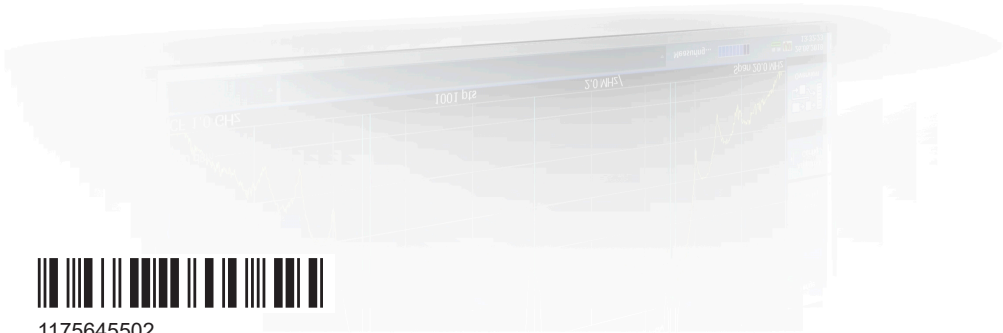


# R&S®FSW MSRA

## Multi-Standard Radio Analyzer

### User Manual



1175645502  
Version 32



This manual applies to the following FSW models with firmware version 6.00 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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1175.6455.02 | Version 32 | R&S®FSW MSRA

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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](http://www.rohde-schwarz.com/manual/FSW)

Further documents are available at:

[www.rohde-schwarz.com/product/FSW](http://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](http://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 firmware version, and describe the firmware installation.

The firmware makes use of 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](http://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](http://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 MSRA operating mode

The MSRA operating mode is part of the standard FSW firmware and adds functionality to perform multi-standard radio analysis.

The R&S FSW MSRA operating mode features:

- Analysis of the same I/Q data in more than one application
- Analysis of correlated effects due to multiple standards
- Configuration of data acquisition settings only required once for all applications
- Overview of all results in one screen in addition to large display of individual results
- Common analysis line (time marker) across all applications
- Performing measurements in the frequency and time domain (such as channel power measurements) on I/Q data

This user manual contains a description of the functionality specific to the MSRA operating mode, including remote control operation.

All functions not discussed in this manual are the same as in Signal and Spectrum Analyzer mode 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.html>.

### Additional information

An application note discussing efficient measurements using the MSRA operating mode is available from the Rohde & Schwarz website:

[1EF83: Using the R&S®FSW for Efficient Measurements on Multi- Standard Radio Base Stations \(MSRA\)](#)

### 2.1 Starting the MSRA operating mode

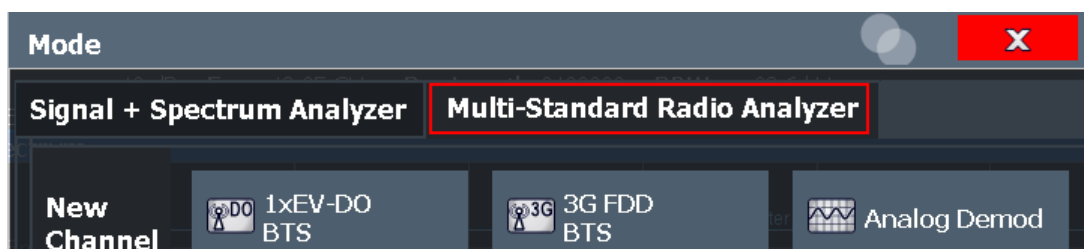
MSRA is a new operating mode on the FSW.

#### To activate the MSRA operating mode

1. Select [MODE].

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

2. Select the "Multi Standard Radio Analyzer" tab.



3. Confirm the message informing you that you are changing operating modes.

The FSW closes all active measurement channels in the current operating mode, then opens a new measurement channel for the MSRA operating mode.

In addition to the "MSRA View", an "MSRA Primary" tab is displayed.

The Sequencer is automatically activated in continuous mode (see [Chapter 5.3, "Using the sequencer in MSRA mode"](#), on page 27), starting an I/Q Analyzer data acquisition with the default settings (but with a "Spectrum" result display). It can be configured in the MSRA "Overview" dialog box, which is displayed when you select "Overview" from any menu (see [Chapter 7, "MSRA configuration"](#), on page 35).

#### Remote command:

INST:MODE MSR, see [INSTrument:MODE](#) on page 120

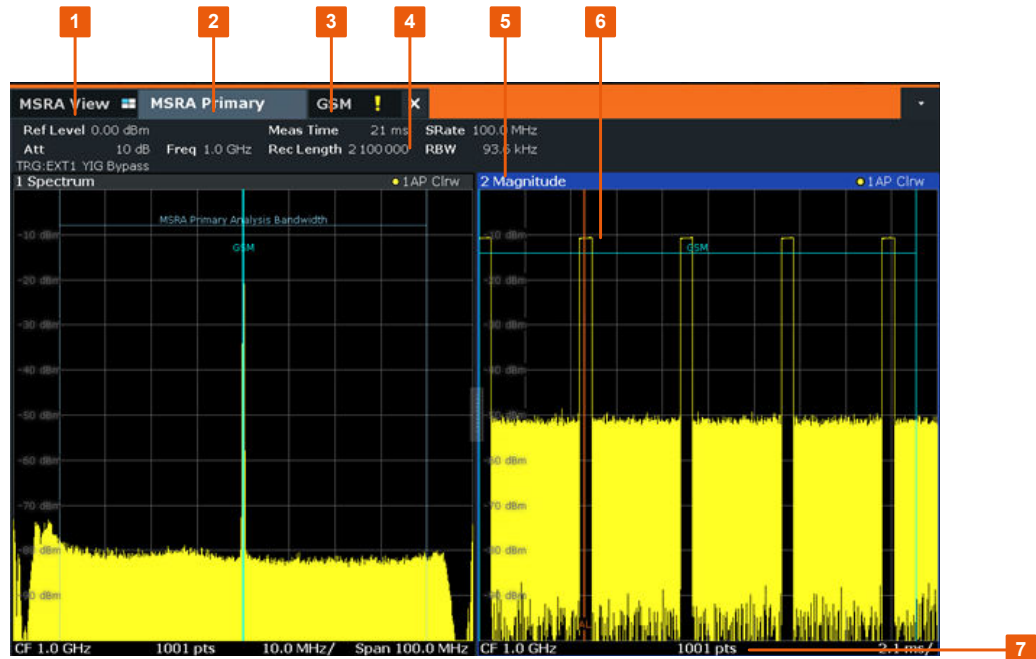
## 2.2 Understanding the display information

The following figure shows a screen display during MSRA operation. All different information areas are labeled. They are explained in more detail in the following sections.



- The orange background of the screen behind the measurement channel tabs indicates that you are in MSRA operating mode.
- The ✖ icon on the tab label indicates that the displayed trace (e.g. in an MSRA secondary application) no longer matches the currently captured data. This may be the case, for example, if a data acquisition was performed in another secondary application. As soon as the result display is refreshed, the icon disappears.
- The ! icon indicates that an error or warning is available for that measurement channel. This is particularly useful if the MSRA View tab is displayed.

An orange "IQ" indicates that the results displayed in the MSRA secondary application(s) no longer match the data captured by the MSRA primary. The "IQ" disappears after the results in the secondary application(s) are refreshed.

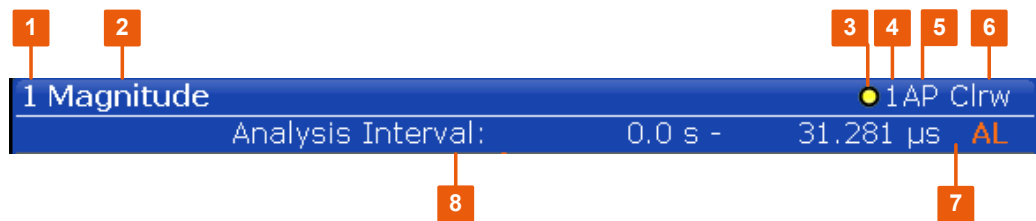


- 1 = MSRA View (overview of all active channels in MSRA mode)
- 2 = MSRA Primary (data acquisition channel with global configuration settings)
- 3 = Measurement channel tab for individual MSRA secondary application
- 4 = Channel bar with firmware and measurement settings for selected channel
- 5 = Window title bar with diagram-specific (trace) information and analysis interval
- 6 = Diagram area
- 7 = Diagram footer with diagram-specific information, depending on evaluation

The diagram area varies depending on the type of measurement channel, as described in detail in the following topics.

**Window title bar information**

For each diagram, the header provides the following information:



**Figure 2-1: Window title bar information in MSRA mode**

- 1 = Window number
- 2 = Window type
- 3 = Trace color
- 4 = Trace number
- 5 = Detector
- 6 = Trace mode
- 7 = Analysis line indication
- 8 = Analysis interval

### 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.

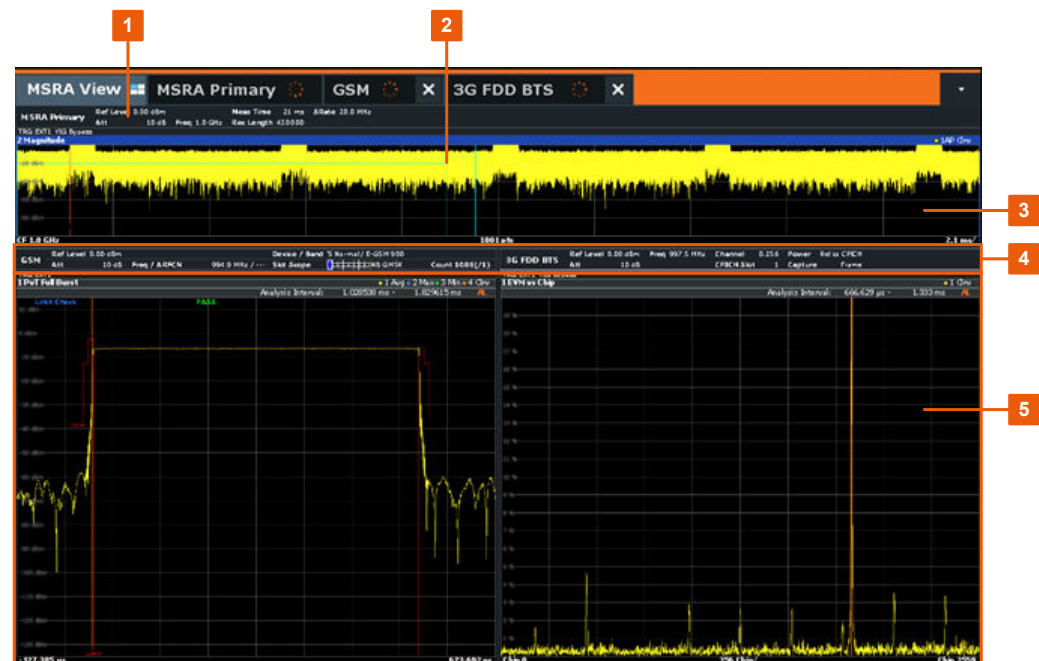


If an error or warning is available for a measurement channel, the  icon is displayed next to the tab label in the channel bar.

## 2.2.1 MSRA view

The MSRA View is an overview of all active channels in MSRA mode, similar to the MultiView tab in Signal and Spectrum Analyzer mode. At the top of the screen the MSRA Primary is displayed, i.e. the application that captures data. Beneath the MSRA Primary, all active secondary applications are displayed in individual windows. Each secondary application has its own channel bar with the current settings as well as a button in order to switch to that secondary application tab directly.

The MSRA View displays the following basic elements:

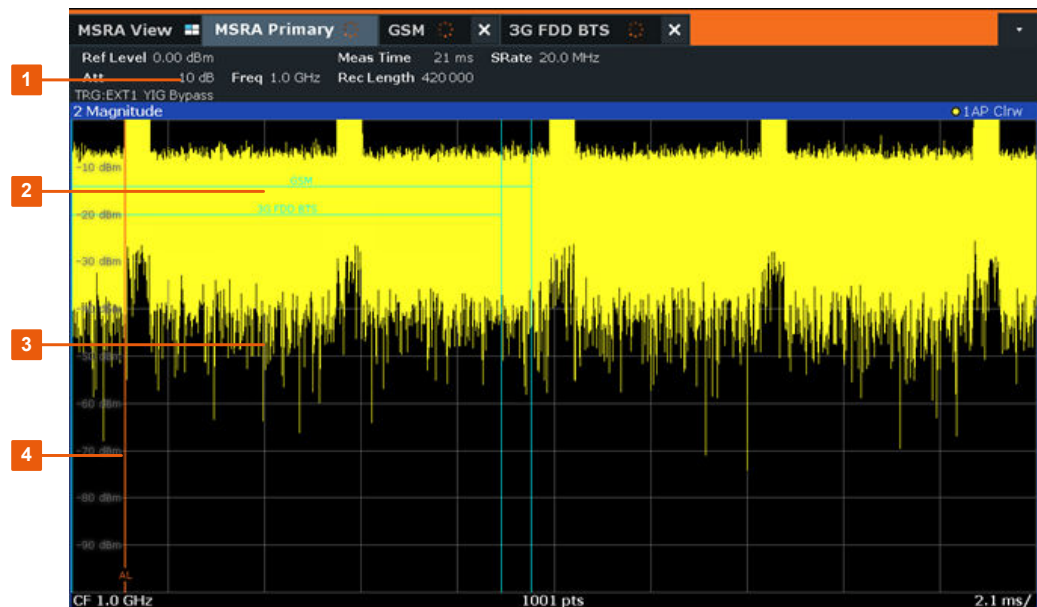


- 1 = Channel information bar for the MSRA Primary
- 2 = Secondary application data coverage for each active secondary application
- 3 = Result display for MSRA Primary (for entire capture buffer)
- 4 = Channel information bar for secondary application with button to switch to secondary application tab
- 5 = Result display for secondary application (for analysis interval)

## 2.2.2 MSRA primary

The MSRA primary is the only channel that captures data. It also controls global configuration settings for all secondary applications. The MSRA primary channel itself is implemented as an I/Q Analyzer secondary application. The MSRA primary measurement channel cannot be deleted or replaced.

The following figure shows the screen elements specific to the MSRA primary.



- 1 = Channel information bar for the MSRA Primary
- 2 = Data coverage for each active secondary application
- 3 = Result display for MSRA Primary (for entire capture buffer)
- 4 = Analysis line

### Channel bar information

The channel bar shows the firmware and measurement information for data acquisition and global configuration.

**Table 2-1: Information displayed in the channel bar for the MSRA Primary**

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

<b>AQT</b>	Defined measurement time, i.e. the duration of data acquisition to the capture buffer
<b>Rec Length</b>	Defined record length (number of samples to capture)
<b>SRate</b>	Defined sample rate for data acquisition
<b>RBW</b>	(Spectrum evaluation only) Resolution bandwidth calculated from the sample rate and record length

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.

