the splitters

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>	<p>New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).</p> <p>The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 11-1.)</p> <p>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.</p> <p>Range: 0 to 100</p>
Example:	<pre>LAY:SPL 1,3,50</pre> <p>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.</p>
Example:	<pre>LAY:SPL 1,4,70</pre> <p>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.</p> <pre>LAY:SPL 3,2,70 LAY:SPL 4,1,70 LAY:SPL 2,1,70</pre>
Usage:	Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

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. Unlike [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.

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 393 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?

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

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>

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 393 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

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see [LAYout:ADD\[:WINDow\]?](#) on page 393.

Note that this command is not available in all applications and measurements.

Suffix:	
<n>	1..n Window

Parameters:
<WindowType>

Example: LAY:WIND2:TYPE?

11.6 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 473)
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 475)
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 primary 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	401
INITiate<n>:CONMeas	402
INITiate<n>:CONTinuous	402
INITiate<n>[:IMMEDIATE]	403
INITiate:SEQuencer:ABORT	403
INITiate:SEQuencer:IMMEDIATE	404
INITiate:SEQuencer:MODE	404
INITiate:SEQuencer:REFResh[:ALL]	404
[SENSe:]SWEep:COUNT	405
[SENSe:]SWEep:COUNT:CURRent?	405
[SENSe:]SWEep[:WINDow<n>]:POINts	406
[SENSe:]SWEep:TIME	406
SYSTem:SEQuencer	406

ABORT

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 ABORT and before the next command.

For details on overlapping execution see [Remote control via SCPI](#).

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 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 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

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.
-----------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Usage: Asynchronous command

Manual operation: See "[Continue Single Sweep](#)" on page 167

INITiate<n>:CONTinuous <State>

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 [Remote control via SCPI](#).

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 (some applications can differ)

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 166

INITiate<n>[:IMMediate]

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 [Remote control via SCPI](#).

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.

Usage:

Asynchronous command

Manual operation: See "[Single Sweep / Run Single](#)" on page 166

INITiate:SEQuencer:ABORt

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

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 406).

Example:

```
SYST:SEQ ON
Activates the Sequencer.
INIT:SEQ:MODE SING
Sets single sequence mode so each active measurement is 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: To synchronize to the end of a measurement sequence using `*OPC`, `*OPC?` or `*WAI`, use `SINGle` Sequencer 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]

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 secondary 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>

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 166

[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 165

[SENSe:]SWEep:TIME <Time>

Defines the sweep time. It automatically decouples the time from any other settings.

Parameters:

<Time> refer to specifications document
 *RST: depends on current settings (determined automatically)
 Default unit: S

Manual operation: See "[Meas Time](#)" on page 162

SYSTem:SEQuencer <State>

Turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error occurs.

A detailed programming example is provided in the "Operating Modes" chapter in the 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 is
performed once.
INIT:SEQ:IMM
Starts the sequential measurements.
SYST:SEQ OFF

```

11.7 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.

- [Configuring standard traces](#).....407
- [Configuring spectrograms](#).....415
- [Using markers](#).....423
- [Configuring an analysis interval and line \(MSRA mode only\)](#).....466
- [Configuring an analysis interval and line \(MSRT mode only\)](#).....469

11.7.1 Configuring standard traces

Useful commands for trace configuration described elsewhere

- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:Y:SPACing](#)
on page 364
- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:Y\[:SCALe\]](#)
on page 362

Remote commands exclusive to trace configuration

DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe]	408
DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT	408
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE	409
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONTinuous	410
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PRESet	410
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]	411
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture	411
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]	412
[SENSe:]AVERAge<n>:TYPE	412
[SENSe:][:WINDow<n>:]DETector<t>[:FUNCTion]	413
[SENSe:][:WINDow<n>:]DETector<t>[:FUNCTion]:AUTO	413
TRACe<n>:COPY	413
[SENSe:]AVERAge<n>:COUNT	414
TRACe:IQ:AVERAge:COUNT	414

[SENSe:]AVERAge<n>[:STATe<t>].....	414
TRACe:IQ:AVERAge[:STATe].....	414

DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] <State>

Turns on the display of a descriptive label for the specified trace instead of the default "Trace <x>" label.

Define the label using the `DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT` command.

You can only configure labels for active traces and for traces whose "State" is enabled.

Suffix:

<n>	1..n Window
<t>	1..n Trace

Parameters:

<State>	OFF Switch the function off
	ON Switch the function on
*RST:	OFF

Example: `DISP:WIND2:TRAC1:LAB ON`
`DISP:WIND2:TRAC1:LAB:TEXT 'MaxTrace'`

Manual operation: See "[Trace Labels](#)" on page 177

DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT <Text>

Defines a descriptive label for the specified trace instead of the default "Trace <x>" label.

Enable the label using the `DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe]` command.

You can only configure labels for active traces and for traces whose "State" is enabled.

Suffix:

<n>	1..n Window
<t>	1..n Trace

Parameters:

<Text>	String containing the trace label.
--------	------------------------------------

Example: `DISP:WIND2:TRAC1:LAB ON`
`DISP:WIND2:TRAC1:LAB:TEXT 'MaxTrace'`

Manual operation: See "[Trace Labels](#)" on page 177

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE <Mode>

Selects the trace mode. If necessary, the selected trace is also activated.

For 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
<w>	subwindow Not supported by all applications
<t>	Trace

Parameters:

<Mode>

WRITE

(default:) Overwrite mode: the trace is overwritten by each sweep.

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 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 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 174

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous
 <State>

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 176

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>

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 174
 See "[Trace 1/ Trace 2/ Trace 3/ Trace 4 \(Softkeys\)](#)" on page 177

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture
 <Aperture>**

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 176

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe] <State>

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 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 176

[SENSe:]AVERAge<n>:TYPE <Mode>

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 176

[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

SAMPIe
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 175

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNcTion]:AUTO <State>

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 175

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

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 177

[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.
```

11.7.2 Configuring spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the 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 178.



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 11.7.3.4, "Marker search \(spectrograms\)"](#), on page 436.

11.7.2.1	Configuring a spectrogram measurement.....	415
11.7.2.2	Configuring the color map.....	421

11.7.2.1 Configuring a spectrogram measurement

CALCulate<n>:SGRam:CLEAR[:IMMEDIATE]	416
CALCulate<n>:SPECtrogram:CLEAR[:IMMEDIATE]	416
CALCulate<n>:SGRam:CONTinuous	416
CALCulate<n>:SPECtrogram:CONTinuous	416
CALCulate<n>:SGRam:FRAME:COUNT	416
CALCulate<n>:SPECtrogram:FRAME:COUNT	416
CALCulate<n>:SGRam:FRAME:SElect	417
CALCulate<n>:SPECtrogram:FRAME:SElect	417
CALCulate<n>:SGRam:HDEPTH	417
CALCulate<n>:SPECtrogram:HDEPTH	417
CALCulate<n>:SGRam:LAYout	418
CALCulate<n>:SPECtrogram:LAYout	418
CALCulate<n>:SGRam[:STATe]	418
CALCulate<n>:SPECtrogram[:STATe]	418
CALCulate<n>:SGRam:THReedim[:STATe]	419
CALCulate<n>:SPECtrogram:THReedim[:STATe]	419
CALCulate<n>:SGRam:TRACe	419
CALCulate<n>:SPECtrogram:TRACe	419

CALCulate<n>:SGRam:TSTamp:DATA?.....	419
CALCulate<n>:SPECtrogram:TSTamp:DATA?.....	419
CALCulate<n>:SGRam:TSTamp[:STATe].....	420
CALCulate<n>:SPECtrogram:TSTamp[:STATe].....	420

CALCulate<n>:SGRam:CLEar[:IMMediate]**CALCulate<n>:SPECtrogram:CLEar[:IMMediate]**

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 168

CALCulate<n>:SGRam:CONTInuous <State>**CALCulate<n>:SPECtrogram:CONTInuous <State>**

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 167

CALCulate<n>:SGRam:FRAME:COUNt <Frames>**CALCulate<n>:SPECtrogram:FRAME:COUNt <Frames>**

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 168

CALCulate<n>:SGRam:FRAM:SElect <Frame> | <Time>
CALCulate<n>:SPECTrogram:FRAM:SElect <Frame> | <Time>

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 167

CALCulate<n>:SGRam:HDEPth <History>
CALCulate<n>:SPECTrogram:HDEPth <History>

Defines the number of frames to be stored in the 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 180

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 179

CALCulate<n>:SGRam[:STATe] <State>

CALCulate<n>:SPECtrogram[:STATe] <State>

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 180

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>

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>	<p>CURRent Returns the starting time of the current frame.</p> <p>ALL Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.</p>
Return values:	
<Seconds>	Number of seconds that have passed since 01.01.1970 until the frame start
<Nanoseconds>	Number of nanoseconds that have passed <i>in addition to the</i> <Seconds> since 01.01.1970 until the frame start.
<Reserved>	The third value is reserved for future uses.
<Reserved>	The fourth value is reserved for future uses.
Example:	<p>CALC:SGR:TST:DATA? ALL</p> <p>Returns the starting times of all frames sorted in a descending order.</p>
Usage:	Query only
Manual operation:	See " Time Stamp " on page 181

CALCulate<n>:SGRam:TSTamp[:STATE] <State>
CALCulate<n>:SPECTrogram:TSTamp[:STATE] <State>

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 441
- [CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe](#) on page 437
- [CALCulate<n>:SPECTrogram:FRAMe:SELEct](#) on page 417

Suffix:	
<n>	1..n Window
Parameters:	
<State>	<p>ON OFF 0 1</p> <p>OFF 0 Switches the function off</p> <p>ON 1 Switches the function on</p>
Example:	<p>//Activates the time stamp</p> <p>CALC:SGR:TST ON</p>

Manual operation: See "Time Stamp" on page 181

11.7.2.2 Configuring the color map

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault.....	421
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault.....	421
DISPlay[:WINDow<n>]:SGRam:COLor:LOWer.....	421
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer.....	421
DISPlay[:WINDow<n>]:SGRam:COLor:SHAPE.....	421
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE.....	421
DISPlay[:WINDow<n>]:SGRam:COLor:UPPer.....	422
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer.....	422
DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe].....	422
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe].....	422

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault

DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

Restores the original color map.

Suffix:

<n> Window

Manual operation: See "Set to Default" on page 183

DISPlay[:WINDow<n>]:SGRam:COLor:LOWer <Percentage>

DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

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 183

DISPlay[:WINDow<n>]:SGRam:COLor:SHAPE <Shape>

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE <Shape>

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 183

DISPlay[:WINDow<n>]:SGRam:COLor:UPPer <Percentage>

DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

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 183

DISPlay[:WINDow<n>]:SGRam:COLor[:STYLE] <ColorScheme>

DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLE] <ColorScheme>

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 183

11.7.3 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.

- [Setting up individual markers](#)..... 423
- [General marker settings](#)..... 430
- [Configuring and performing a marker search](#)..... 431
- [Marker search \(spectrograms\)](#)..... 436
- [Positioning the marker](#)..... 444
- [Band power marker](#)..... 451
- [Marker peak lists](#)..... 454
- [Measuring the time domain power](#)..... 458

11.7.3.1 Setting up individual markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker<m>:AOFF	423
CALCulate<n>:DELTamarker<m>:LINK	424
CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>	424
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>	425
CALCulate<n>:DELTamarker<m>:MODE	425
CALCulate<n>:DELTamarker<m>:MREFerence	426
CALCulate<n>:DELTamarker<m>[:STATe]	426
CALCulate<n>:DELTamarker<m>:TRACe	426
CALCulate<n>:DELTamarker<m>:X	427
CALCulate<n>:MARKer<m>:AOFF	427
CALCulate<n>:MARKer<ms>:LINK:TO:DELTa<md>	427
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>	428
CALCulate<n>:MARKer<m>[:STATe]	428
CALCulate<n>:MARKer<m>:TRACe	429
CALCulate<n>:MARKer<m>:X	429

CALCulate<n>:DELTamarker<m>:AOFF

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>

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 190

CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md> <State>

Links the delta source marker <ms> to any active destination delta marker <md>.

If you change the horizontal position of marker <md>, marker <ms> 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:DELT2:LINK:TO:DELT3 ON`
Links D2 and D3.

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

In I/Q Analyzer mode, if <md> is the reference marker for the delta marker <ms>, the relative distance (delta) between the two markers is maintained when you move the normal marker.

In other applications, the delta marker is set to the same horizontal position as the marker <md>, and if <md> is moved along the x-axis, <ms> follows to the same horizontal position.

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 190

CALCulate<n>:DELTamarker<m>:MODE <Mode>

Defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker. Note that this setting applies to *all* windows.

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 427)!

Suffix:

<n>	irrelevant
<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>

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 190

CALCulate<n>:DELTamarker<m>[:STATE] <State>

Turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTmarker 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 189
See ["Marker Type"](#) on page 190
See ["Select Marker"](#) on page 191

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

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>

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 190

CALCulate<n>:MARKer<m>:AOFF

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 191

CALCulate<n>:MARKer<ms>:LINK:TO:DELTa<md> <State>

Links the normal source marker <ms> to any active delta destination marker <md>.

If you change the horizontal position of marker <md>, marker <ms> 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:DELT2 ON
Links marker 4 to delta marker 2.

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> 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 190

CALCulate<n>:MARKer<m>[:STATe] <State>

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 189
 See "[Marker Type](#)" on page 190
 See "[Select Marker](#)" on page 191

CALCulate<n>:MARKer<m>:TRACe <Trace>

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 191

CALCulate<n>:MARKer<m>:X <Position>

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 20
See "[Marker Peak List](#)" on page 21
See "[Marker Position X-value](#)" on page 190

11.7.3.2 General marker settings

The following commands control general marker functionality.

Remote commands exclusive to general marker functionality

DISPlay[:WINDow<n>]:MTABle.....	430
DISPlay[:WINDow<n>]:MINFo[:STATe].....	430
CALCulate<n>:MARKer<m>:X:SSIZe.....	431

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

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 192

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

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 192

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

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 193

11.7.3.3 Configuring and performing a marker search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:LOEXclude	431
CALCulate<n>:MARKer<m>:PEXCursion	432
CALCulate<n>:MARKer<m>:SEARCh	432
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]	433
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT	433
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT	434
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe]	434
CALCulate<n>:THReshold	435
CALCulate<n>:THReshold:STATe	435

CALCulate<n>:MARKer<m>:LOEXclude <State>

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 195

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

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 195

CALCulate<n>:MARKer<m>:SEARCh <MarkReallmag>

Selects the trace type a marker search is performed on.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<MarkReallmag> **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 196

CALCulate<n>:MARKer<m>:X:SLIMits[:STATE] <State>

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 195
See ["Search Limits Off"](#) on page 196
See ["Limit State"](#) on page 210

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

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 195
See ["Left Limit / Right Limit"](#) on page 210

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>

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 195
See ["Left Limit / Right Limit"](#) on page 210

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

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 196

CALCulate<n>:THReshold <Level>

Defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Note that you must enable the use of the threshold using [CALCulate<n>:THReshold:STATe](#) on page 435.

Suffix:

<n> irrelevant

Parameters:

<Level> Numeric value. The value range and unit are variable.
 *RST: -120 dBm
 Default unit: DBM

Example:

CALC:THR:STAT ON

Example:

CALC:THR -82DBM
 Enables the search threshold and sets the threshold value to -82 dBm.

Manual operation: See ["Search Threshold"](#) on page 196

CALCulate<n>:THReshold:STATe <State>

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 ["Search Threshold"](#) on page 196
See ["Search Limits Off"](#) on page 196

11.7.3.4 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 445
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 446
- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 446
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHT` on page 446
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 447
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 447
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 447
- `CALCulate<n>:MARKer<m>:MINimum:RIGHT` on page 448

Remote commands exclusive to spectrogram markers

<code>CALCulate<n>:MARKer<m>:SGRam:FRAME</code>	437
<code>CALCulate<n>:MARKer<m>:SPEctrogram:FRAME</code>	437
<code>CALCulate<n>:MARKer<m>:SGRam:SARea</code>	437
<code>CALCulate<n>:MARKer<m>:SPEctrogram:SARea</code>	437
<code>CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]</code>	438
<code>CALCulate<n>:MARKer<m>:SPEctrogram:XY:MAXimum[:PEAK]</code>	438
<code>CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]</code>	438
<code>CALCulate<n>:MARKer<m>:SPEctrogram:XY:MINimum[:PEAK]</code>	438
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVE</code>	438
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:ABOVE</code>	438
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELOW</code>	438
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:BELOW</code>	438
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT</code>	438
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:NEXT</code>	438
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]</code>	439
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum[:PEAK]</code>	439
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVE</code>	439
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:ABOVE</code>	439
<code>CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELOW</code>	439
<code>CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:BELOW</code>	439

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT.....	440
CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT.....	440
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK].....	440
CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum[:PEAK].....	440

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame>

CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe <Frame> | <Time>

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 190

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>

CALCulate<n>:MARKer<m>:SPECTrogram:SARea <SearchArea>

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 198

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECTrogram:XY:MAXimum[:PEAK]

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]

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

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELOW
CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:BELOW

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:NEXT

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum[:PEAK]

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

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELOW

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:BELOW

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT

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 197

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum[:PEAK]

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 448
- [CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 449
- [CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 449
- [CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 449
- [CALCulate<n>:DELTamarker<m>:MINimum:LEFT](#) on page 449
- [CALCulate<n>:DELTamarker<m>:MINimum:NEXT](#) on page 450
- [CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 450
- [CALCulate<n>:DELTamarker<m>:MINimum:RIGHT](#) on page 450

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe	441
CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAMe	441
CALCulate<n>:DELTamarker<m>:SGRam:SARea	442

CALCulate<n>:DELTamarker<m>:SPECTrogram:SARea.....	442
CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK].....	442
CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MAXimum[:PEAK].....	442
CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK].....	442
CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MINimum[:PEAK].....	442
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe.....	442
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:ABOVe.....	442
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow.....	443
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:BELow.....	443
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT.....	443
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:NEXT.....	443
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK].....	443
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum[:PEAK].....	443
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe.....	443
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:ABOVe.....	443
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow.....	444
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELow.....	444
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT.....	444
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT.....	444
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK].....	444
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum[:PEAK].....	444

CALCulate<n>:DELTamarker<m>:SGRam:FRAME <Frame>**CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAME <Frame>**

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 190

CALCulate<n>:DELTaMarker<m>:SGRam:SARea <SearchArea>

CALCulate<n>:DELTaMarker<m>:SPECTrogram:SARea <SearchArea>

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 198

CALCulate<n>:DELTaMarker<m>:SGRam:XY:MAXimum[:PEAK]

CALCulate<n>:DELTaMarker<m>:SPECTrogram:XY:MAXimum[:PEAK]

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]

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

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 197

CALCulate<n>:DELTaMarker<m>:SGRam:Y:MAXimum:BELOW
CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum:BELOW

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 197

CALCulate<n>:DELTaMarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum:NEXT

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 197

CALCulate<n>:DELTaMarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum[:PEAK]

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

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 197

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELOW

CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELOW

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 197

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT

CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT

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 197

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]

CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum[:PEAK]

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](#)

11.7.3.5 Positioning the marker

This chapter contains remote commands necessary to position the marker on a trace.

- [Positioning normal markers](#).....445