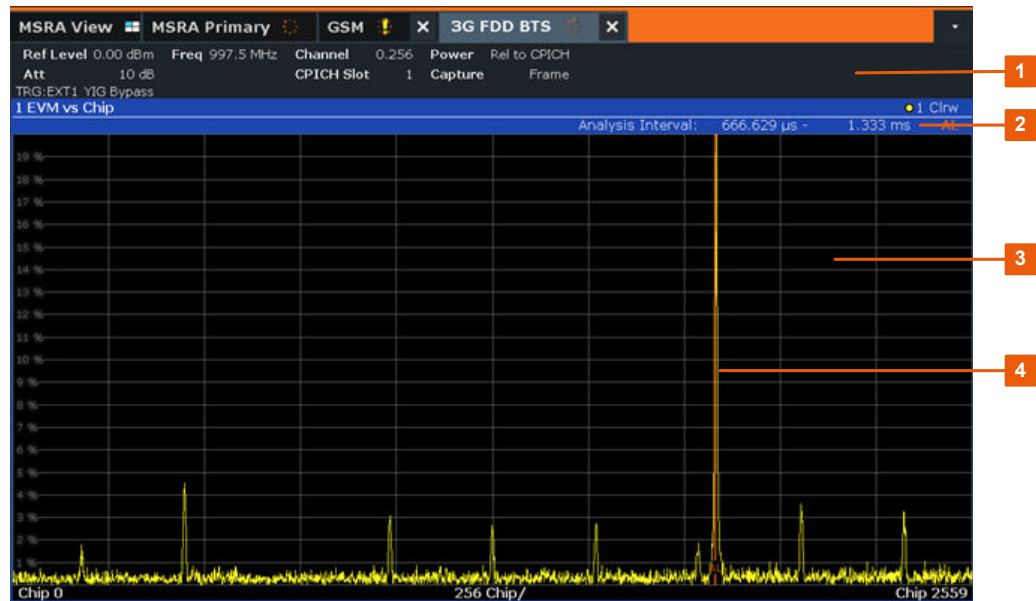
### Data coverage for each active secondary application

Each secondary application obtains an extract of the data captured by the MSRA primary (see also [Chapter 6.3, "Multi-standard analysis"](#), on page 31). Generally, if a signal contains data channels for multiple standards, the individual secondary applications are used to analyze the channel for the corresponding standard. Thus, it is of interest to know which secondary application is analyzing which part of the captured data, or more precisely, which data channel. The MSRA Primary display indicates the data covered by each secondary application, restricted to the channel bandwidth used by the corresponding standard, by vertical blue lines labeled with the secondary application name. For secondary applications that support several standards (e.g. VSA, LTE) an estimated or user-defined bandwidth is indicated.

### 2.2.3 MSRA secondary applications

The data captured by the MSRA primary measurement (or only parts of it) can be evaluated by various secondary applications. The measurement channel for each secondary application contains the settings and results for the secondary application data extract from the capture buffer.

The following figure shows the screen elements specific to the MSRA secondary application tabs.



- 1 = Channel information bar for secondary application
- 2 = Analysis interval for current evaluation
- 3 = Result display for analysis interval
- 4 = Analysis line

The display for the individual MSRA secondary applications is identical to the display in Signal and Spectrum Analyzer mode except for the following differences:

- The analysis interval indicates which part of the capture buffer is being evaluated and displayed in each window.
- The acquisition time indicated in the channel bar (Meas Time) indicates the *analyzed* measurement time, not the captured time.
- Any bandwidth or sample rate values refer to the secondary application data, not to the actual data acquisition from the input signal.
- The analysis line for time-based displays is only available in MSRA mode. It represents a common time marker in all secondary applications whose analysis interval includes that time (see "[Analysis line](#)" on page 32).

For details on the individual secondary application displays see the corresponding User Manuals for those applications.



## 3 Typical applications

The technological advances made in the field of mobile radio have given rise to a wide variety of standards over the past several decades. These standards, which include those produced by the global cooperative for standardization – the 3rd Generation Partnership Project (3GPP) – are based on various transmission technologies. Network operators can deploy GSM/EDGE, WCDMA, TD-SCDMA and LTE or combinations of these four standards.

To handle these complex scenarios, the Multistandard Radio Base Station (MSR-BS) was developed. These can transmit and receive multiple standards simultaneously on various carriers. An MSR-BS combines at least two different radio access technologies (RAT).

### Specifications and Tests

3GPP has published the specifications TS 37.141 and TS 37.104 for multistandard base stations. The latter describes the minimum requirements for multistandard base stations in terms of RF requirements for the downlink and uplink. TS 37.141 defines the tests and test requirements for the MSR-BS based on these RF requirements.

To allow for efficient MSR-BS testing, TS 37.141 includes test configurations. The goal of these test configurations is to significantly reduce the complexity of the many possible test scenarios. They are limited to the worst-case scenarios with the strictest criteria. Thus, for example, a test configuration is provided for receiver tests in which two signals – a GSM carrier and an LTE carrier with a  $BW_{\text{Channel}} = 5 \text{ MHz}$  – are positioned at the lower and upper edge of  $BW_{\text{RF}}$  while maintaining  $F_{\text{offset-RAT}}$ . This allows receiver tests to be performed with a configuration that fully utilizes the maximum bandwidth  $BW_{\text{RF}}$  of the MSR-BS.

### MSR-BS Testing using FSW Multi-Standard Radio Analysis

The newly introduced FSW MSRA mode allows you to capture signals from a multistandard base station and analyze the same data in various standard applications.

## 4 Measurements and result displays

### MSRA measurement

The only true measurement in MSRA mode in which I/Q data from the input signal is captured and stored is performed by the MSRA primary application. This data acquisition is performed as in the I/Q Analyzer application, i.e. a specified frequency span of the input signal is swept for a specified measurement time. The captured I/Q data can then be analyzed in various different applications.

### Result displays

The data that was captured by the MSRA primary can be evaluated in various different applications. All evaluation modes available for the MSRA applications are displayed in the selection bar in SmartGrid mode.



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

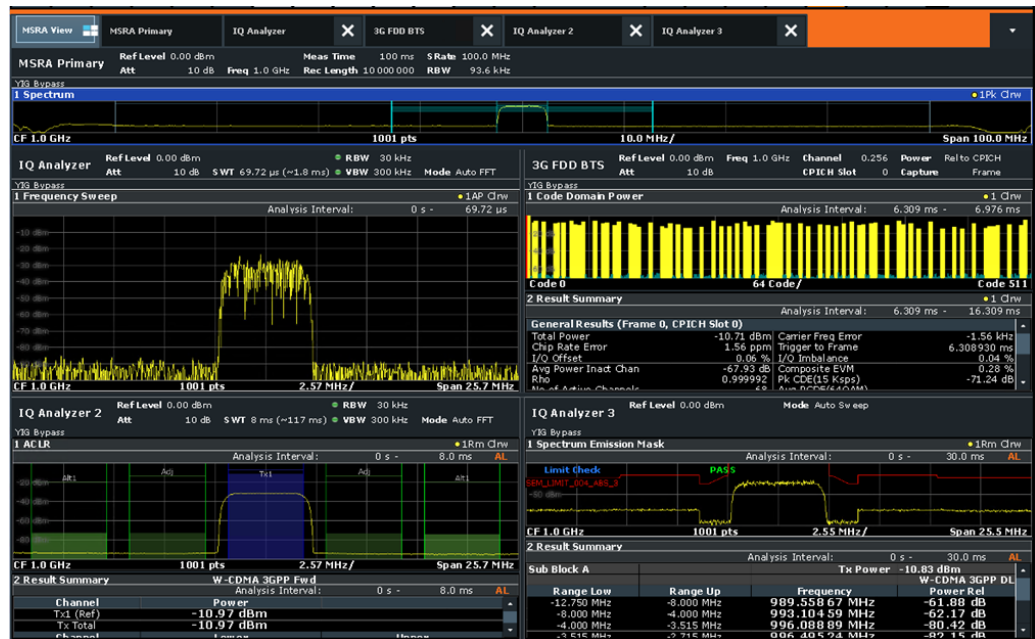
The result displays available in MSRA mode are those described for the individual applications. The MSRA primary is implemented as an I/Q Analyzer application and has the same result displays.

See the FSW I/Q Analyzer User Manual for a description of the result displays available for the I/Q Analyzer and thus the MSRA primary.

### 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 6.5, "Measurements in the time and frequency domain"](#), on page 33).

This allows you to perform standard-specific and general power measurements (such as ACLR or SEM) or statistical evaluations, as well as analyzing the EVM or modulation accuracy, on the same captured I/Q data.



Time and frequency-based measurements are configured using the same settings and provide similar results as in the Spectrum application. In addition, the analysis interval used for the measurement is indicated as in all MSRA applications.

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

## 5 Applications and operating modes

The FSW provides several applications for different analysis tasks and different types of signals, e.g. WCDMA, I/Q analysis or basic spectrum analysis. When you activate an application, a new measurement channel is created which determines the measurement settings for that application. The same application can be activated with different measurement settings by creating several channels for the same application. Each channel is displayed in a separate tab on the screen.



The maximum number can be limited further by the available memory on the instrument.

### Measurements

Depending on the task, the application can provide different measurement functions. The measurement function determines which settings, functions and evaluation methods are available in the FSW. Only one measurement can be performed at the same time within the same application instance. You select the measurement for an application via the [MEAS] key.

In the Spectrum application, for example, the FSW provides a variety of different measurement functions, including:

- Frequency sweep or zero span measurement
- **Basic measurements** - measure the spectrum of your signal or watch your signal in time domain
- **Power measurements** - calculate the powers involved in modulated carrier signals
- **Emission measurements** - detect unwanted signal emission
- **Statistic measurements** - evaluate the spectral distribution of the signal
- **Further measurements** - provide characteristic values of the signal
- **EMI measurements** - detect electromagnetic interference in the signal

The individual functions are described in detail in the FSW User Manual.

### Independent vs correlating measurements

With the **conventional FSW signal and spectrum analyzer**, you can perform several different measurements almost simultaneously. However, the individual measurements are independent of each other - **each application captures and evaluates its own set of data**, regardless of what the other applications do.

Sometimes, it can be useful to **analyze the exact same input data using different applications**. For example, imagine capturing data from a base station and analyzing the RF spectrum in the Modulation Analysis application. If a spur or an unexpected peak occurs, possibly you want to analyze the same data in the I/Q Analyzer. There, you see the real and imaginary components of the signal and can thus detect the reason for the irregular signal. Normally, when you switch to a different application, evaluation is performed on the data that was captured by that application, and not the previous one. In our example, the irregular signal is lost. Therefore, a second operating mode is available in the FSW: Multistandard radio analyzer (MSRA) mode.

### Multistandard radio analyzer mode

In **multistandard radio analyzer (MSRA) mode**, data acquisition is performed once as an I/Q measurement by a primary application. The captured data is then evaluated by any number of secondary applications for different radio standards. Data acquisition and global configuration settings are controlled globally, while the evaluation and display settings can be configured individually for each secondary application. Using the multistandard radio analyzer, unwanted correlations between different signal components using different transmission standards can be detected. Thus, for example, an irregularity in a GSM burst can be examined closer in the FSW 3G FDD BTS (WCDMA) secondary application. There you can analyze dependencies like a change in the EVM value.

### Multi-Standard Real-Time mode

To combine the advantages of the MSRA mode with its correlated measurements and the gapless results provided by real-time measurements, a third operating mode has been introduced: the **Multi-Standard Real-Time (MSRT) mode**. This operating mode is only available if one of the real-time options (FSW-B160R/-K160RE/-U160R) is installed.

In this operating mode, data acquisition is performed once as a real-time measurement, and the captured data is then evaluated by any number of secondary applications. Thus, you can perform a real-time measurement triggered with a frequency mask. Then you evaluate the results in the VSA secondary application, for example, to detect the cause of a frequency exception.

### Distinct operating modes

Although the applications themselves are identical in all operating modes, the handling of the data between applications is not. Thus, the operating mode determines which secondary applications are available and active. Whenever you change the operating mode, the currently active measurement channels are closed. The default operating mode is "Signal and Spectrum Analyzer" mode; however, the presetting can be changed.

### Remote command:

INST:MODE MSR, see [INSTrument:MODE](#) on page 120

### Switching between applications

When you switch to a new application, a set of parameters is passed on from the current application to the new one:

- Center frequency and frequency offset
- Reference level and reference level offset
- Attenuation

After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

## 5.1 Available secondary applications

Not all options available for the FSW are supported as secondary applications in the MSRA mode. The supported secondary applications are listed here. Note that some of the applications are provided with the base unit, while others are available only if the corresponding firmware options are installed.

Currently, only applications for **base-station** tests and applications that process I/Q data are supported in MSRA mode, in particular:

1xEV-DO BTS.....	22
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### 1xEV-DO BTS

The 1xEV-DO BTS secondary application requires an instrument equipped with the 1xEV-DO BTS measurements option, R&S FSW-K84. This secondary application provides test measurements for 1xEV-DO BTS downlink signals (base station signals) according to the test specification.

RF measurements are not supported in MSRA mode.

For details, see the R&S FSW 1xEV-DO user manual.

Remote command:

INST:SEL BDO, see [INSTrument\[:SElect\]](#) on page 120

### 3G FDD BTS

The 3G FDD BTS secondary application requires an instrument equipped with the 3GPP base station measurements option, R&S FSW-K72. This secondary application provides test measurements for WCDMA downlink signals (base station signals) according to the test specification.

RF measurements are not supported in MSRA mode.

For details, see the R&S FSW 3G FDD user manual.

Remote command:

INST:SEL BWCD, see [INSTrument\[:SElect\]](#) on page 120

### 5G NR

The 3GPP 5G NR secondary application requires an instrument equipped with one of the 3GPP 5G NR measurements option, R&S FSW-K144. This secondary application provides test measurements for 3GPP 5G NR downlink and uplink signals (base station signals) according to the test specification.

For details see the user manuals for the 5G NR downlink and uplink measurement application.

Remote command:

INST:SEL 5GNR, see [INSTrument\[:SElect\]](#) on page 120

### AM/FM/PM Modulation Analysis

The AM/FM/PM Modulation Analysis secondary application requires an instrument equipped with the corresponding optional software. This secondary application provides measurement functions for demodulating AM, FM, or PM signals.

For details, see the R&S FSW AM/FM/PM Modulation Analysis user manual.

Remote command:

INST:SEL ADEM, see [INSTrument\[:SElect\]](#) on page 120

### cdma2000 BTS

The cdma2000 BTS secondary application requires an instrument equipped with the cdma2000 BTS measurements option, R&S FSW-K82. This secondary application provides test measurements for cdma2000 BTS downlink signals (base station signals) according to the test specification.

RF measurements are not supported in MSRA mode.

For details, see the R&S FSW cdma2000 user manual.

Remote command:

INST:SEL BC2K, see [INSTrument\[:SElect\]](#) on page 120

### GSM

The GSM secondary application requires an instrument equipped with the corresponding optional software. This secondary application provides measurement functions for measuring GSM signals.

For details, see the R&S FSW GSM user manual.

Remote command:

INST:SEL GSM, see [INSTrument\[:SElect\]](#) on page 120

### I/Q Analyzer

The I/Q Analyzer secondary application provides measurement and display functions for I/Q signals. Evaluation of the captured I/Q data in the frequency and time domain is also possible.

For details, see the R&S FSW I/Q Analyzer user manual.

Remote command:

INST:SEL IQ, see [INSTrument\[:SElect\]](#) on page 120

**LTE**

The LTE secondary application requires an instrument equipped with one of the LTE options, R&S FSW-K10x. This secondary application provides test measurements for LTE downlink and uplink signals according to the test specification.

Frequency sweep measurements are not supported in MSRA mode.

For details, see the R&S FSW LTE downlink and uplink user manual.

For details see the user manuals for the LTE downlink and uplink measurement application.

Remote command:

INST:SEL LTE, see [INSTrument\[:SElect\]](#) on page 120

**NB-IoT**

The NB-IoT application requires an instrument equipped with the NB-IoT measurements option R&S FSW-K106. This application provides NB-IoT measurements in the downlink.

For details, see the R&S FSW-K106 (NB-IoT downlink) user manual.

Remote command:

INST:SEL NIOT, see [INSTrument\[:SElect\]](#) on page 120

**OFDM Vector Signal Analysis (OFDM VSA)**

The OFDM VSA application requires the OFDM Vector Signal Analysis option, FSW-K96, to be installed. This application provides measurements and evaluations for OFDM Vector Signal Analysis.

For details see the FSW-K96 User Manual.

Remote command:

INST:SEL OFDMVSA, see [INSTrument\[:SElect\]](#) on page 120

**OneWeb**

The OneWeb application requires an instrument equipped with the OneWeb measurements option R&S FSW-K201. This application provides OneWeb reverse link measurements.

For details, see the R&S FSW-K201 (OneWeb reverse link measurements) user manual.

Remote command:

INST:SEL OWEB, see [INSTrument\[:SElect\]](#) on page 120

**Pulse Measurements**

The Pulse measurements secondary application requires an instrument equipped with the pulse measurements option, R&S FSW-K6. This secondary application provides measurement functions for pulsed signals.

For details, see the R&S FSW-K6 user manual.

Remote command:

INST:SEL PULSE, see [INSTrument\[:SElect\]](#) on page 120



**TD-SCDMA BTS**

The TD-SCDMA BTS secondary application requires an instrument equipped with the TD-SCDMA BTS measurements option, R&S FSW-K82. This secondary application provides test measurements for TD-SCDMA BTS downlink signals (base station signals) according to the test specification.

RF measurements are not supported in MSRA mode.

For details, see the R&S FSW TD-SCDMA user manual.

Remote command:

INST:SEL BTDS, see [INSTrument\[:SElect\]](#) on page 120

**Transient Analysis**

The Transient Analysis secondary application requires an instrument equipped with the Transient Analysis option, R&S FSW-K60. This secondary application provides measurements and evaluations for Transient Analysis.

For details, see the R&S FSW-K60 user manual.

Remote command:

INST:SEL TA, see [INSTrument\[:SElect\]](#) on page 120

**Verizon 5GTF measurement application (V5GTF)**

The Verizon 5GTF measurement application requires an instrument equipped with the V5GTF option, R&S FSW-K118/K119. This application provides measurements and evaluations for uplink and downlink signals according to the Verizon 5G technical forum (TS V5G.211 standard).

For details, see the R&S FSW-K118/-K119 user manual.

Remote command:

INST:SEL V5GT, see [INSTrument\[:SElect\]](#) on page 120

**Vector Signal Analysis (VSA)**

The VSA secondary application requires an instrument equipped with the Vector Signal Analysis option, R&S FSW-K70. This secondary application provides measurements and evaluations for single-carrier digitally modulated signals.

For details, see the R&S FSW VSA user manual.

Remote command:

INST:SEL DDEM, see [INSTrument\[:SElect\]](#) on page 120

**WLAN**

The WLAN application requires an instrument equipped with the WLAN option, R&S FSW-K91/91n. This application provides measurements and evaluations according to the WLAN IEEE 802.11 standards.

For details see the R&S FSW-K91 User Manual.

Remote command:

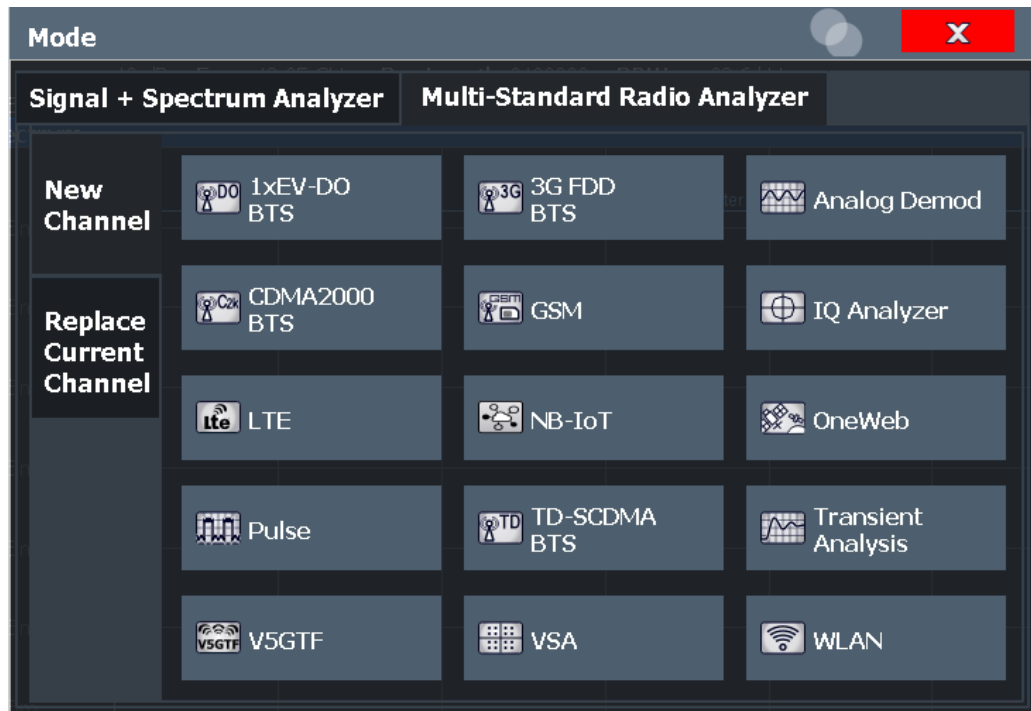
INST:SEL WLAN, see [INSTrument\[:SElect\]](#) on page 120

## 5.2 Selecting the operating mode and secondary applications

**Access:** [MODE]

The default operating mode is "Signal and Spectrum Analyzer" mode, however, the presetting can be changed.

(See the "Instrument Setup" section in the FSW user manual).



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### Switching the operating mode

To switch the operating mode, select the corresponding tab (see [Chapter 2.1, "Starting the MSRA operating mode"](#), on page 10).

Remote command:

`INSTRUMENT:MODE` on page 120

### Selecting an MSRA secondary application

To start a new or replace an existing secondary application, select the corresponding button in the correct tab.

Remote command:

`INSTRUMENT[:SElect]` on page 120

**New Channel ← Selecting an MSRA secondary application**

The secondary application selected on this tab is started in a new channel, i.e. a new tab in the display.

Remote command:

[INSTrument:CREate\[:NEW\]](#) on page 117

[INSTrument\[:SElect\]](#) on page 120

**Replace Current Channel ← Selecting an MSRA secondary application**

The secondary application selected on this tab is started in the currently displayed channel, replacing the current secondary application.

Remote command:

[INSTrument:CREate:REPLace](#) on page 118

**Closing an application**

To close an application, simply close the corresponding tab by selecting the "x" next to the channel name.

Remote command:

[INSTrument:DELeTe](#) on page 118

## 5.3 Using the sequencer in MSRA mode

When you switch to MSRA mode, the Sequencer is automatically activated in continuous mode. Unless it is stopped or you select a different Sequencer mode, the FSW continuously performs the following tasks:

1. The MSRA primary application acquires data.
2. The active secondary applications evaluate the data one after the other.
3. The display in the tab is updated.

This behavior is identical to "Signal and Spectrum Analyzer" mode (also for single sequence or channel-defined Sequencer modes).

However, if you switch the Sequencer off, the behavior of the sweep functions is slightly different to "Signal and Spectrum Analyzer" mode (see also "[Performing sweeps](#)" on page 30):

- If continuous sweep is active (default) and you switch to a different secondary application, continuous sweep is aborted. Thus, the same data is evaluated in different secondary applications without overwriting the data in the capture buffer. You can start continuous sweep again as usual.
- Only the secondary application that is currently displayed when a measurement is performed is updated automatically. A new "Refresh" function is available to update the display in one or all other secondary applications.

For details on the Sequencer function, see the FSW user manual.



The "Sequencer" menu is available from the toolbar.

### Sequencer State

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

Remote command:

[SYSTem:SEQuencer](#) on page 221

[INITiate:SEQuencer:IMMediate](#) on page 219

[INITiate:SEQuencer:ABORt](#) on page 219

### Sequencer Mode

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

#### "Single Sequence"

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

#### "Continuous Sequence"

The measurements in each active channel are performed one after the other, repeatedly, in the same order, until sequential operation is stopped.

This is the default Sequencer mode.

#### "Channel Defined Sequence"

First, a single sequence is performed. Then, only channels in continuous sweep mode are repeated.

Remote command:

[INITiate:SEQuencer:MODE](#) on page 219

### Refresh All

This function is only available if the Sequencer is deactivated, no sweep is currently running, and only in MSRA mode.

The data in the capture buffer is re-evaluated by all active secondary applications, for example after a new sweep was performed while the Sequencer was off.

**Note:** To update only the displays in the currently active secondary application, use the "Refresh" function in the "Sweep" menu for that secondary application (see "[Refresh \(MSRA only\)](#)" on page 92).

Remote command:

[INITiate:SEQuencer:REFResh\[:ALL\]](#) on page 220

## 6 MSRA basics

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

### 6.1 Configuration

#### Primary parameters

In MSRA mode, only the MSRA primary performs a data acquisition. Thus, all parameters that determine how the I/Q data is captured from the I/Q channel can only be configured in the "MSRA Primary" tab. In all secondary application tabs, these settings are deactivated (or have a different meaning).

Typical primary parameters include:

- Sample rate
- Record length
- Bandwidth
- Center frequency
- Reference level
- Trigger settings
- External reference
- Impedance, preamplification, attenuation

#### Channel-specific parameters

Each secondary application, however, can define all parameters concerning analysis individually.

Typical channel-specific parameters include:

- Center frequency, duration and number of trace points for the secondary application data extract
- Offset of the secondary application data extract from the trigger event
- Evaluation methods
- Range and scaling
- Trace mode
- Marker positions

#### Conflicting parameters

Primary and channel-specific parameters can be configured independently of one another, in any order that is convenient to you. However, there are dependencies between the parameters, as the secondary applications can only evaluate data that has been captured by the MSRA primary previously. Thus, configuring parameters is

not restricted, but you are informed about the violation of possible restrictions by error messages in the status bar of the secondary applications where necessary.

## 6.2 Data acquisition

As mentioned before, only the MSRA primary performs a data acquisition. Thus, the MSRA primary defines the center frequency, sample rate and record length of the captured I/Q data. It also defines the trigger event, thus all secondary applications have the same trigger. However, an offset from the trigger can be defined by the individual secondary applications (see "[Trigger offset vs. capture offset](#)" on page 32).

### Performing sweeps

When you switch to MSRA mode, the Sequencer is automatically activated in continuous mode. The MSRA primary continuously performs a data acquisition. If any secondary applications are activated, then after each measurement, the data in the active secondary applications is evaluated one after the other. The MSRA primary will then repeat the data acquisition and evaluate the new data etc. The channel displays are updated after each measurement or evaluation.

Alternatively, you can perform measurements manually. You can start a single or continuous sweep from any secondary application, which updates the data in the capture buffer and the results in the current secondary application. The results in the other secondary applications, however, remain unchanged. You must refresh them manually, either individually or all at once, using a "**Refresh**" function.

Note that in **continuous sweep mode**, sweeping is aborted when you switch to a different secondary application. You can then continue sweeping from there. This is necessary in order to evaluate the same data in different secondary applications without overwriting the data in the capture buffer.

In **single sweep mode**, only one sweep is performed; a sweep count is not available - neither for the MSRA primary, nor for the secondary applications. However, depending on the secondary application, a statistics count may be available for statistics based on a single data acquisition. Trace averaging is performed as usual for sweep count = 0, the current trace is averaged with the previously stored averaged trace.

### Data availability

The secondary applications can only receive data that is available in the capture buffer. As soon as data has been stored to the capture buffer successfully, a status bit (#9) in the `STAT:OPER` register is set. If the required secondary application data is not available, an error message is displayed. Details on restrictions are described in [Chapter 6.4, "Restrictions for secondary applications"](#), on page 33.

## 6.3 Multi-standard analysis

### Secondary application data

The secondary applications receive data for analysis from the capture buffer, if necessary resampled or with filters applied. The secondary applications can define their own center frequency, sample rate and record length for their **secondary application data**, which is an **extract of the capture buffer data**. The secondary applications may not request more sample points than the captured data contains, or samples from a frequency outside the range of the capture buffer, for example.

Generally, if a signal contains data channels for multiple standards, the individual secondary applications are used to analyze the channel for the corresponding standard. Thus, it is of interest to know which secondary application, or more precisely: which data channel is analyzing which part of the captured data and how each data channel is correlated (in time) to others.

The MSRA primary display indicates the data covered by each secondary application, restricted to the channel bandwidth used by the corresponding standard, by vertical blue lines labeled with the secondary application name. For secondary applications that support several standards (e.g. VSA, LTE) an estimated or user-defined bandwidth is indicated.

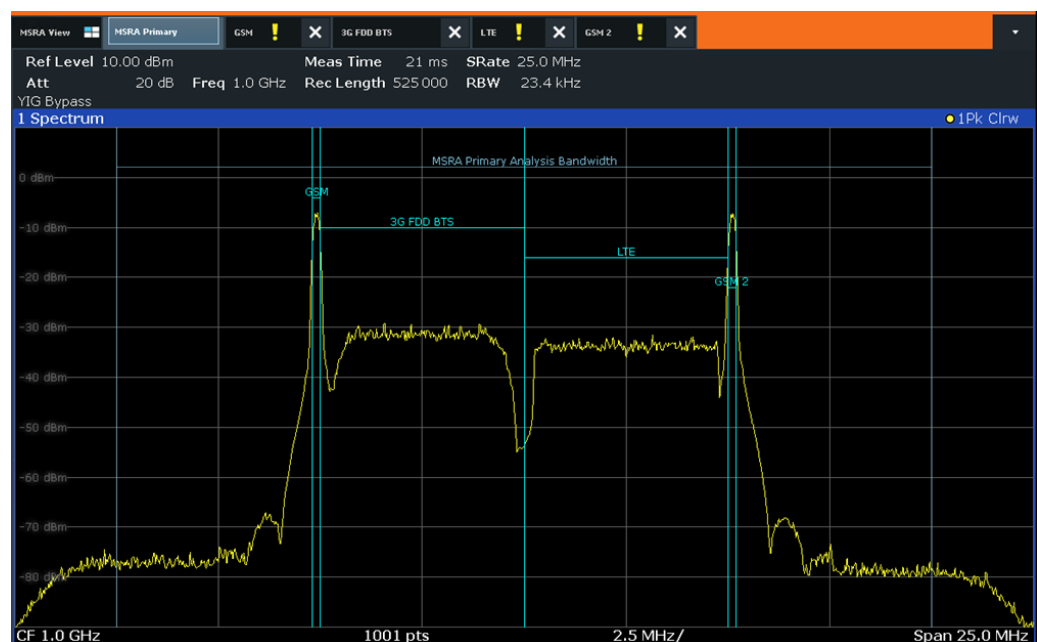


Figure 6-1: MSRA primary indicating covered bandwidth for 4 secondary applications

### Analysis interval

Each secondary application receives an extract of the data from the capture buffer. However, the individual evaluation methods of the secondary application need not analyze the complete data range. Some secondary applications allow you to select a specific part of the data for analysis, e.g. an individual frame, burst or pulse, or to use an

offline trigger that defines an additional offset to the capture offset. The data range that is actually analyzed is referred to as the **analysis interval**.

The analysis interval is indicated in the window title bar for each evaluation, and can be queried via remote control.



For secondary applications that do not allow you to restrict the evaluation range (e.g. I/Q Analyzer, Modulation Analysis), the analysis interval is identical to the secondary application data extract.

### Trigger offset vs. capture offset

The beginning of the capture buffer is defined by the trigger event and the trigger offset. The trigger source is defined by the MSRA primary, which means that all channels use the same trigger. However, each secondary application might need a different trigger offset or a different number of pretrigger samples. Instead of a trigger offset, the secondary applications define a **capture offset**. The capture offset is defined as an **offset to the beginning of the capture buffer**.