- [Positioning delta markers](#).....448

Positioning normal markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:AUTO.....	445
CALCulate<n>:MARKer<m>:MAXimum:LEFT.....	445
CALCulate<n>:MARKer<m>:MAXimum:NEXT.....	446
CALCulate<n>:MARKer<m>:MAXimum[:PEAK].....	446
CALCulate<n>:MARKer<m>:MAXimum:RIGHT.....	446
CALCulate<n>:MARKer<m>:MINimum:AUTO.....	446
CALCulate<n>:MARKer<m>:MINimum:LEFT.....	447
CALCulate<n>:MARKer<m>:MINimum:NEXT.....	447
CALCulate<n>:MARKer<m>:MINimum[:PEAK].....	447
CALCulate<n>:MARKer<m>:MINimum:RIGHT.....	448

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

Turns an automatic marker peak search for a trace maximum on and off (using marker 1). The FSW performs the peak search after each sweep.

Suffix:

<n>	Window
<m>	irrelevant

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 195

CALCulate<n>:MARKer<m>:MAXimum:LEFT

Moves a marker to the next positive 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 200

CALCulate<n>:MARKer<m>:MAXimum:NEXT

Moves a marker to the next positive 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 200

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

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 200

CALCulate<n>:MARKer<m>:MAXimum:RIGHT

Moves a marker to the next positive 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 200

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

Turns an automatic marker peak search for a trace minimum on and off (using marker 1). The FSW performs the peak search after each sweep.

Suffix:

<n> [Window](#)

<m> irrelevant

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 195

CALCulate<n>:MARKer<m>:MINimum:LEFT

Moves a marker to the next minimum peak 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 200

CALCulate<n>:MARKer<m>:MINimum:NEXT

Moves a marker to the next minimum peak 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 200

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

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 200**CALCulate<n>:MARKer<m>:MINimum:RIGHT**

Moves a marker to the next minimum peak 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 200**Positioning delta markers**

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT	448
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT	449
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]	449
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT	449
CALCulate<n>:DELTamarker<m>:MINimum:LEFT	449
CALCulate<n>:DELTamarker<m>:MINimum:NEXT	450
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]	450
CALCulate<n>:DELTamarker<m>:MINimum:RIGHT	450

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

Moves a delta marker to the next positive peak 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 200

CALCulate<n>:DELTaMarker<m>:MAXimum:NEXT

Moves a marker to the next positive peak 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 200

CALCulate<n>:DELTaMarker<m>:MAXimum[:PEAK]

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 200

CALCulate<n>:DELTaMarker<m>:MAXimum:RIGHT

Moves a delta marker to the next positive peak value on the trace.

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 200

CALCulate<n>:DELTaMarker<m>:MINimum:LEFT

Moves a delta marker to the next minimum peak 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 200

CALCulate<n>:DELTaMarker<m>:MINimum:NEXT

Moves a marker to the next minimum peak 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 200

CALCulate<n>:DELTaMarker<m>:MINimum[:PEAK]

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 200

CALCulate<n>:DELTaMarker<m>:MINimum:RIGHT

Moves a delta marker to the next minimum peak 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 200

11.7.3.6 Band power marker

The following commands control the marker for band power measurements.

Using markers

CALCulate<n>:MARKer<m>:FUNction:BPOWer:AOff	451
CALCulate<n>:MARKer<m>:FUNction:BPOWer:MODE	451
CALCulate<n>:MARKer<m>:FUNction:BPOWer:RESult?	451
CALCulate<n>:MARKer<m>:FUNction:BPOWer:SPAN	452
CALCulate<n>:MARKer<m>:FUNction:BPOWer[:STATe]	452

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>

Selects the way the results for a band power marker are displayed.

(Note: relative power results are only available for delta markers, see [.CALCulate<n>:DELTAmarker<m>:FUNction:BPOWer:MODE](#) on page 453)

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 207

CALCulate<n>:MARKer<m>:FUNction:BPOWer:RESult?

Queries the results of the band power measurement.

Suffix:	
<n>	Window
<m>	Marker
Return values:	
<Power>	Signal power over the marker bandwidth.
Example:	<p>Activate the band power marker:</p> <pre>CALC:MARK:FUNC:BPOW:STAT ON</pre> <p>Select the density mode for the result:</p> <pre>CALC:MARK:FUNC:BPOW:MODE DENS</pre> <p>Query the result:</p> <pre>CALC:MARK:FUNC:BPOW:RES?</pre> <p>Response:</p> <pre>20dBm/Hz</pre>
Usage:	Query only

**CALCulate<n>:MARKer<m>:FUNCTion:BPOWer:SPAN **

Defines the bandwidth around the marker position.

Suffix:	
<n>	Window
<m>	Marker
Parameters:	
	<p>Frequency. The maximum span depends on the marker position and FSW model.</p> <p>*RST: 5% of current span</p> <p>Default unit: Hz</p>
Example:	<pre>CALC:MARK:FUNC:BPOW:SPAN 2MHz</pre> <p>Measures the band power over 2 MHz around the marker.</p>
Manual operation:	See " Span " on page 206

CALCulate<n>:MARKer<m>:FUNCTion:BPOWer[:STATe] <State>

Turns markers for band power measurements on and off.

Suffix:	
<n>	Window
<m>	Marker
Parameters:	
<State>	<p>ON OFF 0 1</p> <p>OFF 0</p> <p>Switches the function off</p> <p>ON 1</p> <p>Switches the function on</p>

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 206
See ["Switching All Band Power Measurements Off"](#) on page 207

Using delta markers

<code>CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:MODE</code>	453
<code>CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:RESult?</code>	453
<code>CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:SPAN</code>	454
<code>CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer[:STATe]</code>	454

`CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:MODE <Mode>`

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.

$$[\text{Relative band power (Delta2) in dB}] = [\text{absolute band power (Delta2) in dBm}] - [\text{absolute (band) power of reference marker in dBm}]$$

For details see ["Relative band power markers"](#) on page 204.

*RST: POWER

Manual operation: See ["Power Mode"](#) on page 207

`CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:RESult?`

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 **

Defines the bandwidth around the delta marker position.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

 Frequency. The maximum span depends on the marker position and FSW model.

*RST: 5% of current span

Default unit: Hz

Manual operation: See "[Span](#)" on page 206

CALCulate<n>:DELTaMarker<m>:FUNctIon:BPowEr[:STATe] <State>

Turns delta markers for band power measurements on and off.

If necessary, 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 206
See "[Switching All Band Power Measurements Off](#)" on page 207

11.7.3.7 Marker peak lists

Useful commands for peak lists described elsewhere

- [CALCulate<n>:MARKer<m>:PEXCursion](#) on page 432
- [MMEMoRy:STORe<n>:PEAK](#) on page 458

Remote commands exclusive to peak lists

CALCulate<n>:MARKer<m>:FUNctIon:FPEaks:ANNotation:LABel[:STATe]	455
CALCulate<n>:MARKer<m>:FUNctIon:FPEaks:COUnT?	455
CALCulate<n>:MARKer<m>:FUNctIon:FPEaks[:IMMEDIATE]	455

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:LIST:SIZE.....	456
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:SORT.....	456
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:STATe.....	457
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:X?.....	457
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:Y?.....	457
MMEMory:STORe<n>:PEAK.....	458

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:ANNOtation:LABel[:STATe] <State>

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 214

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:COUNT?

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>

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>

Defines the maximum number of peaks that the 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 214

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT <SortMode>

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 214

CALCulate<n>:MARKer<m>:FUNction:FPEaks:STATe <State>

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 214

CALCulate<n>:MARKer<m>:FUNction:FPEaks:X?

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?

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>

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 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 214

11.7.3.8 Measuring the time domain power

All remote control commands specific to time domain power measurements are described here.

- [Configuring the measurement](#)..... 458
- [Performing a time domain power measurement](#)..... 461
- [Retrieving measurement results](#)..... 461

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	459
CALCulate<n>:MARKer<m>:FUNCTion:SUMMARY:AVERage	459
CALCulate<n>:MARKer<m>:FUNCTion:SUMMARY:PHOLd	459
CALCulate<n>:MARKer<m>:FUNCTion:SUMMARY[:STATe]	460
CALCulate<n>:MARKer<m>:FUNCTion:SUMMARY:MEAN[:STATe]	460

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak[:STATE].....	460
CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS[:STATE].....	461
CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEVIation[:STATE].....	461

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AOFF

Turns all time domain power evaluation modes off.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERAge <State>

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>

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>

Turns time domain power measurements on and off. This measurement is only available in zero span.

When you turn the measurement on, the 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>

Turns the evaluation to determine the mean time domain power on and off.

The 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 210

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak[:STATe] <State>

Turns the evaluation to determine the positive peak time domain power on and off.

The 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 210

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS[:STATe] <State>

Turns the evaluation to determine the RMS time domain power on and off.
 The 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 210

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEviation[:STATe] <State>

Turns the evaluation to determine the standard deviation of the time domain power on and off.

The 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 403

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?](#)..... 462
[CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:PHOLd:RESult?](#)..... 462
[CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:RESult?](#)..... 462

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:AVERAGE:RESULT?

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 459.

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 402.

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?

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 402.

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?

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 402.

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 210

Measuring the peak power

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:AVERage:RESult?

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 459.

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 402.

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?

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 402.

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?

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 402.

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 210

Measuring the RMS power

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:AVERage:RESult?

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 459.

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 402.

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?

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 402.

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?**

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 402.**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 210**Measuring the standard deviation****CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:AVERage:RESult?**

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 459.

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 402.**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?

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 402.

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?

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 402.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

11.7.4 Configuring an analysis interval and line (MSRA mode only)

In MSRA operating mode, only the MSRA primary actually captures data; the MSRA secondary 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 secondary applications.

For the I/Q Analyzer secondary application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see [Chapter 11.4.5, "Configuring data acquisition"](#), on page 379. 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 386
- [TRACe:IQ:BWIDth](#) on page 383
- [TRACe:IQ:RLENgth](#) on page 384
- [\[SENSe:\]SWEep:TIME](#) on page 406

Remote commands exclusive to MSRA secondary applications

The following commands are only available for MSRA secondary application channels:

CALCulate<n>:MSRA:ALINe:SHOW	467
CALCulate<n>:MSRA:ALINe[:VALue]	467
CALCulate<n>:MSRA:WINDow<n>:IVAL	468
INITiate<n>:REFResh	468
[SENSe:]MSRA:CAPTure:OFFSet	468

CALCulate<n>:MSRA:ALINe:SHOW

Defines whether or not the analysis line is displayed in all time-based windows in all MSRA secondary applications and the MSRA primary application.

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 secondary 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 216

CALCulate<n>:MSRA:ALINe[:VALue] <Position>

Defines the position of the analysis line for all time-based windows in all MSRA secondary applications and the MSRA primary application.

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 215

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

Updates the current measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Suffix:

<n> irrelevant

Example: INIT:REFR
Updates the IQ measurement results.

Usage: Asynchronous command

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for secondary applications in MSRA mode, not for the MSRA primary application. 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 secondary application data. The offset must be a positive value, as the secondary 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 164

11.7.5 Configuring an analysis interval and line (MSRT mode only)

In MSRT operating mode, only the MSRT primary actually captures data; the MSRT secondary 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 secondary applications.

For the I/Q Analyzer secondary application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see [Chapter 11.4.5, "Configuring data acquisition"](#), on page 379. 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 468
- `INITiate:SEQuencer:REFresh[:ALL]` on page 404

Remote commands exclusive to MSRT secondary applications

The following commands are only available for MSRT secondary application channels:

<code>CALCulate<n>:RTMS:ALINe:SHOW</code>	469
<code>CALCulate<n>:RTMS:ALINe[:VALue]</code>	469
<code>CALCulate<n>:RTMS:WINDow<n>:IVAL</code>	470
<code>[SENSe]:RTMS:CAPTure:OFFSet</code>	470

`CALCulate<n>:RTMS:ALINe:SHOW`

Defines whether or not the analysis line is displayed in all time-based windows in all MSRT secondary applications and the MSRT primary.

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 secondary 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 216

`CALCulate<n>:RTMS:ALINe[:VALue] <Position>`

Defines the position of the analysis line for all time-based windows in all MSRT secondary applications and the MSRT primary.

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 215

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 secondary applications in MSRT mode, not for the MSRT primary. 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 secondary application data. The offset must be a positive value, as the secondary 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 164

11.8 Configuring I/Q noise cancellation

If you have an input file (.wv or .iq.tar) with the reference signal, you can remove the internal noise from the measured raw I/Q data in the I/Q Analyzer application

remotely. The resulting data is stored in a specified `iq.tar` file, which you can load in any other I/Q application for analysis.



Set the same sample rate and level settings in the I/Q Analyzer as in the application you require for analysis.

For details, see "[I/Q noise cancellation via remote control](#)" on page 88.

[SENSe:]ADJust:NCANcel:AVERAge[:COUNT]	471
[SENSe:]ADJust:NCANcel:ERRor?	471
[SENSe:]ADJust:NCANcel:FILE:REFerence	472
[SENSe:]ADJust:NCANcel:FILE:RESult	472
[SENSe:]ADJust:NCANcel:STARt	472

[SENSe:]ADJust:NCANcel:AVERAge[:COUNT] <Length>

Defines the number of measurements that are performed on the captured I/Q data to determine the average noise density due to the spectrum analyzer.

Parameters:

<Length>	integer
	Number of measurements

[SENSe:]ADJust:NCANcel:ERRor?

Returns any errors that occur during the I/Q noise cancellation process.

See also [Chapter 10.2, "Troubleshooting I/Q noise cancellation"](#), on page 242.

Return values:

<ErrorNumber>	numeric value
	Error number
<ErrorText>	Error description.

Usage: Query only

Table 11-5: Possible errors

Error number	Error text
1	I/Q noise cancellation successful
-1	Option K575 not available
-2	Wrong application. Function only available in I/Q Analyzer
-3	Number of averages needs to be at least 2
-7	Unable to open reference file
-9	Invalid format of reference file. Expected file type <code>.vv</code> or <code>.iq.tar</code>
-11	Invalid format of result file. Expected file type <code>.iq.tar</code>

Error number	Error text
-12	Writing results to file failed. Invalid file path
-13	K575 error

[SENSe:]ADJust:NCANcel:FILE:REFErence <Ref File>

Reference signal to be used by the I/Q noise cancellation process.

Parameters:

<RefFile> string
 Path and file name of the reference signal in .wv or .iq.tar format.

[SENSe:]ADJust:NCANcel:FILE:RESult <Result File>

Exports the I/Q data with the analyzer noise removed to a file.

Prerequisites for this command:

- Turn on I/Q noise cancellation.
 (See [\[SENSe:\]ADJust:NCANcel:STARt](#) on page 472).

Parameters:

<FileName> String containing the path and name of the file. The specified path must exist already.
 The file extension must be .iq.tar.

[SENSe:]ADJust:NCANcel:STARt

Starts an I/Q noise cancellation process for the input signal using the specified reference signal. The result displays are not changed.

Example:

```
//Perform 8 averaging operations
ADJ:NCAN:AVER:COUN 8
//Use reference file "ideal_iqdata.iq.tar"
ADJ:NCAN:FILE:REF'c:\ideal_iqdata.iq.tar'
//Store corrected I/Q data to "corrected_iqdata.iq.tar"
ADJ:NCAN:FILE:RESult'c:\corrected_iqdata.iq.tar'
//Start correction process
ADJ:NCAN:STAR
//Query possible errors
ADJ:NCAN:ERR?
```

Usage: Event

11.9 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 257).
- Use a HiSlip or raw socket connection to export the data from the 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 504).
- Use the "Compatible" or "IQPair" data mode (see [Chapter C, "Reference: format description for I/Q data files"](#), on page 505).
- 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.

- [Retrieving captured I/Q data](#)..... 473
- [Retrieving I/Q trace data](#)..... 477
- [Exporting traces and data](#)..... 480
- [Retrieving marker results](#)..... 483

11.9.1 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 (FSW-B517/-B1017) is described in [Chapter 11.4.1.13, "Digital I/Q 40G streaming output commands"](#), on page 353.

- [TRACe:IQ:DATA?](#)..... 473
- [TRACe:IQ:DATA:FORMat](#)..... 474
- [TRACe:IQ:DATA:MEMory?](#)..... 475

TRACe:IQ:DATA?

Initiates a measurement with the current settings and returns the captured data from I/Q measurements.

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 54.
 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 474.
 Default unit: V

Example:

```
TRAC:IQ:STAT ON
Enables acquisition of I/Q data
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 0
Number of Samples = 4096
FORMat REAL,32
Selects format of response data
TRAC:IQ:DATA?
Starts measurement and reads results
```

Usage: Query only

TRACe:IQ:DATA:FORMat <Format>

Selects the order of the I/Q data.

For details see [Chapter C, "Reference: format description for I/Q data files"](#), on page 505.

For traces captured using the optional 2 GHz / 5 GHz bandwidth extension (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,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 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 FSW I/Q Analyzer and I/Q Input User Manual)

*RST: IQBL

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

Queries the I/Q data currently stored in the capture buffer of the 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 [TRACe: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 (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:

$\text{<SampleRate> * <CaptureTime>}$

(See [TRACe:IQ:SET](#), [TRACe:IQ:SRATe](#) on page 386 and [\[SENSe:\]SWEep:TIME](#) on page 406)

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 477.

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

11.9.2 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].....	477
TRACe<n>[:DATA]?.....	477
TRACe<n>[:DATA]:MEMory?.....	479
TRACe<n>[:DATA]:X?.....	479

FORMat[:DATA] <Format>[, <BitLength>]

Selects the data format that is used for transmission of trace data from the FSW to the controlling computer.

Note that the command has no effect for data that you send to the FSW. The 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 can 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.

The data format depends on `FORMat [:DATA]` on page 477.

Suffix:<n> [Window](#)**Query parameters:**<ResultType> Selects the type of result to be returned.
See [Table 11-6](#).**Example:** TRAC? TRACE3
Queries the data of trace 3.**Example:** See [Chapter 11.12.3, "Data acquisition via the optional Digital Baseband interface"](#), on page 495.**Example:** See [Chapter 11.12.6, "Data acquisition via the optional Analog Baseband interface"](#), on page 499.**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 11-6: Return values for result type parameters**

Parameter	Result display / measurement	Results
TRACE1 ... TRACE6	"Magnitude" "Spectrum"	Returns the sweep point values as shown in the result display. For 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 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. Magnitude of the I and Q values (I+jQ) for each sweep point (=1001 values)
	"Real/Imag (I/Q)"	First the real parts for each trace point, then the imaginary parts (I ₁ ,...,I ₁₀₀₁ , Q ₁ ,...,Q ₁₀₀₁).
	"I/Q Vector"	The I and Q values for each trace point are returned (1001 pairs of I and Q values).
LIST	SEM measurements	Peak list evaluation, one peak per range is returned.
	Spurious emission measurements	Peak list evaluation For each peak, the command returns 11 values in the following order: <ul style="list-style-type: none"> • <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)

Parameter	Result display / measurement	Results
SPURious		Peak list evaluation of Spurious Emission measurements.
SPECTrogram SGRam		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 configured unit. Only REAL, 32 format is supported.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

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

11.9.3 Exporting traces and data

The following commands are required to export traces and spectrograms.

FORMat:DEXPort:CSEParator.....	480
FORMat:DEXPort:DSEParator.....	480
FORMat:DEXPort:FORMat.....	481
FORMat:DEXPort:HEADer.....	481
FORMat:DEXPort:TRACes.....	481
MMEMory:STORe<n>:SPECTrogram.....	482
MMEMory:STORe<n>:TRACe.....	482

FORMat:DEXPort:CSEParator <Separator>

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 96

FORMat:DEXPort:DSEParator <Separator>

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 96
See ["Export Peak List"](#) on page 214

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program that creates the data file or evaluates it, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Parameters:
<FileFormat> CSV | DAT
*RST: DAT

Example: FORM:DEXP:FORM CSV

Manual operation: See ["File Type"](#) on page 96

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 185

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see [MMEMory:STORe<n>:TRACe](#) on page 482).

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 184

MMEMory:STORe<n>:SPECtrogram <FileName>

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 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 187

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

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 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 95

11.9.4 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 427
- [CALCulate<n>:MARKer<m>:X](#) on page 429
- [CALCulate<n>:MARKer<m>:FUNction:FPEaks:X?](#) on page 457
- [CALCulate<n>:MARKer<m>:FUNction:FPEaks:Y?](#) on page 457

Remote commands exclusive to retrieving marker results:

CALCulate<n>:DELTaMarker<m>:X:RELative?	483
CALCulate<n>:DELTaMarker<m>:Y?	483
CALCulate<n>:MARKer<m>:Y?	484
MMEMory:STORe<n>:LIST	484

CALCulate<n>:DELTaMarker<m>:X:RELative?

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 20
See "[Marker Peak List](#)" on page 21

MMEMory:STORe<n>:LIST <FileName>

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 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.

11.10 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 5.10, "I/Q data import and export"](#), on page 79.

MMEMory:LOAD:IQ:STATe	485
MMEMory:STORe<n>:IQ:COMMeNt	485
MMEMory:STORe<n>:IQ:FORMat	486
MMEMory:STORe<n>:IQ:STATe	486

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

Restores I/Q data from a file.

Setting parameters:

<FileName>	string
------------	--------

String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

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 94

MMEMory:STORe<n>:IQ:COMMeNt <Comment>

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 96

MMEMory:STORe<n>:IQ:FORMat <Format>, <DataFormat>

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>

Writes the captured I/Q data to a file.

By default, the contents of the file are in 32-bit floating point format.

Suffix:

<n> 1..n

Parameters:

<1>

<FileName> String containing the path and name of the target file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

Example: MMEM:STOR:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iq.tar'
Stores the captured I/Q data to the specified file.

Usage: Asynchronous command

Manual operation: See "[I/Q Export](#)" on page 96

11.11 Querying the status registers

The R&S FSW-I/Q Analyzer uses the standard status registers of the FSW.

In addition, the `STATus:QUEStionable:SYNC` register indicates errors concerning I/Q data processing.

The following status registers of the 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 FSW status registers refer to the description of remote control basics in the FSW User Manual.



*RST does not influence the status registers.

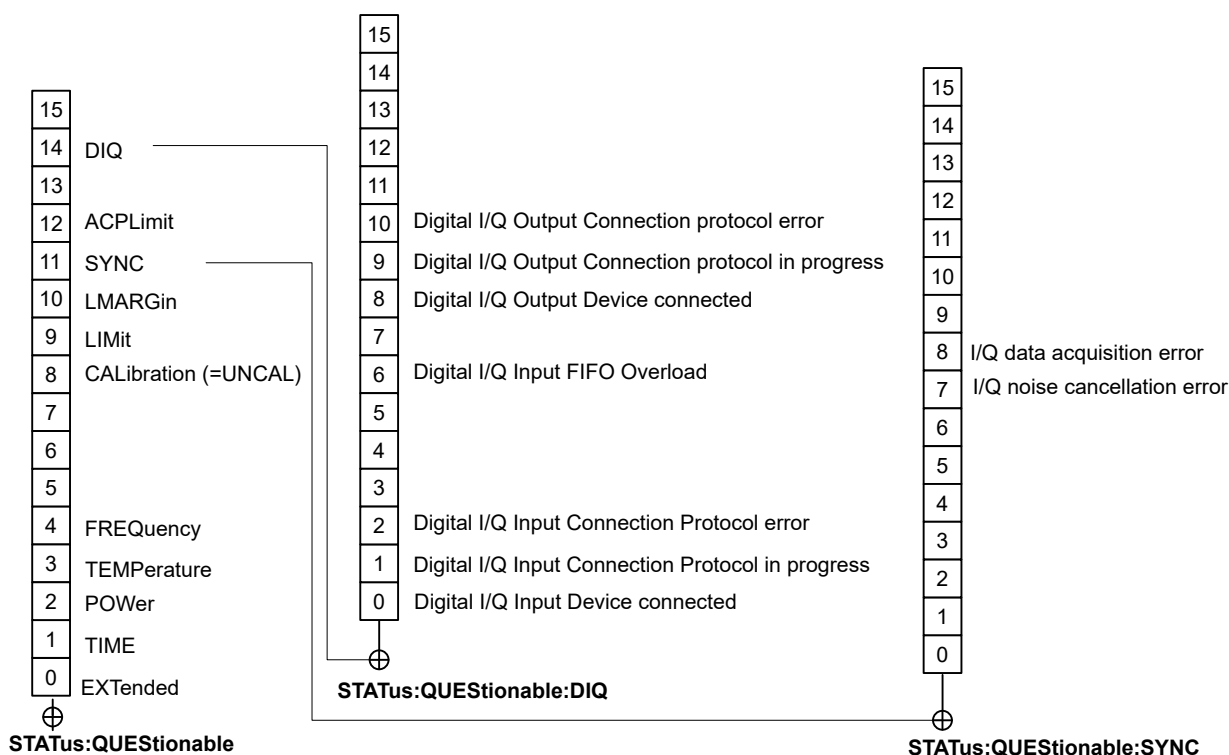


Figure 11-2: Status registers used by the Digital Baseband interface (R&S FSW-B17)

- [STATus:QUEStionable:SYNC register](#).....487
- [STATus:QUEStionable:DIQ register](#).....490

11.11.1 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 488 and `STATUS:QUESTIONable:SYNC[:EVENT]?` on page 489.

Bit No.	Meaning
0-6	not used
7	I/Q noise cancellation error This bit is set if an error occurs during I/Q noise cancellation, e.g. due to failed synchronization. See Chapter 10.2, "Troubleshooting I/Q noise cancellation" , on page 242.
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 FSW do not match. See also Chapter 10.1, "Error messages" , on page 239
9-14	not used
15	This bit is always set to 0.

<code>STATUS:QUESTIONable:SYNC:CONDition?</code>	488
<code>STATUS:QUESTIONable:SYNC:ENABLE</code>	488
<code>STATUS:QUESTIONable:SYNC:NTRansition</code>	489
<code>STATUS:QUESTIONable:SYNC:PTRansition</code>	489
<code>STATUS:QUESTIONable:SYNC[:EVENT]?</code>	489

STATUS:QUESTIONable:SYNC:CONDition? <ChannelName>

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>

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>]

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>

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

11.11.2 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 491 and STATus:QUESTionable:DIQ[:EVENT]? on page 492.

For more information on the optional "Digital Baseband" interface see [Chapter 5.2, "Processing data from the Digital Baseband interface"](#), on page 45.

Bit No.	Meaning
0	<p>Digital I/Q Input Device connected</p> <p>This bit is set if a device is recognized and connected to the "Digital Baseband" interface of the analyzer.</p>
1	<p>Digital I/Q Input Connection Protocol in progress</p> <p>This bit is set while the connection between analyzer and digital baseband data signal source (e.g. R&S SMW) is established.</p>
2	<p>Digital I/Q Input Connection Protocol error</p> <p>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) is established.</p>
3	<p>Digital I/Q Input PLL unlocked</p> <p>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.</p>
4	<p>Digital I/Q Input DATA Error</p> <p>This bit is set if the data from the Digital I/Q input module is erroneous. Possible reasons:</p> <ul style="list-style-type: none"> • 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. <p>NOTE: If this error is indicated repeatedly either the Digital I/Q LVDS connection cable or the receiving or transmitting device might be defect.</p>
5	Not used
6	<p>Digital I/Q Input FIFO Overload</p> <p>This bit is set if the sample rate on the connected instrument is higher than the input sample rate setting on the FSW. Possible solution:</p> <ul style="list-style-type: none"> • Reduce the sample rate on the connected instrument • Increase the input sample rate setting on the FSW
7	Not used
8	<p>Digital I/Q Output Device connected</p> <p>This bit is set if a device is recognized and connected to the Digital I/Q Output.</p>

Bit No.	Meaning
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) 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) is established.
11	Digital I/Q Output FIFO Overload This bit is set if an overload of the Digital I/Q Output FIFO occurred. This happens if the output data rate is higher than the maximal data rate of the connected instrument. Reduce the sample rate to solve the problem.
12-14	Not used
15	This bit is always set to 0.

STATus:QUESTionable:DIQ:CONDition?	491
STATus:QUESTionable:DIQ:ENABLE	491
STATus:QUESTionable:DIQ:NTRansition	492
STATus:QUESTionable:DIQ:PTRansition	492
STATus:QUESTionable:DIQ[:EVENT]?	492

STATus:QUESTionable:DIQ:CONDition? <ChannelName>

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>

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>

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>

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>

Queries the contents of the "EVENT" section of the STATus:QUESTionable:DIQ register for IQ measurements.

Readout deletes the contents of the "EVENT" section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Example: STAT:QUES:DIQ?

Usage: Query only

11.12 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.

- [I/Q analysis with graphical evaluation](#)..... 493
- [Basic I/Q analysis with improved performance](#)..... 494
- [Data acquisition via the optional Digital Baseband interface](#)..... 495
- [Converting an RF signal to a digital I/Q signal via the optional Digital Baseband interface](#)..... 497
- [Output via the optional Digital Baseband interface](#)..... 498
- [Data acquisition via the optional Analog Baseband interface](#)..... 499

11.12.1 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.
```