Thus, the beginning of the secondary application data extract is calculated as:

[time of trigger event] + [trigger offset] + [capture offset]

Note that while the trigger offset value may be negative, thus starting before the trigger event, the capture offset may not. A negative capture offset would mean the secondary application data would start before the first sample of the capture buffer. The (pre-)trigger offset in the MSRA primary must be configured such that the required number of pre-trigger samples for the secondary applications are available.

### Analysis line

A frequent question when analyzing multi-standard radio 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 (e.g. cross-talk).

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



## 6.4 Restrictions for secondary applications

As mentioned in various contexts before, the MSRA secondary applications themselves are identical to Signal and Spectrum operating mode, however, the correlation between secondary applications and the MSRA primary require some restrictions. Principally, you are not restricted in setting parameters. However, if any contradictions occur between the configured capture settings and the analysis settings, error messages are displayed in the status bar of the secondary application and an icon (ⓘ) is displayed next to the channel label. However, it does not matter in which order you configure the settings - you will not be prevented from doing so.

In particular, the following restrictions apply to secondary applications in MSRA mode:

- **Data acquisition:** parameters related to data acquisition can only be configured by the MSRA primary
- **Secondary application data:** only data contained in the capture buffer can be analyzed by the secondary application; this implies the following restrictions:
  - **Center frequency:** must lie within the captured data bandwidth
  - **Measurement time/Record length:** must be smaller than or equal to the values of the MSRA primary
  - **Capture offset:** must be smaller than the record length of the MSRA primary
  - **Trace averaging:** only for sweep count = 0
- **AUTO SET functions:** in secondary applications, only the frequency can be adjusted automatically; all other adjustment functions require a new data acquisition



General restrictions concerning sample rates and maximum usable I/Q bandwidths for I/Q data also apply in MSRA mode; see [Chapter C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237.

## 6.5 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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237 and [Chapter D, "Sample rates and bandwidths for digital I/Q data"](#), on page 252).

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

## 7 MSRA configuration

**Access:** [MODE] > "Multi Standard Radio Analyzer" tab

MSRA is a special operating mode on the FSW.

When you switch the operating mode of a measurement channel to MSRA mode the first time, the Sequencer is automatically activated in continuous mode (see [Chapter 5.3, "Using the sequencer in MSRA mode"](#), on page 27), starting an I/Q Analyzer data acquisition with the default settings (but with a "Spectrum" result display). The "I/Q Analyzer" menu is displayed, providing access to the most important configuration functions.

### Configuring the MSRA primary

The MSRA primary is the only channel that captures data. It also controls global configuration settings for all secondary applications. Thus, all settings that refer to data acquisition can only be configured in the MSRA primary tab. These settings are deactivated in the configuration overviews and dialog boxes for all secondary application channels. All other settings, e.g. concerning the evaluated data range, the display configuration or analysis, can be configured individually for each secondary application and the primary application.



### Restrictions

Note that although some restrictions apply to parameters that affect both the MSRA primary and secondary applications (see [Chapter 6.4, "Restrictions for secondary applications"](#), on page 33), it does not matter in which order you configure them. If any contradictions occur between the captured data and the data to be evaluated, error messages are displayed in the status bar of the secondary application and an icon (✱ or ⚠) is displayed next to the channel label. However, you will not be prevented from configuring contradictory settings.



### 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 MSRA primary itself, it can also be imported to the FSW, provided it has the correct format. Furthermore, the captured I/Q data from the MSRA primary can be exported for further analysis in external applications.

For details see the FSW I/Q Analyzer and I/Q Input User Manual.

### Configuring an I/Q Analyzer as an MSRA secondary application

**Access:** [MODE] > "Multi Standard Radio Analyzer" tab > "Select Meas"

In principle, the I/Q Analyzer in MSRA mode is configured as in Signal and Spectrum Analyzer mode.

However, 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 6.5, "Measurements in the time and frequency domain"](#),

on page 33). You can select which type of measurement is to be performed: conventional I/Q data analysis or a time or frequency domain measurement.

The common measurements as in the Spectrum application are available. In addition, "IQ 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. Further configuration of the I/Q Analyzer secondary application is described in the FSW I/Q Analyzer and I/Q Input User Manual.

The following chapters describe configuration for the MSRA primary.

• <a href="#">Configuration overview</a> .....	36
• <a href="#">Input source settings</a> .....	38
• <a href="#">Amplitude</a> .....	69
• <a href="#">Frequency settings</a> .....	77
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## 7.1 Configuration overview



**Access:** all menus

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

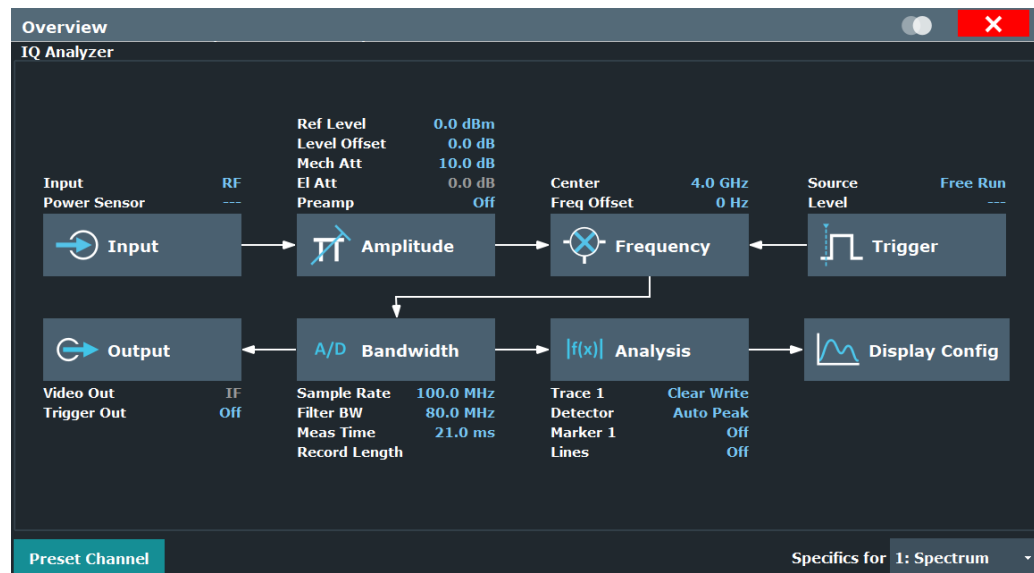


Figure 7-1: Configuration Overview for MSRA primary

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



The "Overview" varies depending on the secondary application; for detailed descriptions see the corresponding application User Manual.

If the I/Q Analyzer is used as an MSRA secondary application, the "Overview" also provides a measurement selection button in order to perform measurements in the frequency and time domain. See the FSW I/Q Analyzer and I/Q Input User Manual for details.

The "Overview" for the MSRA primary provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Input settings  
See [Chapter 7.2, "Input source settings"](#), on page 38
2. Amplitude settings  
See [Chapter 7.3, "Amplitude"](#), on page 69
3. Frequency settings  
See [Chapter 7.4, "Frequency settings"](#), on page 77
4. Optionally, trigger settings  
See [Chapter 7.5, "Trigger settings"](#), on page 79
5. Bandwidth settings  
See [Chapter 7.6, "Data acquisition and bandwidth settings"](#), on page 86
6. Optionally, output settings  
See [Chapter 7.7, "Output settings"](#), on page 93
7. Analysis settings and functions  
See [Chapter 8, "Analysis"](#), on page 97
8. Display configuration  
See [Chapter 7.8, "Display configuration"](#), on page 94

#### To configure settings

- ▶ Select any button to open the corresponding dialog box.

For step-by-step instructions on configuring MSRA measurements, see [Chapter 9, "How to perform measurements in MSRA mode"](#), on page 99.

#### 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 122

### 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.

## 7.2 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 MSRA operating mode application can also process input from the following sources:

- External mixer
- Probes

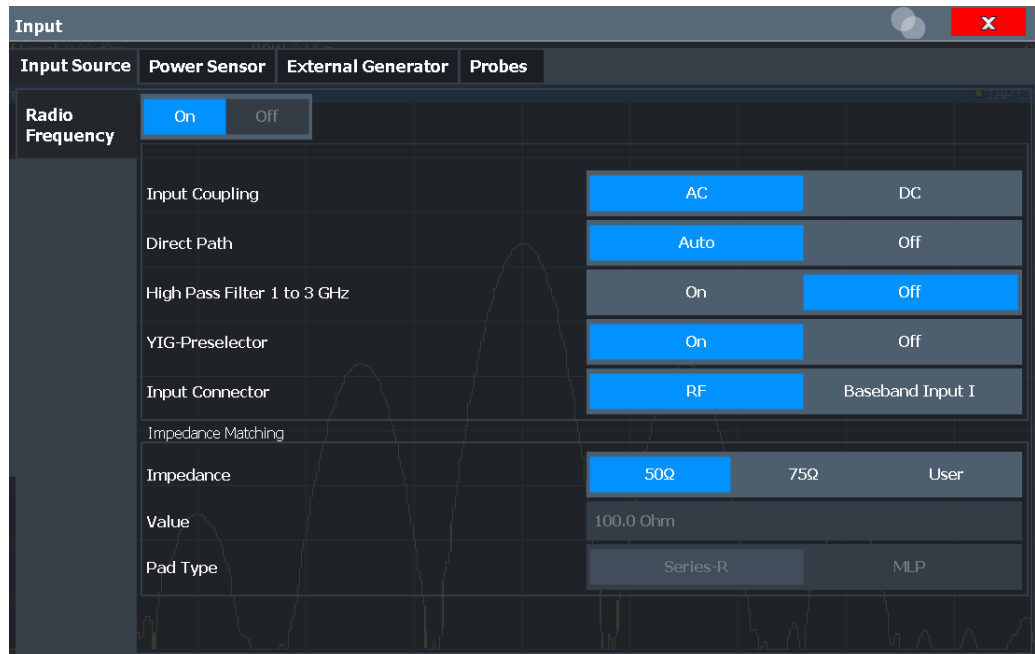
For details, see the FSW User Manual.

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.

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- [Settings for input from I/Q data files](#).....43
- [External frontend settings](#)..... 45
- [Digital I/Q input settings](#)..... 55
- [Analog baseband input settings](#).....57
- [Oscilloscope Baseband Input](#).....60
- [Settings for 2 GHz / 5 GHz bandwidth extension \(R&S FSW-B2000/B5000\)](#).....63

## 7.2.1 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.

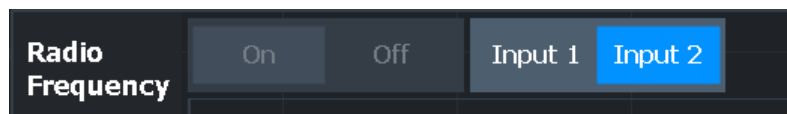
When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case, you must decrease the level at the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

<a href="#">Radio Frequency State</a> .....	39
<a href="#">Input Coupling</a> .....	40
<a href="#">Impedance</a> .....	40
<a href="#">Impedance</a> .....	41
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<a href="#">High Pass Filter 1 to 3 GHz</a> .....	42
<a href="#">YIG-Preselector</a> .....	42
<a href="#">Input Connector</a> .....	42

### 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 126

[INPut:TYPE](#) on page 127

### 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 DC.

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 124

### Impedance

The FSW has an internal impedance of 50  $\Omega$ . 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  $\Omega$ .

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 $\Omega$ "            (Default:) no conversion takes place



"75Ω"	The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)
"User"	The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)

Remote command:

[INPut: IMPedance](#) on page 125

[INPut: IMPedance: PTYPE](#) on page 125

For Analog Baseband input:

[INPut: IQ: IMPedance](#) on page 170

[INPut: IQ: IMPedance: PTYPE](#) on page 170

### Impedance

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

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

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

This value also affects the unit conversion (see ["Reference Level"](#) on page 72).

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

Not available for input from the optional "Analog Baseband" interface. For analog baseband input, an impedance of 50 Ω is always used.

Remote command:

[INPut: IMPedance](#) on page 125

### 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 124

### 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 124

### YIG-Preselector

Enables or disables the YIG-preselector.

This setting requires an additional option on the FSW.

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
- Multicarrier "Group Delay"
- GSM
- VSA
- OFDM VSA

Remote command:

`INPut:FILTer:YIG[:STATe]` on page 125

### 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".

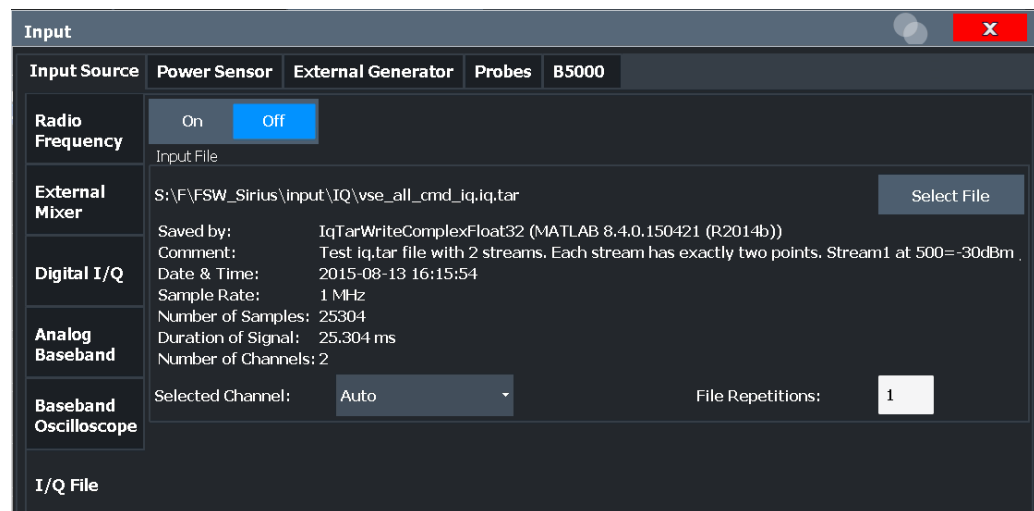
Remote command:

[INPut:CONNector](#) on page 123

## 7.2.2 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"



<a href="#">I/Q Input File State</a> .....	43
<a href="#">Select I/Q data file</a> .....	44
<a href="#">Selected Channel</a> .....	44
<a href="#">File Repetitions</a> .....	44

### 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 126

### 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 the FSW I/Q Analyzer and I/Q Input user manual.

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 127

### 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 128

[MMEMory:LOAD:IQ:STReam:AUTO](#) on page 128

[MMEMory:LOAD:IQ:STReam:LIST?](#) on page 129

### 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 129

## 7.2.3 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 applications that support zero-span or I/Q-based measurements, such as the I/Q Analyzer application.

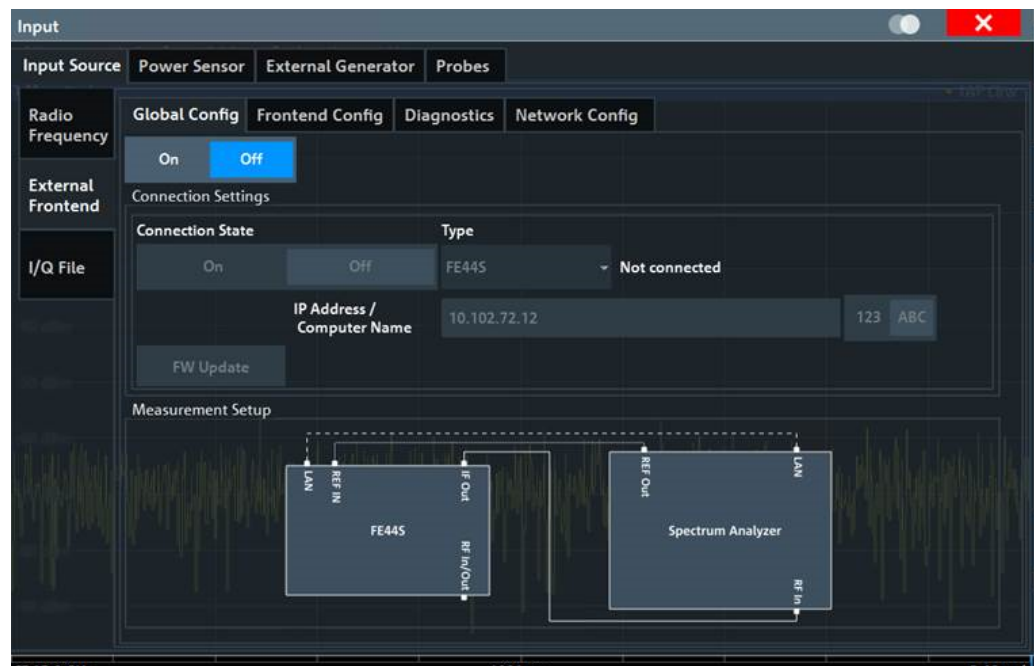
For details see the FSW user manual.