11.12.2 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 functionality 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 (internal) operating mode of the current measurement channel to
//simple I/Q data acquisition mode 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.

```

11.12.3 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

```

11.12.4 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 11-7: 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 11-8: 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
```

11.12.5 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 11.12.1, "I/Q analysis with graphical evaluation"](#), on page 493.

```
//-----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.
```

11.12.6 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 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)

```

11.13 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](#).....500

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 for the I/Q analyzer application, this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see [Chapter 11.5.2, "Working with windows in the display"](#), on page 393).

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 11-9: <Evaluation> parameter values for the I/Q Analyzer application

Parameter value	Window type
FREQ	Spectrum
MAGN	Magnitude
MTABle	Marker table
PEAKlist	Marker peak list
RIMAG	Real/Imag (I/Q)
VECT	I/Q Vector

Annex

A Description of the LVDS connector

The "Digital Baseband" interface is a proprietary LVDS serial interface. For adaption 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).

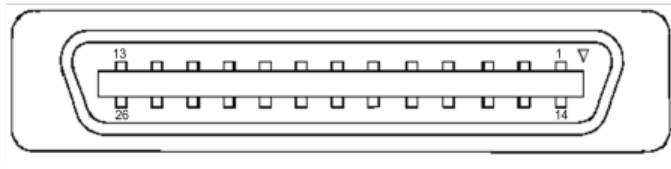


Figure A-1: LVDS connector on the FSW rear panel, connector front view

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 477. 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,16/32/64):**
The data is stored as binary data (definite length block data according to IEEE 488.2), each measurement value being formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.
The schema of the result string is as follows:
`#<Length of length><Length of data><value1><value2>...<value n>`
with:

<code><Length of length></code>	Number of digits of the following number of data bytes
<code><Length of data></code>	Number of following data bytes
<code><Value></code>	2-byte/4-byte/8-byte floating point value

Example: `#41024<Data>...` contains 1024 data bytes

Data blocks larger than 999,999,999 bytes

According to SCPI, the header of the block data format allows for a maximum of 9 characters to describe the data length. Thus, the maximum REAL 32 data that can be represented is 999,999,999 bytes. However, the FSW is able to send larger data blocks. In this case, the length of the data block is placed in brackets, e.g.
`#(1234567890)<value1><value2>...`



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 504.