- [Global configuration settings](#).....45
- [Frontend configuration settings](#).....47
- [Diagnostics](#).....51
- [Network configuration](#).....52
- [External Devices](#).....53

### 7.2.3.1 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](#).....46
- [External Frontend Connection State](#).....46
- [Frontend Type](#).....46
- [IP Address/ Computer Name](#).....46
- [FW Update](#).....47

### 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 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 138

### 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 130

`[SENSe:]EFRontend:CONNECTION:CSTate?` on page 131

### 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 131

### 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 [Chapter 7.2.3.4, "Network configuration"](#), on page 52.

Remote command:

`[SENSe:]EFRontend:CONNECTION:CONFig` on page 131

### 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.

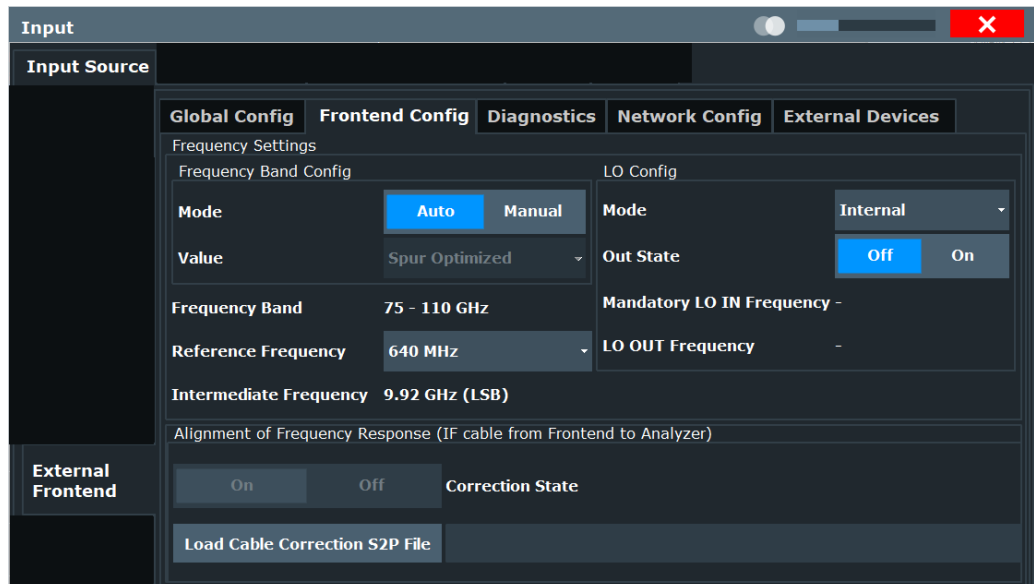
Remote command:

[SENSe:]EFRontend:FWUpdate on page 140

### 7.2.3.2 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.

Frequency Band Configuration.....	48
Frequency Band.....	49
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Intermediate Frequency.....	49
LO Mode.....	50
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LO OUT Frequency.....	50
Correction State.....	50
Load Cable Correction S2P File.....	50

### 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/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 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 133

[\[SENSe:\]EFRontend:FREQuency:BCONfig:LIST?](#) on page 133

[\[SENSe:\]EFRontend:FREQuency:BCONfig:SElect](#) on page 134

### 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 132

[\[SENSe:\]EFRontend:FREQuency:BAND<b>:LOWER?](#) on page 132

[\[SENSe:\]EFRontend:FREQuency:BAND<b>:UPPER?](#) on page 132

### 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 137

[\[SENSe:\]EFRontend:FREQuency:REFerence:LIST?](#) on page 137

### 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 48.

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:

[SENSe:]EFRontend:FREQUENCY:IFrequency[:VALue]? on page 135

[SENSe:]EFRontend:FREQUENCY:IFrequency:SIDeband? on page 135

### LO Mode

Determines whether the external frontend uses its internal LO or an external 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 50.

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

"Internal" Uses the internal LO

Remote command:

[SENSe:]EFRontend:FREQUENCY:LOSCillator:MODE on page 136

### 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 136

### 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 135

### 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 136

### 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 139

### 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 139

### 7.2.3.3 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.

test description	min	act	max	state
Frontend Voltages				
FE1_3V3	3.000	3.311	3.600	PASSED
FE1_5V	4.250	5.027	5.750	PASSED
FE1_6V5	6.000	5.893	7.000	FAILED***
FE1_MS33	-3.600	3.347	-3.000	FAILED***
Frontend Voltages Test				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_MS3V	-5.500	-4.948	-4.500	PASSED
SYNTH_REFSV	4.500	5.031	5.500	PASSED
Synthesizer Voltage Test				PASSED
Supply Voltage				
SUPPLY_12V	10.800	11.909	13.200	PASSED
SUPPLY_3V3D	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_MS3V	-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.....	51
Abort Selftest.....	52
Selftest Results.....	52

#### 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 140

**Abort Selftest**

Aborts a running self-test.

Remote command:

[SENSe:]EFRontend<fe>:SELfTest? on page 140

**Selftest Results**

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

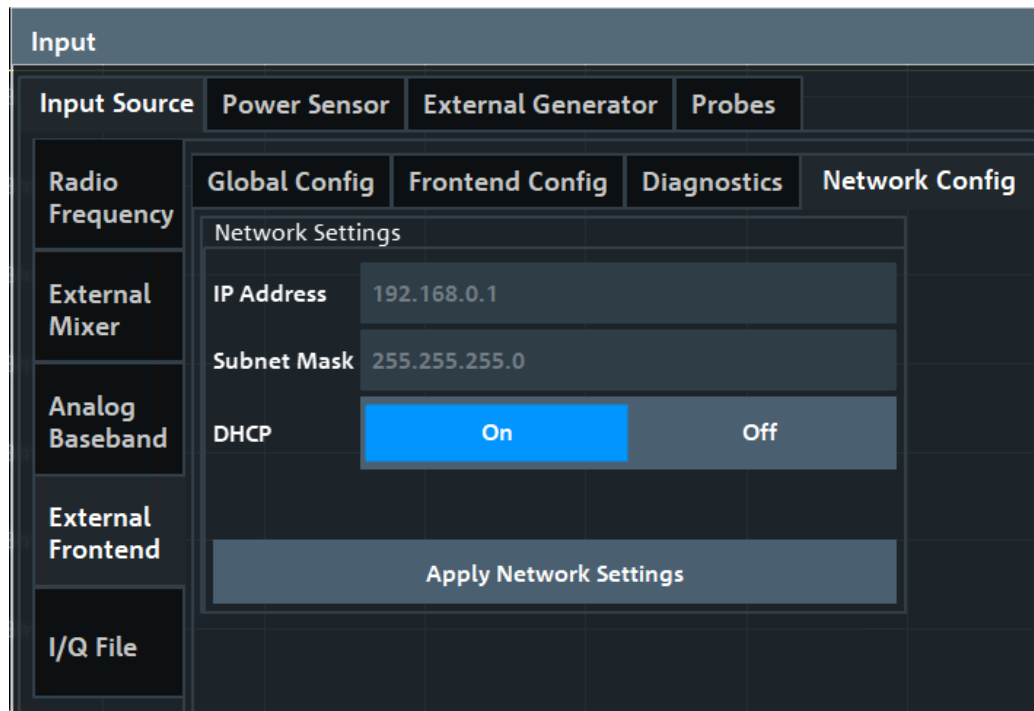
Remote command:

[SENSe:]EFRontend<fe>:SELfTest:RESult? on page 140

**7.2.3.4 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.....52  
 Subnet Mask..... 53  
 DHCP..... 53  
 Apply Network Settings..... 53

**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 138

### 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 138

### 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 138

### 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 46).

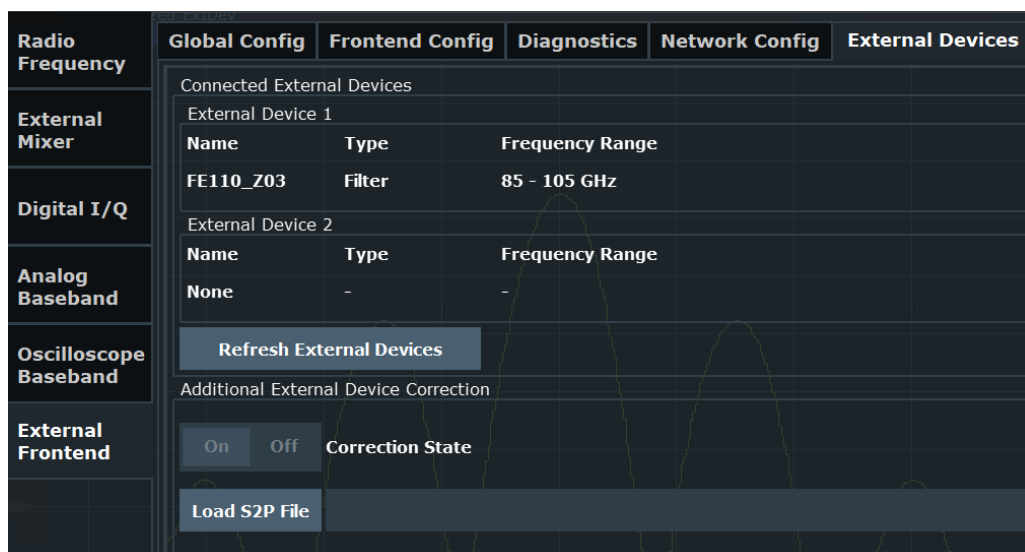
Remote command:

[SENSe:]EFRontend:NETWork on page 138

## 7.2.3.5 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.....	54
Type.....	54
Frequency Range.....	54
Gain.....	55
Refresh External Devices.....	55
Correction State.....	55
Load S2P File.....	55

### Name

Name of the external device for reference.

Remote command:

[\[SENSe:\]EFRontend\[:CHANnel<ch>\]:EXTDevice<di>:NAME?](#) on page 145

[\[SENSe:\]EFRontend\[:CHANnel<ch>\]:EXTDevice<di>:LIST?](#) on page 143

### 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 145

### Frequency Range

The supported frequency range of the connected device.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?`  
on page 144

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?`  
on page 143

### Gain

For connected external amplifiers only: provided gain.

Remote command:

`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?` on page 144

### 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 143

### 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 142

### 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 141

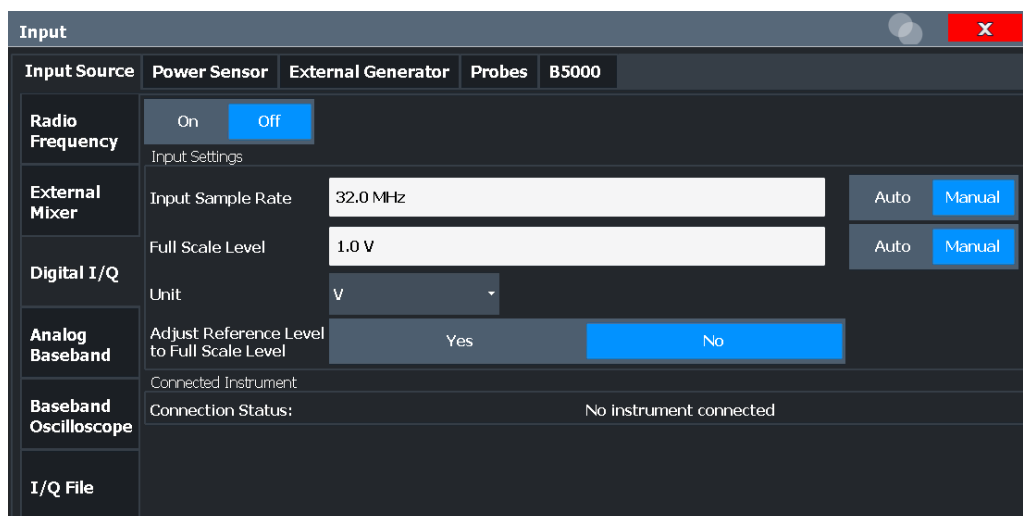
`[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?`  
on page 142

## 7.2.4 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.



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

Digital I/Q Input State.....	56
Input Sample Rate.....	56
Full Scale Level.....	56
Adjust Reference Level to Full Scale Level.....	57
Connected Instrument.....	57

### Digital I/Q Input State

Enables or disables 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 126

### 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 168

[INPut:DIQ:SRATe:AUTO](#) on page 168

### 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 167

`INPut:DIQ:RANGe[:UPPer]:UNIT` on page 168

`INPut:DIQ:RANGe[:UPPer]:AUTO` on page 167

### 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 167

### 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 166

## 7.2.5 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.

The screenshot displays the 'Input' configuration interface. The 'Analog Baseband' tab is active, showing various settings. The 'Radio Frequency' section has 'On' and 'Off' buttons. The 'External Mixer' section includes 'I/Q Mode' (set to I/Q), 'Input Config' (set to Differential), and 'Impedance Matching' (set to 50Ω, 100.0 Ohm, and Series-R). The 'Digital I/Q' section has 'High Accuracy Timing Trigger - Baseband - RF' set to Off. The 'Analog Baseband' section shows 'Signal Path' and 'Analog-I/Q'. The 'Baseband Oscilloscope' and 'I/Q File' sections are also visible. A block diagram at the bottom illustrates the signal path: I/Q inputs feed into a multiplier (X), which is connected to an NCO block. The output of the multiplier goes through an impedance matching symbol (≈), then a downward arrow, and finally into a RAM block.

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

Analog Baseband Input State.....	58
I/Q Mode.....	58
Input Configuration.....	58
High Accuracy Timing Trigger - Baseband - RF.....	59
Impedance.....	59
Center Frequency.....	60

### 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 126

### I/Q Mode

Defines the format of the input signal.

For more information on I/Q data processing modes, see the FSW I/Q Analyzer and I/Q Input User Manual.

- "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 171

### 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 169

### 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 the FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:

[CALibration:AIQ:HATiming\[:STATe\]](#) on page 171

### Impedance

The FSW has an internal impedance of 50  $\Omega$ . 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  $\Omega$ .

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 $\Omega$ " | (Default:) no conversion takes place  |
| "75 $\Omega$ " | The 50 $\Omega$ input impedance is transformed to a higher impedance using a 75 $\Omega$ adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad) |
| "User"         | The 50 $\Omega$ 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 125

`INPut:IMPedance:PTYPe` on page 125

For Analog Baseband input:

`INPut:IQ:IMPedance` on page 170

`INPut:IQ:IMPedance:PTYPe` on page 170

### 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 the FSW I/Q Analyzer and I/Q Input User Manual.

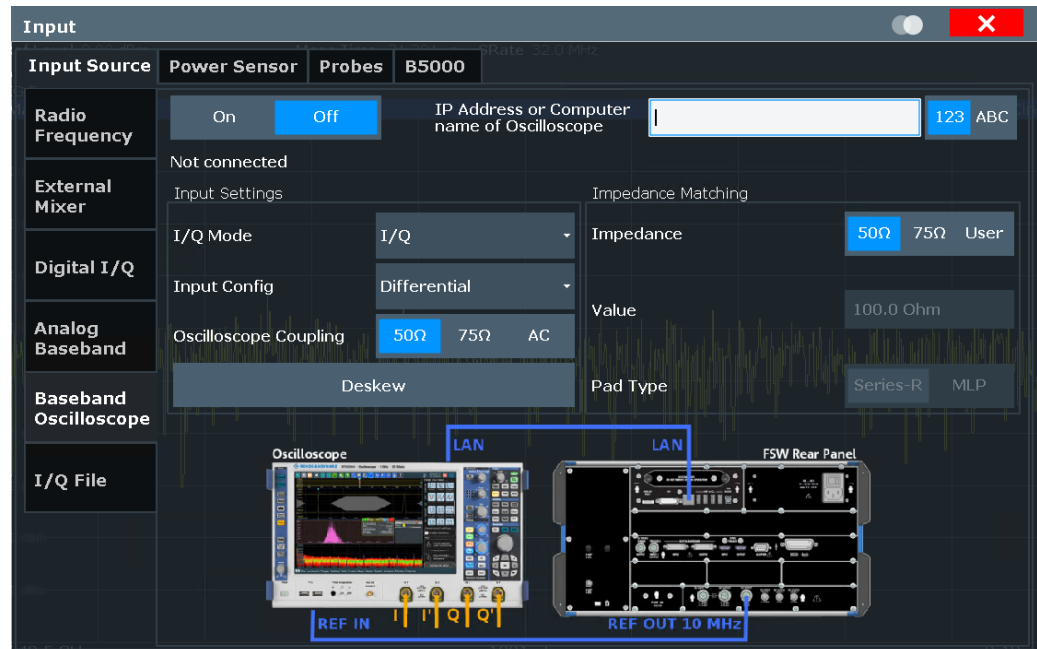
Remote command:

`[SENSe:]FREQuency:CENTer` on page 198

## 7.2.6 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.

Oscilloscope Baseband Input State.....	61
TCPIP Address / Computer Name.....	61
I/Q Mode.....	61
Input Configuration.....	62
Oscilloscope Coupling.....	62
I/Q Skew.....	62
Impedance.....	63

### 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 176

### 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.

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 176

`INPut:IQ:OSC:IDN?` on page 173

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

`INPut:IQ:OSC:VDEvice?` on page 177

`INPut:IQ:OSC:VFIRmware?` on page 177

### I/Q Mode

Defines the format of the input signal.

For more information on I/Q data processing modes, see the FSW I/Q Analyzer and I/Q Input User Manual.

"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 177

**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 172

**Oscilloscope Coupling**

The input coupling influences the signal path between input connector and the following internal signal stage.

"50  $\Omega$ " DC coupling shows all parts of an input signal. DC 50  $\Omega$  coupling is the default for 50  $\Omega$  input impedance to connect, for example, active probes.

"1 M $\Omega$ " DC coupling with 1 M $\Omega$  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 173

**I/Q Skew**

Compensates for skewed I/Q values, e.g. due to different input cables

I		Q	
Channel 1	0.0 s	Channel 3	0.0 s
Channel 2	0.0 s	Channel 4	0.0 s

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  $\pm 100$  ns are allowed.

Remote command:

[INPut:IQ:OSC:SKEW:I](#) on page 175

[INPut:IQ:OSC:SKEW:I:INVerted](#) on page 175

[INPut:IQ:OSC:SKEW:Q](#) on page 175

[INPut:IQ:OSC:SKEW:Q:INVerted](#) on page 175

### Impedance

The FSW has an internal impedance of 50  $\Omega$ . 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  $\Omega$ .

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 $\Omega$ "	(Default:) no conversion takes place
"75 $\Omega$ "	The 50 $\Omega$ input impedance is transformed to a higher impedance using a 75 $\Omega$ adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (Minimum Loss Pad)
"User"	The 50 $\Omega$ 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 125

[INPut:IMPedance:PTYPe](#) on page 125

For Analog Baseband input:

[INPut:IQ:IMPedance](#) on page 170

[INPut:IQ:IMPedance:PTYPe](#) on page 170

## 7.2.7 Settings for 2 GHz / 5 GHz bandwidth extension (R&S FSW-B2000/B5000)

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

The MSRA operating mode supports the optional 2 GHz / 5 GHz bandwidth extensions (R&S FSW-B2000/B5000), if installed.

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

- [General settings](#)..... 64
- [Alignment](#)..... 65

### 7.2.7.1 General settings

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



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

#### 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.

Remote command:

`SYSTem:COMMunicate:RDEvice:OSCilloscope[:STATe]` on page 179

#### 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.

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.

**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 182

[SYSTem:COMMunicate:RDEvice:OSCilloscope:IDN](#) on page 180

### 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 181

### 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.

Remote command:

[SYSTem:COMMunicate:RDEvice:OSCilloscope:PSMode\[:STATe\]](#) on page 181

## 7.2.7.2 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

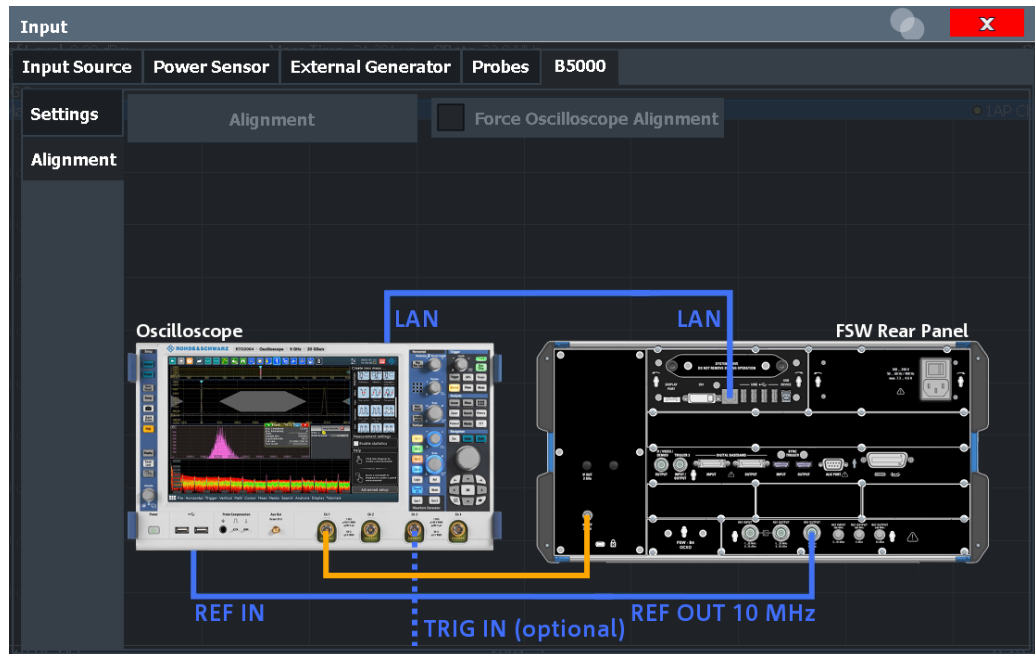


Sometimes, it is useful to force a self-alignment on the oscilloscope before the actual B5000 alignment, see ["Force Oscilloscope Alignment"](#) on page 66.

### 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.



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 66.

Remote command:

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

on page 179

```
SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:DATE
```

on page 180

### Force Oscilloscope Alignment

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

- Major temperature changes occur (> 5 °C)
- The last alignment on the oscilloscope 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.

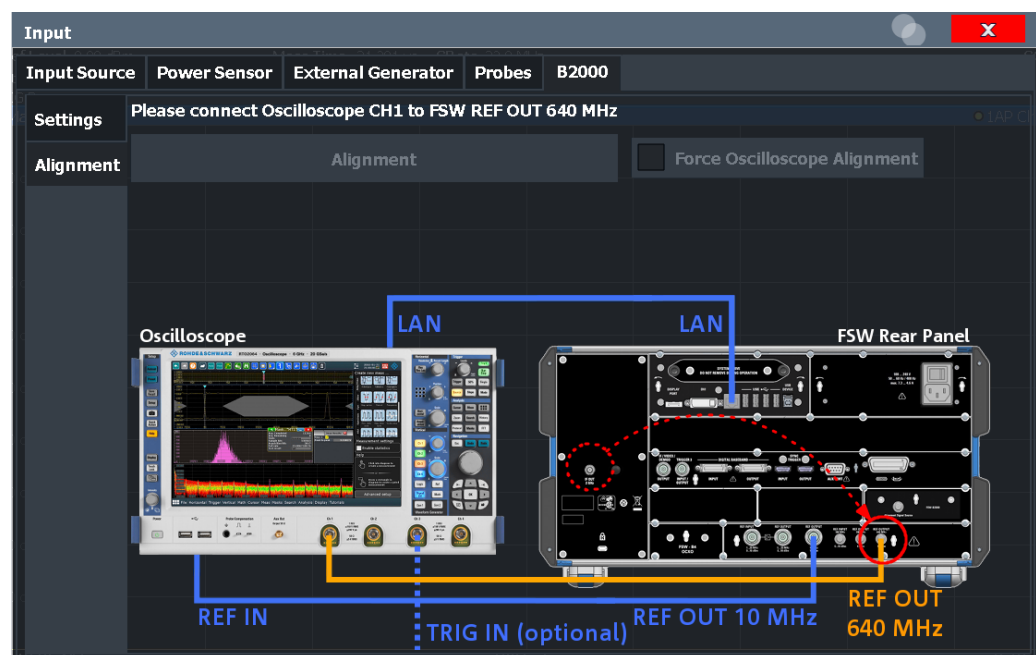
Remote command:

`SYSTEM:COMMunicate:RDEvice:OSCilloscope:ALIGnment:FAliGnment`  
on page 180

### 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.

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.)

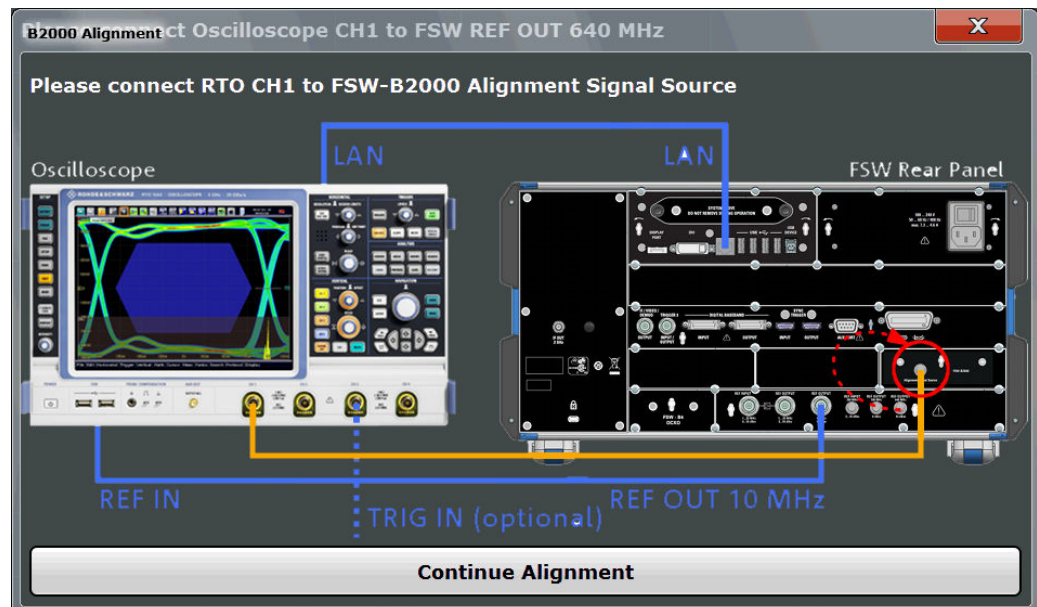
To perform the alignment, select "Alignment".



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 66.

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

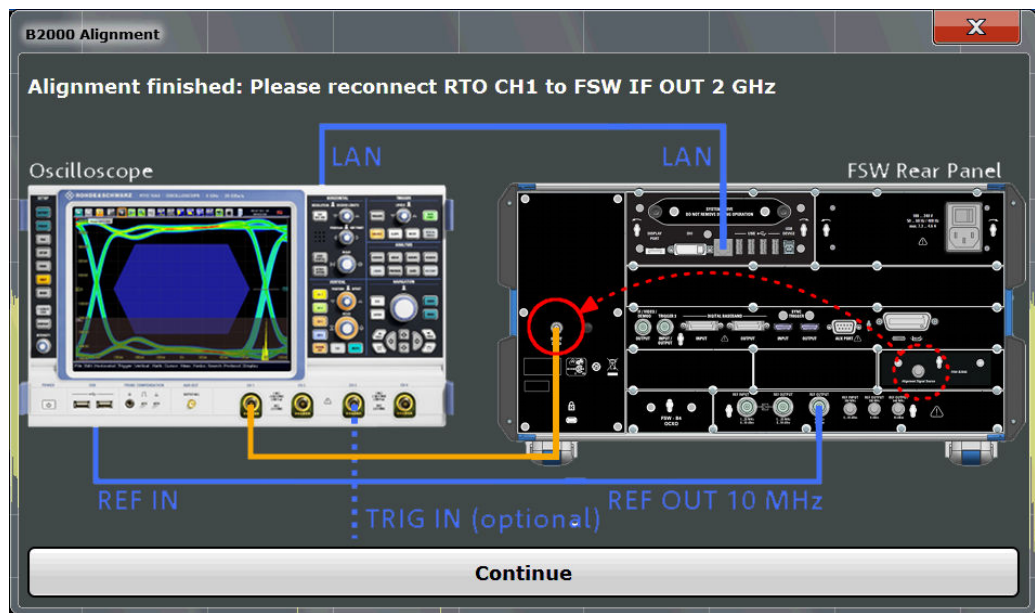


For the second alignment step, the connector must be disconnected from the "REF OUTPUT 640 MHz" connector and instead connected to the "FSW B2000 Alignment Signal Source" connector on the FSW.

(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.

#### Remote commands:

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:STEP<st>[:STATe]` on page 179

`SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:DATE` on page 180

## 7.3 Amplitude

**Access:** [AMPT]

Amplitude settings are identical to the Signal and Spectrum Analyzer mode.