For details on the format of I/Q export files (using the "I/Q Export" function), see the FSW User Manual.

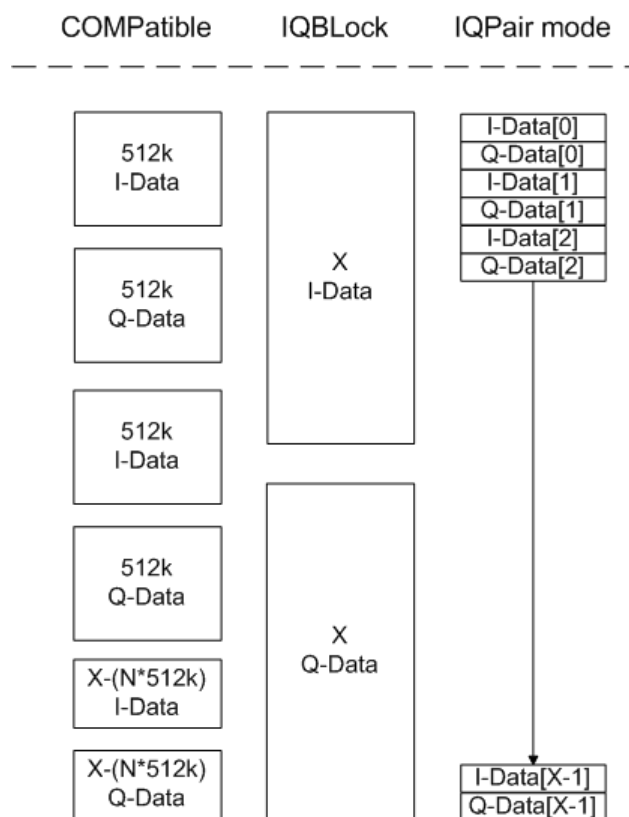


Figure C-1: I/Q data formats

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:

$$\# \text{ of I-Data} = \# \text{ of Q-Data} = \frac{\# \text{ of DataBytes}}{8}$$

For the format "QBLock", the offset of Q-data in the output buffer can be calculated as follows:

$$Q-Data-Offset = \frac{(\# \text{ of } DataBytes)}{2} + LengthIndicatorDigits$$

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 94.



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	<code>.iq.tar</code>	An <code>IQ.tar</code> 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 <code>IQ.tar</code> 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	<code>.iqw</code>	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	<code>.csv</code>	A file containing I/Q data as comma-separated values (CSV). Additional metadata can be included.
Simple CSV	<code>.csv</code>	(Import only) 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	<code>.mat</code>	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 <code>Ch1_ChannelName</code> contains the name of the first channel. The corresponding data is contained in <code>ChX_Data</code> . Optional user data can be saved to variables named <code>UserDataX</code> , where 'X' starts at 0. The variable <code>UserData_Count</code> contains the number of <code>UserData</code> 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 <code>*.mat</code> files in arbitrary order. Limitations: In general, the file format is limited to a maximum of 2 GB. A maximum of 10000000 values can be stored in a single variable, e.g. 50000000 complex data samples.
Matlab® v7.3	<code>.mat</code>	A file containing I/Q data in Matlab® file format v7.3.
Simple Matlab®	<code>.mat</code>	(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.

File format	File extension	Comment
AMMOS intermediate frequency data format	.aid	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.

- [I/Q data file format \(iq-tar\)](#)..... 508
- [CSV file format](#)..... 516
- [IQW file format](#)..... 518
- [Matlab® v. 4 / v. 7.3 file format](#)..... 519
- [AID format](#)..... 522
- [WV format](#)..... 532

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

Some sample `iq-tar` files are provided in the `C:\R_S\INSTR\USER\Demo\` directory on the 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.

- [I/Q parameter XML file specification](#)..... 509
- [I/Q data binary file](#)..... 513

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>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>
</RS_IQ_TAR_FileFormat>
</FileFormat>
```