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



#### Amplitude settings for analog baseband input

Amplitude settings for analog baseband input are described in the FSW I/Q Analyzer and I/Q Input User Manual

### 7.3.1 Amplitude settings

**Access:** "Overview" > "Input/Frontend" > "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  $\Omega$ .

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

**Amplitude** X

**Amplitude** **Scale**

Reference Level

Value: 0.0 dBm

Offset: 0.0 dB

Unit: dBm

Auto Level

Input Settings

Preamplifier: On Off

Input Coupling: AC DC

Impedance Matching

Impedance: 50Ω 75Ω User

Value: 100.0 Ohm

Pad Type: Series-R MLP

Attenuation

Mode: Auto Manual

Value: 10.0 dB

Electronic Attenuation

State: On Off

Mode: Auto Manual

Value: 0.0 dB

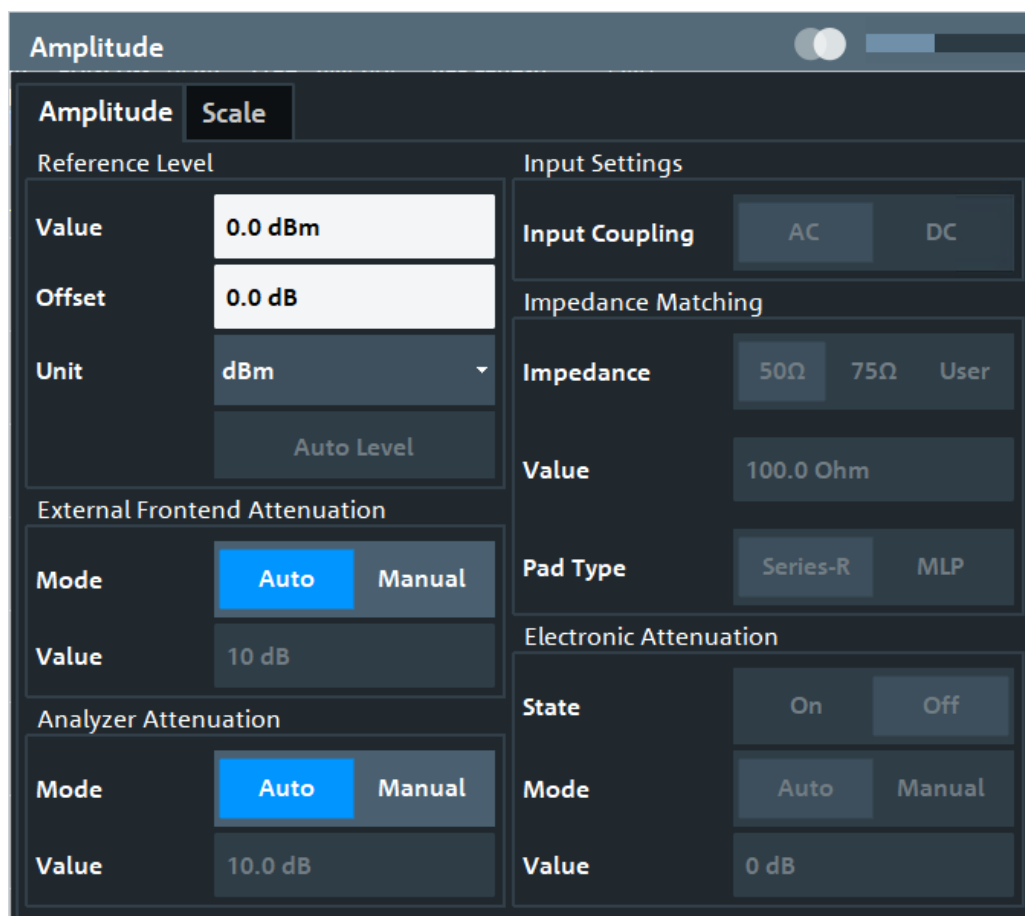


Figure 7-2: Amplitude settings for active external frontend

Reference Level.....	72
└ Shifting the Display (Offset).....	73
External Frontend Attenuation.....	73
Attenuation Mode / Value.....	73
Using Electronic Attenuation.....	74
Input Settings.....	75
└ Preamplifier.....	75
└ Ext. PA Correction.....	75

### Reference Level

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 189

### 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  $\pm 200$  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 190

### 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 190  
`INPut:ATTenuation:AUTO` on page 191

### 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 User Manual.

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

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the 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 190

[INPut:ATTenuation:AUTO](#) on page 191

Defining attenuation for the analyzer when using an external frontend:

[INPut:SANalyzer:ATTenuation:AUTO](#) on page 193

[INPut:SANalyzer:ATTenuation](#) on page 193

### 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.

**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 192

`INPut:EATT:AUTO` on page 192

`INPut:EATT` on page 192

### 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 7.2, "Input source settings"](#), on page 38.

### 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 FSW85 models, the input signal is amplified by 30 dB if the preamplifier is activated.

Remote command:

`INPut:GAIN:STATe` on page 194

`INPut:GAIN[:VALue]` on page 195

### 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:

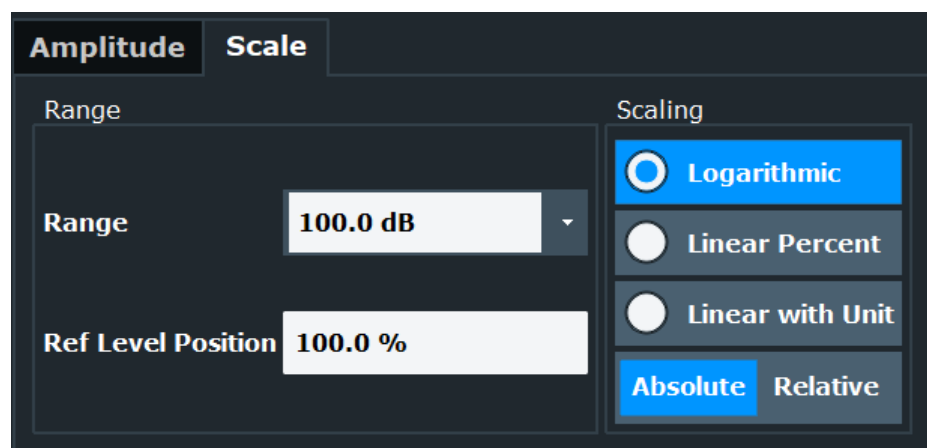
`INPut:EGain[:STATe]` on page 194

### 7.3.2 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.....	76
Ref Level Position.....	76
Scaling.....	77
Y-Axis Max.....	77

#### 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 195

#### 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 197

### 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 197  
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE`  
on page 196

### 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 195

## 7.4 Frequency settings

**Access:** "Overview" > "Frequency"

The screenshot shows a 'Frequency' configuration window. It contains three main sections: 'Center' with a text input field set to '4.0 GHz'; 'Center Frequency Step Size' with a dropdown menu set to 'Manual' and a 'Value' text input field set to '1.0 MHz'; and 'Frequency Offset' with a 'Value' text input field set to '0 Hz'. The window has a dark grey background and a red close button in the top right corner.

Center Frequency.....	78
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Frequency Offset.....	78

### Center Frequency

Defines the center frequency of the signal in Hertz.

Remote command:

[\[SENSe:\] FREQuency:CENTer](#) on page 198

### 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 198

### 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 mode, this function is only available for the MSRA primary.

Remote command:

[SENSe:] FREQuency: OFFSet on page 199

## 7.5 Trigger settings

**Access:** "Overview" > "Trigger"

**or:** [TRIG] > "Trigger Config"

Trigger settings determine when the input signal is measured. These settings are only available for the MSRA primary.



The "Capture Offset", which has a similar function to the trigger offset but is available for MSRA secondary applications only, is described in [Chapter 7.6, "Data acquisition and bandwidth settings"](#), on page 86.

Trigger		Trigger In/Out	
Source	IF Power		
Level	-20.0 dBm	Drop-Out Time	0.0 s
Offset	0.0 s	Slope	Rising Falling
Hysteresis	3.0 dB	Holdoff	0.0 s

External triggers from one of the [TRIGGER INPUT/OUTPUT] connectors on the FSW are configured in a separate tab of the dialog box.

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

Trigger Source.....	80
L Trigger Source.....	80
L Free Run.....	80
L External Trigger 1/2/3.....	80
L Baseband Power.....	81
L Digital I/Q.....	81
L IF Power.....	81
L RF Power.....	82
L I/Q Power.....	82
L Power Sensor.....	82
L Trigger Level.....	83

L	Repetition Interval.....	83
L	Drop-Out Time.....	83
L	Trigger Offset.....	83
L	Hysteresis.....	83
L	Trigger Holdoff.....	84
L	Slope.....	84
Trigger 2/3.....		84
L	Output Type.....	85
L	Level.....	85
L	Pulse Length.....	85
L	Send Trigger.....	85

### Trigger Source

The trigger settings define the beginning of a measurement.

#### Trigger Source ← Trigger Source

Defines the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

Remote command:

`TRIGger [ :SEquence ] :SOURce` on page 203

#### 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 203

#### 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 83).

**Note:** "External Trigger 1" automatically selects the trigger signal from the "TRIGGER 1 INPUT" connector on the front panel.

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.

For FSW85 models, "Trigger 2" is not available due to the second RF input connector on the front panel.

"External Trigger 3"

Trigger signal from the "TRIGGER 3 INPUT / OUTPUT" connector on the rear panel.

Remote command:

`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`

`TRIG:SOUR EXT3`

See `TRIGger [ :SEquence ] :SOURce` on page 203



**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 203

**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.

The following table describes the assignment of the general-purpose bits to the LVDS connector pins.

*Table 7-1: 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 203

**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.

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

Remote command:

TRIG:SOUR IFP, see [TRIGger\[:SEquence\]:SOURce](#) on page 203

### **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 203

### **I/Q Power ← Trigger Source ← Trigger Source**

Not available for the optional "Digital Baseband" interface.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

Remote command:

TRIG:SOUR IQP, see [TRIGger\[:SEquence\]:SOURce](#) on page 203

### **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.

**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 203

**Trigger Level ← Trigger Source**

Defines the trigger level for the specified trigger source.

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

Remote command:

[TRIGger\[:SEquence\]:LEVel\[:EXternal<port>\]](#) on page 202

For baseband input only:

[TRIGger\[:SEquence\]:LEVel:BBPower](#) on page 202

**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 205

**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).

(For details, see the FSW I/Q Analyzer and I/Q Input User Manual.)

Remote command:

[TRIGger\[:SEquence\]:DTIME](#) on page 200

**Trigger Offset ← Trigger Source**

Defines the time offset between the trigger event and the start of the sweep for the MSRA primary.

This setting is not available in MSRA secondary application measurement channels. For secondary applications, use the "[Capture Offset](#)" on page 90 instead.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pre-trigger) Maximum allowed range limited by the sweep time: $\text{pretrigger}_{\text{max}} = \text{sweep time}$

Remote command:

[TRIGger\[:SEquence\]:HOLDoff\[:TIME\]](#) on page 201

**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.

(For details see the FSW I/Q Analyzer and I/Q Input User Manual.)

Remote command:

`TRIGger[:SEquence]:IFPower:HYSteresis` on page 201

#### 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 201

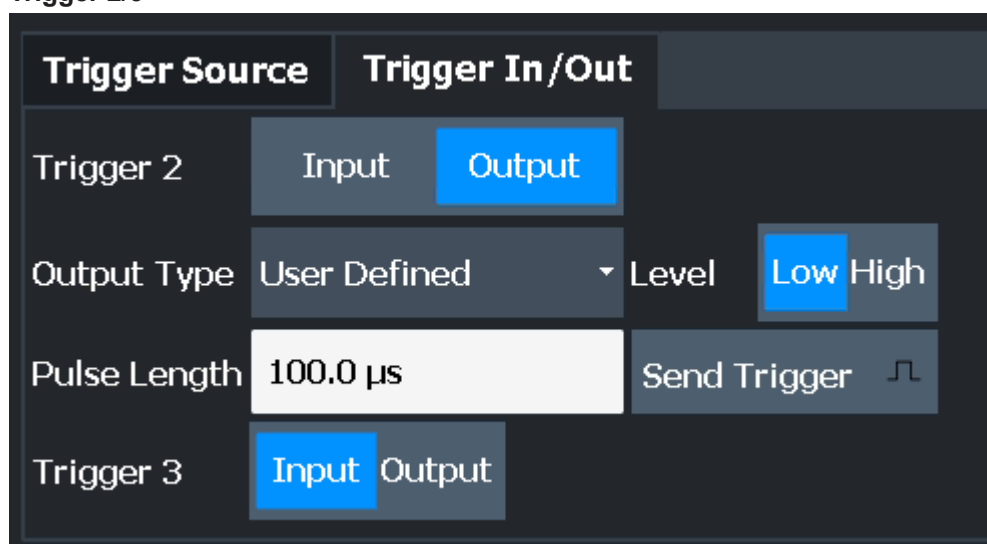
#### Slope ← Trigger Source

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.

Remote command:

`TRIGger[:SEquence]:SLOPe` on page 203

#### 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 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 205

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

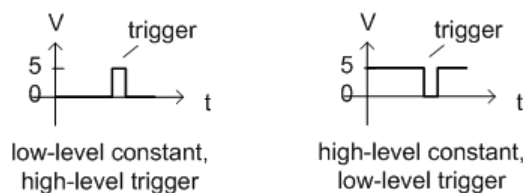
Remote command:

[OUTPut:TRIGger<tp>:OTYPe](#) on page 206

### 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 206

### 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 207

### 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 207

## 7.6 Data acquisition and bandwidth settings

How data is to be acquired is configured in the "Bandwidth" dialog box.

- [Data acquisition](#).....86
- [Sweep settings](#).....91

### 7.6.1 Data acquisition

**Access:** "Overview" > "Bandwidth"

**or:** [MEAS CONFIG] > "Data Acquisition"

The data acquisition settings define which parts of the input signal are captured for further evaluation in the applications. They are configured in the "Data Acquisition" tab of the "Bandwidth" dialog box.

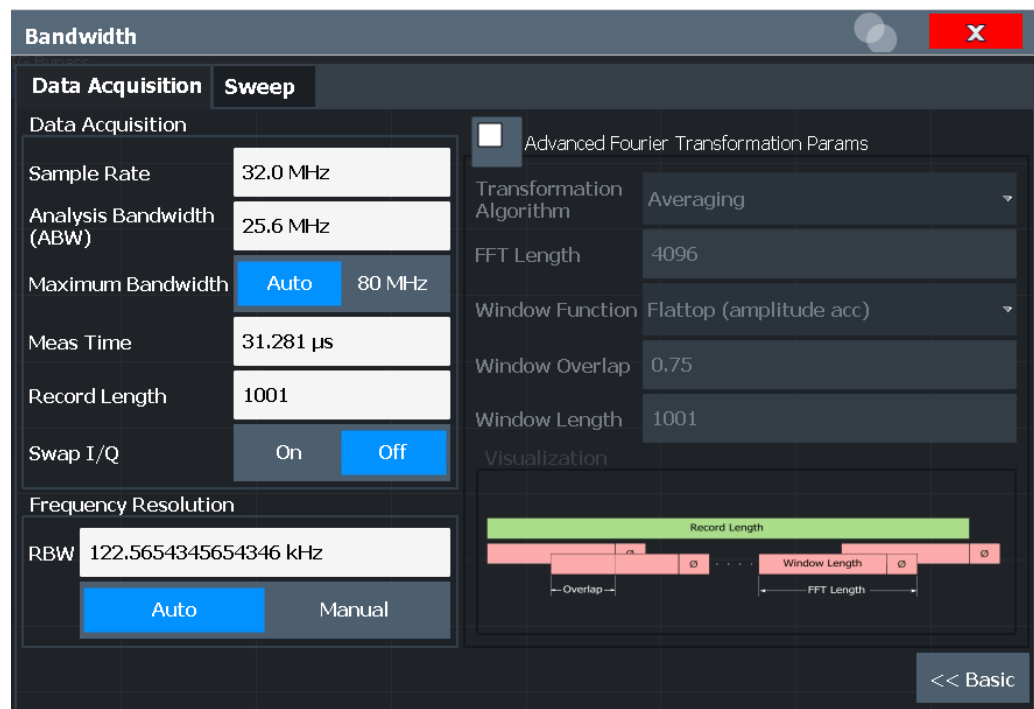


Figure 7-3: Data acquisition settings with advanced FFT parameters



Configuring data acquisition is only possible for the MSRA primary channel. In I/Q Analyzer application channels, these settings define the analysis interval (see [Chapter 6.3, "Multi-standard analysis"](#), on page 31). Be sure to select the correct measurement channel before changing these settings.