```

</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>

```

D.1.1.1 Minimum data elements

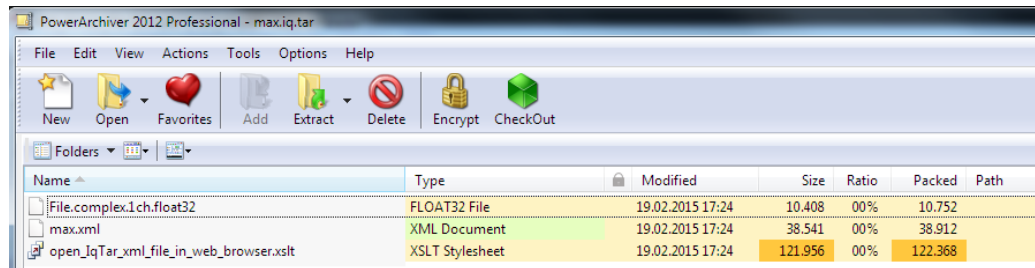
The following data elements are the minimum required for a valid `iq-tar` file. They are always provided by an `iq-tar` file export from a Rohde & Schwarz product. If not specified otherwise, it must be available in all `iq-tar` files used to import data to a Rohde & Schwarz product.

Element	Possible Values	Description
<RS_IQ_TAR_FileFormat>	-	The root element of the XML file. It must contain the attribute <code>fileFormatVersion</code> 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 <code>xs:dateTime</code> (see <code>RsIqTar.xsd</code>).
<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: <ul style="list-style-type: none"> • A complex number represented as a pair of I and Q values • A complex number represented as a pair of magnitude and phase values • A real number represented as a single real value See also <Format> element.
<Clock>	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 <code>unit</code> must be set to "Hz".
<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: <ul style="list-style-type: none"> • <code>complex</code>: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless • <code>real</code>: Real number (unitless) • <code>polar</code>: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires <code>DataType = float32 or float64</code>
<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 513). The following data types are allowed: <ul style="list-style-type: none"> • <code>int8</code>: 8 bit signed integer data • <code>int16</code>: 16 bit signed integer data • <code>int32</code>: 32 bit signed integer data • <code>float32</code>: 32 bit floating point data (IEEE 754) • <code>float64</code>: 64 bit floating point data (IEEE 754)

Element	Possible Values	Description
<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 <code>unit</code> 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 513). If the <NumberOfChannels> element is not defined, one channel is assumed.
<DataFilename>		Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> <ul style="list-style-type: none"> • <xyz> = a valid Windows file name • <Format> = complex, polar or real (see <code>Format</code> element) • <Channels> = Number of channels (see <code>NumberOfChannels</code> element) • <Type> = float32, float64, int8, int16, int32 or int64 (see <code>DataType</code> element) Examples: <ul style="list-style-type: none"> • 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. FSW). For the definition of this element refer to the <code>RsIqTar.xsd</code> schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet <code>open_IqTar_xml_file_in_web_browser.xslt</code> 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. 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.

max.xml (of .iq.tar file)

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 / 2¹⁵ = 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 inter-

leaved 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>
    </Channel>
  </ArrayOfChannel>
  <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.

- [Mandatory data elements](#).....516
- [Optional data elements](#).....516
- [Example](#).....517
- [Simple CSV format](#).....518

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

Parameter name	Possible Values
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
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, one after the other.

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.

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- [Optional data elements](#)..... 520
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D.4.1 Mandatory data elements

Variable name	Class	Format / possible values
Name	char	
Comment	char	
DateTime	char	Year-Month-DayTHour:Min:Sec

Variable name	Class	Format / possible values
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	
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

Parameter name	Possible Values
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.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 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.

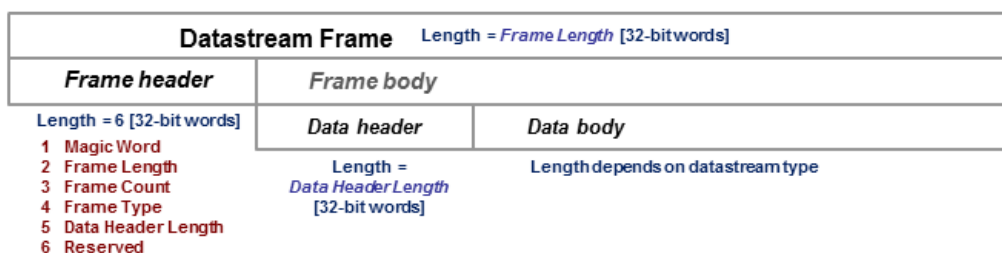


Figure D-1: Generic Datastream Frame structure

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	<code>uintMagicWord</code> <code>ptypUINT</code>	Magic Word - 32-bit word, always identical (<code>0xFB746572</code>), defines the start of the <i>Frame header</i> and is used for frame synchronization. The <i>Magic Word</i> and the <i>Frame Length</i> are used to identify the beginning of each frame.
2	<code>uintFrameLength</code> <code>ptypUINT</code>	Frame Length - gives the length of the frame including both <i>Frame header</i> and <i>Frame body</i> . The length is expressed in 32-bit words. The minimum length is six in case the <i>Frame body</i> is empty and the maximum length is limited to the value: <ul style="list-style-type: none"> <code>kFRH_FRAME_LENGTH_MAX = 0x100000</code> ($1048576 = 2^{20}$) in case of normal frames <code>kFRH_FRAME_LENGTH_MAX_EX = 0x400000</code> ($64 * 1048576 = 2^{26}$) 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 <code>rs_gx40x_global_frame_types_if_defs.h</code>. The next <i>Magic Word</i> which denotes the next frame in this data stream will occur <code>uintFrameLength</code> [32-bit words] after the <i>Magic Word</i> in this frame.
3	<code>uintFrameCount</code> <code>ptypUINT</code>	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: <code>rs_gx40x_global_frame_types_if_defs.h</code>
5	uintDataHeaderLength ptypUINT	Data Header Length - gives the length of the <i>data header</i> positioned at the beginning of the <i>Frame body</i> . 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	<ul style="list-style-type: none"> • Bits #31 to #1 - Reserved (not yet used, must be 0) • Bit #0 - Marks the frame with extended size (up to <code>kFRH_FRAME_LENGTH_MAX_EX</code> 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 $6 + \text{uintDataHeaderLength}$ 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 523, 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.

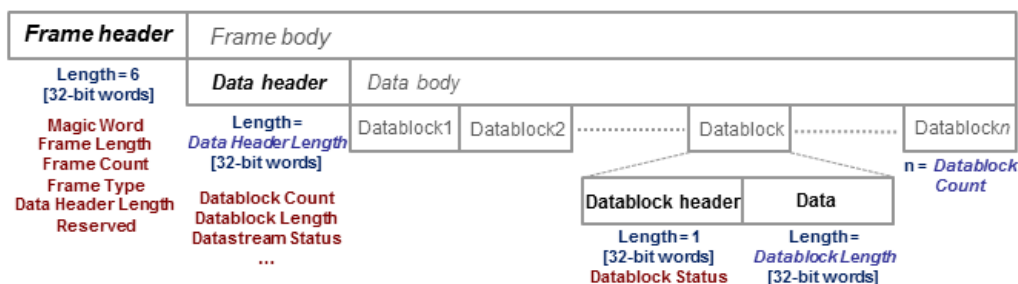


Figure D-2: IF Data frame format

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 $N \geq 2$). 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. <ul style="list-style-type: none"> • Bit #31 - Reserved • Bit #30 - dBFS flag <ul style="list-style-type: none"> - 1 indicates that all samples in this frame are considered to be dBFS (dB full scale). - 0 indicates that the values <i>Antenna Voltage Reference</i> and <i>Reciprocal gain correction</i> (see the <i>Status Word</i> 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	<p>Current Signal Source State (value 0×0 if not used)</p> <ul style="list-style-type: none"> gives the <i>Configuration Set Identifier</i> of the Task Data Set (in GX400) currently being applied by the IF signal source OR the current <i>Scan Step Number</i> 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 0×1 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 (Ant-VoltRef) 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 dB μ V]. 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 Recip-Gain (Reciprocal Gain) value, one can calculate the true signal level at the antenna input connector (see "Data samples" on page 530). 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 dB μ V/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
<code>uintStatusword</code> <code>ptypUINT</code>	Status of the Datablock <ul style="list-style-type: none"> 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 <code>0x2220</code>. 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 530). 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
<code>typIFD_SAMPLE_32RE_32IM_FIX</code>	64-bit I/Q format	First 32-bit Real component		<code>ptypINT</code> or <code>ptyp-FLOAT_SP</code>
<code>typIFD_SAMPLE_32RE_32IM_FLOAT</code>		Second 32-bit Imaginary component		<code>ptypINT</code> or <code>ptyp-FLOAT_SP</code>

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:

$$\text{Level [dB}\mu\text{V]} = 10 \cdot \log(I_{\text{rel}}^2 + Q_{\text{rel}}^2) \text{ [dB]} + 20 \cdot \log(\text{RecipGain} / 2^{16}) \text{ [dB]} + 0.1 \cdot \text{AntVoltRef [dB}\mu\text{V]}$$

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:

$$I \text{ [}\mu\text{V]} = I_{\text{rel}} \cdot (\text{RecipGain} / 2^{16}) \cdot \text{AntVoltLin}$$

$$Q \text{ [}\mu\text{V]} = Q_{\text{rel}} \cdot (\text{RecipGain} / 2^{16}) \cdot \text{AntVoltLin}$$

$$\text{where AntVoltLin [}\mu\text{V]} = 10^{(0.1 \cdot \text{AntVoltRef}) / 20}$$

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}):

- $I_{\text{rel}} = I_{\text{int32}} / (2^{31} - 1)$ where I_{int32} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- $I_{\text{rel}} = I_{\text{int16}} / (2^{15} - 1)$ where I_{int16} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- $I_{\text{rel}} = I_{\text{float}}$

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 [μ s] 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	42E9EC0	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 = 3dB μ V
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	<p>The actual waveform data (I/Q stream)</p> <p>Length specifies the number of bytes in a WAVEFORM tag and is calculated as follows:</p> <p>Length = Number of I/Q pairs * 4 (2 bytes per I and 2 bytes per Q value) + 1 byte (the length of the #)</p> <p>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).</p>

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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[SENSe:] [WINDow<n>:] DETector<t>[:FUNCTION]:AUTO	413
[SENSe:] ADJust:ALL	389
[SENSe:] ADJust:CONFigure:HYSTeresis:LOWer	390
[SENSe:] ADJust:CONFigure:HYSTeresis:UPPer	391
[SENSe:] ADJust:CONFigure:LEVel:DURation	389
[SENSe:] ADJust:CONFigure:LEVel:DURation:MODE	390
[SENSe:] ADJust:CONFigure:TRIGger	391
[SENSe:] ADJust:FREQuency	391
[SENSe:] ADJust:LEVel	392
[SENSe:] ADJust:NCANcel:AVERage[:COUNT]	471
[SENSe:] ADJust:NCANcel:ERRor?	471
[SENSe:] ADJust:NCANcel:FILE:REFerence	472
[SENSe:] ADJust:NCANcel:FILE:RESult	472
[SENSe:] ADJust:NCANcel:STARt	472
[SENSe:] AVERage<n>:COUNT	414
[SENSe:] AVERage<n>:TYPE	412
[SENSe:] AVERage<n>[:STATe<t>]	414
[SENSe:] CORRection:COLLect[:ACQuire]	330
[SENSe:] CORRection:CVL:BAND	313
[SENSe:] CORRection:CVL:BIAS	313
[SENSe:] CORRection:CVL:CATalog?	313
[SENSe:] CORRection:CVL:CLEar	314
[SENSe:] CORRection:CVL:COMMeNt	314
[SENSe:] CORRection:CVL:DATA	314
[SENSe:] CORRection:CVL:HARMonic	314
[SENSe:] CORRection:CVL:MIXer	315
[SENSe:] CORRection:CVL:PORTs	315
[SENSe:] CORRection:CVL:SELEct	315
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[SENSe:] EFRontend:CONNection:CSTATe?	268
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[SENSe:] EFRontend:FREQuency:BAND:COUNT?	268
[SENSe:] EFRontend:FREQuency:BAND:LOWer?	268
[SENSe:] EFRontend:FREQuency:BAND:UPPer?	269
[SENSe:] EFRontend:FREQuency:BCONfig:AUTO	269
[SENSe:] EFRontend:FREQuency:BCONfig:LIST?	270
[SENSe:] EFRontend:FREQuency:BCONfig:SELEct	270

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[SENSe:]EFRontend:FREQUENCY:IFREQUENCY:MINimum?	271
[SENSe:]EFRontend:FREQUENCY:IFREQUENCY:SIDeband?	271
[SENSe:]EFRontend:FREQUENCY:IFREQUENCY[:VALue]?	272
[SENSe:]EFRontend:FREQUENCY:LOSCillator:INPut:FREQUENCY?	272
[SENSe:]EFRontend:FREQUENCY:LOSCillator:MODE	272
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[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?	279
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQUENCY:MAXimum?	280
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQUENCY:MINimum?	281
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?	281
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?	279
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