Remote command to query the current analysis interval:

`CALCulate<n>:MSRA:WINDow<n>:IVAL` on page 230

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Analysis Bandwidth.....	87
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Meas Time.....	88
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L Transformation Algorithm.....	89
L FFT Length.....	90
L Window Function.....	90
L Window Overlap.....	90
L Window Length.....	90
Capture Offset.....	90

### 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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237.

Remote command:

`TRACe: IQ:SRATe` on page 211

### 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:** 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.

Remote command:

`TRACe: IQ:BWIDth` on page 211

### 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.

"Auto"	(Default:) All installed bandwidth extension options are enabled. The currently available maximum bandwidth is allowed. (See <a href="#">"Restricting the maximum bandwidth manually"</a> on page 239). Note that using bandwidth extension options greater than 160 MHz may cause more spurious effects.
"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.

Remote command:

[TRACe: IQ:WBANd\[:STATe\]](#) on page 212

[TRACe: IQ:WBANd:MBWidth](#) on page 213

### 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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237.

Remote command:

[\[SENSe:\] SWEep:TIME](#) on page 221

### 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.



Remote command:

[TRACe: IQ: RLENgth](#) on page 211

### RBW

Defines the resolution bandwidth. The maximum RBW corresponds to the [Analysis Bandwidth](#). The minimum RBW depends on the sample rate.

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 the "Basics on FFT" section of the FSW I/Q Analyzer and I/Q Input User Manual.

- |                     |  |
|---------------------|--|
| "Auto mode"         | (Default) The RBW is determined automatically depending on the <a href="#">Sample Rate</a> and <a href="#">Record Length</a> .   |
| "Manual mode"       | The RBW can be defined by the user. The maximum RBW corresponds to the <a href="#">Analysis Bandwidth</a> . The minimum RBW depends on the sample rate.<br>The user-defined RBW is used and the <a href="#">Window Length</a> (and possibly <a href="#">Sample Rate</a> ) are adapted accordingly. |
| "Advanced FFT mode" | This mode is used if the "Advanced Fourier Transformation Params" option is enabled.<br>The RBW is determined by the <a href="#">advanced FFT parameters</a> .   |

Remote command:

[\[SENSe:\] IQ: BWIDth: MODE](#) on page 208

[\[SENSe:\] IQ: BWIDth: RESolution](#) on page 209

### 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.

#### Transformation Algorithm ← Advanced FFT mode / Basic settings

Defines the FFT calculation method.

- |             |   |
|-------------|---|
| "Single"    | One FFT is calculated for the entire record length; if the <a href="#">FFT Length</a> 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 <a href="#">Window Overlap</a> and the <a href="#">Window Length</a> . |

Remote command:

[\[SENSe:\] IQ: FFT: ALGorithm](#) on page 209

**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 209

**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 210

**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 210

**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 88.)

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 210

**Capture Offset**

This setting is only available for secondary applications in **MSRA 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 more information, see "[Trigger offset vs. capture offset](#)" on page 32.

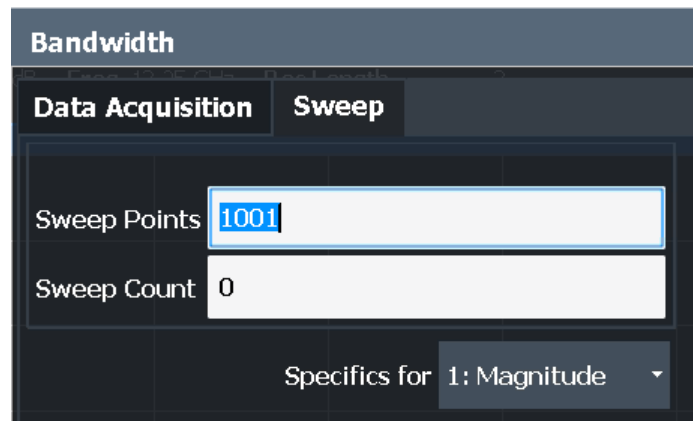
Remote command:

[SENSe:]MSRA:CAPTure:OFFSet on page 231

## 7.6.2 Sweep settings

**Access:** "Overview" > "Bandwidth" > "Sweep" tab

or: [SWEEP]



For background information on performing sweeps in MSRA mode see [Chapter 6.2, "Data acquisition"](#), on page 30.

<a href="#">Sweep Points</a> .....	91
<a href="#">Refresh (MSRA only)</a> .....	92
<a href="#">Continuous Sweep/RUN CONT</a> .....	92
<a href="#">Single Sweep/ RUN SINGLE</a> .....	92
<a href="#">Continue Single Sweep</a> .....	93

### 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.

Remote command:

[\[SENSe:\]SWEep\[:WINDow<n>\]:POINts](#) on page 220

### Refresh (MSRA only)

This function is only available if the Sequencer is deactivated and only for **MSRA secondary applications**.

The data in the capture buffer is re-evaluated by the currently active secondary application only. The results for any other secondary applications remain unchanged.

This is useful, for example, after evaluation changes have been made or if a new sweep was performed from another secondary application. In this case, only that secondary application is updated automatically after data acquisition.

**Note:** To update all active secondary applications at once, use the "Refresh All" function in the "Sequencer" menu.

Remote command:

[INITiate<n>:REFresh](#) on page 230

### Continuous Sweep/RUN CONT

After triggering, initiates data acquisition continuously until stopped. If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

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 has an 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.

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 User Manual.

Remote command:

[INITiate<n>:CONTinuous](#) on page 218

### Single Sweep/ RUN SINGLE

After triggering, starts a single data acquisition. If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

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 has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.

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 measurement channel is updated.

For details on the Sequencer, see the FSW User Manual.

Remote command:

`INITiate<n>[:IMMediate]` on page 219

### Continue Single Sweep

After triggering, repeats data acquisition without deleting the trace of the last measurement. If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

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 218

## 7.7 Output settings

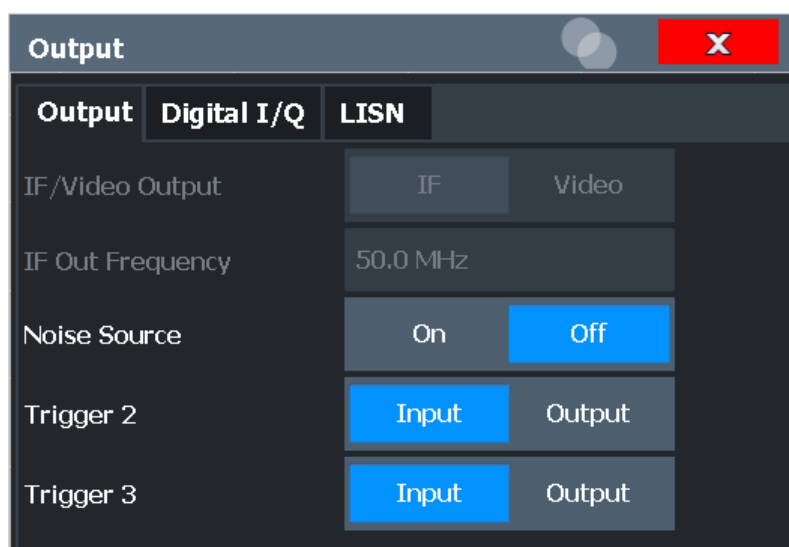
**Access:** [Input/Output] > "Output"

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 User Manual.



Noise Source Control..... 94

### 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 199

## 7.8 Display configuration



**Access:** "Overview" > "Display Config"

or: [MEAS]

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 when you do one of the following:

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

For a description of the available evaluation methods see the "Measurements and Result Displays" topic of the corresponding application User Manual.

## 7.9 automatic settings

**Access:** [AUTO SET]

Some settings can be adjusted by the FSW automatically according to the current measurement settings.



Settings related to data acquisition (measurement time, hysteresis) can only be adjusted in the MSRA primary, not in the applications.

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Adjusting the Center Frequency Automatically (Auto Frequency).....	95
Setting the Reference Level Automatically (Auto Level).....	95
Resetting the Automatic Measurement Time (Meas Time Auto).....	96
Changing the Automatic Measurement Time (Meas Time Manual).....	96
Upper Level Hysteresis.....	96
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### Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings, including:

- [Auto Level](#)

**Note:** MSRA operating modes. In MSRA operating mode, this function is only available for the MSRA primary, not the secondary applications.

Remote command:

[SENSe:]ADJust:ALL on page 214

### 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.

Remote command:

[SENSe:]ADJust:FREQuency on page 215

### 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.

You can change the measurement time for the level measurement if necessary (see "[Changing the Automatic Measurement Time \(Meas Time Manual\)](#)" on page 96).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 216

### 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 215

### 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 215

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation](#) on page 214

### 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 216

### 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 215



## 8 Analysis

The data that was captured by the MSRA primary can be analyzed in various different secondary applications.

The analysis settings and functions available in MSRA mode are those described for the individual secondary applications. The MSRA primary is in effect an I/Q Analyzer application and has the same analysis functions and settings.

See the FSW I/Q Analyzer User Manual for a description of the analysis functions and settings available for the I/Q Analyzer and thus the MSRA primary.

### Configuring the secondary application data extract and analysis interval

The settings required to configure the secondary application data extract or analysis intervals vary depending on the secondary application. See the corresponding application manuals for details.

For the I/Q Analyzer, the settings are the same as those used to define the actual data acquisition (see [Chapter 7.6.1, "Data acquisition"](#), on page 86. In MSRA secondary application channels, they define the analysis interval. Be sure to select the correct measurement channel before executing these commands.



### Exporting I/Q Data

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

The captured I/Q data from the MSRA primary can be exported for further analysis in external applications.

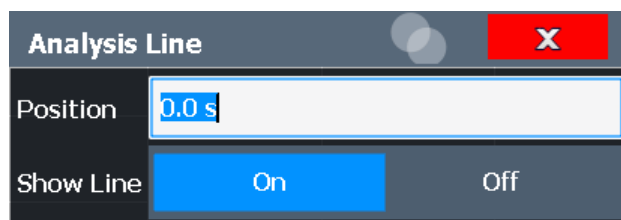
For details on exporting I/Q data see the FSW I/Q Analyzer User Manual.

## 8.1 Configuring the analysis line

**AL** 10.0 ms

**Access:** toolbar

The analysis line is a common time marker across all secondary applications (only available in MSRA mode). You can hide or show and change the position of the analysis line in each secondary application. The current position of the analysis line is indicated on the icon.



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**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 230

**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 229

## 9 How to perform measurements in MSRA mode

The following step-by-step instructions demonstrate how to perform a measurement in MSRA mode.

### How to capture I/Q data in MSRA mode

1. Press [MODE] and select the "MSRA" operating mode.  
Confirm the message.
2. Select "Overview" to display the "Overview" for an MSRA measurement.
3. Select "Input" to select the 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 IQ 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 a bandwidth extension (> 160 MHz) 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. If necessary, select "Display Config" and select other displays (up to a total of 6) required to control the acquired data.  
Arrange them on the display to suit your preferences.
9. Exit the SmartGrid mode.
10. Optionally, stop 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) Press [RUN SINGLE].
11. Optionally, export the captured or analyzed I/Q data (depending on the active channel) to a file.
  - a) Select the  "Save" icon in the toolbar.

- b) Select "I/Q Export".
- c) Define a file name and storage location and select "Save".

The captured data is stored to a file with the extension `.iq.tar`.

Now you can analyze the captured I/Q data in various MSRA secondary applications at the same time.

### How to analyze the captured I/Q data in MSRA secondary applications

1. Press [MODE] and select an MSRA secondary application.
2. Select "Overview" to display the "Overview" for the MSRA secondary application.
3. Define the secondary application data extract, i.e. the range of the capture buffer you want to analyze in this secondary application.
4. Define the analysis interval, i.e. the frame number or similar within the secondary application data you want to analyze in this secondary application (not necessary for I/Q Analyzer or Analog Demodulation secondary applications).
5. Select "Frequency" and define the center frequency for the analysis interval.
6. Select "Display Config" and select other displays (up to a total of 6) to analyze the data in the configured interval.  
Arrange them on the display to suit your preferences.
7. Exit the SmartGrid mode.  
Repeat these steps for any other secondary applications.

### How to perform multi-standard analysis of the I/Q data

1. Perform a single I/Q data acquisition measurement as described in ["How to capture I/Q data in MSRA mode"](#) on page 99.
2. Activate measurement channels for the MSRA secondary applications you require as described in ["How to analyze the captured I/Q data in MSRA secondary applications"](#) on page 100.
3. Select the MSRA View to get an overview of the captured data and the configured secondary applications.  
Determine the individual data ranges that are relevant for a specific standard. If necessary, adapt the secondary application data and analysis interval settings for the secondary applications to reflect the relevant data ranges.
4. If the results indicate that dependencies between different standards in the signal may exist:
  - a) Select the secondary application in which unusual data occurs.
  - b) If necessary, perform a new data acquisition.
  - c) Determine the bandwidth or measurement time of the unusual data.

- d) Select the MSRA View to compare the data with the other standard secondary applications.  
If a specific event (e.g. a burst, spur etc.) occurs in another standard at the same time as the unusual data in the first secondary application, the two effects may be correlated.
- e) Select the possibly dependant standard secondary application.
- f) Define an analysis interval for the conspicuous data range (as described in ["How to analyze the captured I/Q data in MSRA secondary applications"](#) on page 100).
- g) Refresh the result display for the changed analysis interval ("Sweep" menu).

Now you can analyze the data in detail to determine the cause of the unusual signal behavior.

### How to perform a measurement in the time or frequency domain in MSRA mode

1. Capture I/Q data with the MSRA primary application as described in ["How to capture I/Q data in MSRA mode"](#) on page 99.
2. Activate an "I/Q Analyzer" channel as an MSRA secondary application as described in ["How to analyze the captured I/Q data in MSRA secondary applications"](#) on page 100.
3. In the I/Q Analyzer secondary application, press [MEAS].
4. From the "Select Measurement" dialog box, select the required measurement in the time or frequency domain.
5. Configure the measurement as described in the FSW User Manual.  
The I/Q data captured by the MSRA primary application is analyzed in the time or frequency domain, according to the selected measurement and result displays.
6. To switch back to a conventional I/Q analysis, press [MEAS] and select the "IQ Analyzer" measurement.

## 10 Measurement example: analyzing MSR signals

Using the MSRA operating mode, you can examine crosstalk between different radio access technologies (RAT) sent out from a base station at the same time. Furthermore, you can determine any signal interference between two or more carriers due to time correlation, as you can analyze the same signal data (captured at exactly the same time) in various secondary applications.

The following measurement example demonstrates how to capture data from a signal with 4 carriers using different standards (GSM, WCDMA, LTE, GSM) and then analyze the data in the MSRA operating mode using the I/Q Analyzer and the 3GPP FDD BTS secondary applications.

### Measurement setup

The measurements are performed using the following instruments and accessories:

- The FSW with application firmware R&S FSW-K72: 3GPP FDD BTS Measurements
- A Vector Signal Generator:  
For example: R&S SMBV (with options R&S SMBV -K240 Dig. Std GSM/EDGE, SMBV-K242 Dig. Std 3GPP FDD, SMBV-K255 Dig. Std EUTRA)  
(The vector signal generator is referred to as SMx in the example.)
- 1 coaxial cable, 50Ω, approx. 1 m, N connector
- 1 coaxial cable, 50Ω, approx. 1 m, BNC connector

### To set up the instruments

1. Connect the "RF output" of the SMx to the [RF input] connector of the FSW (coaxial cable with an N connector).
2. Connect the "Marker1" output of the SMx to the [Trigger Input] connector of the FSW (coaxial cable with a BNC connector).

### Preparation

The waveform of the described multi-standard signal is provided in the following file on the FSW:

```
C:\R_S\Instr\user\Waveforms\MSRA_GSM_WCDMA_LTE_GSM.wv
```

The signal is described in the `Readme.txt` file in the same folder.

- ▶ Copy the file from the FSW to the SMx using a USB stick, for example.

### Settings on the R&S SMx

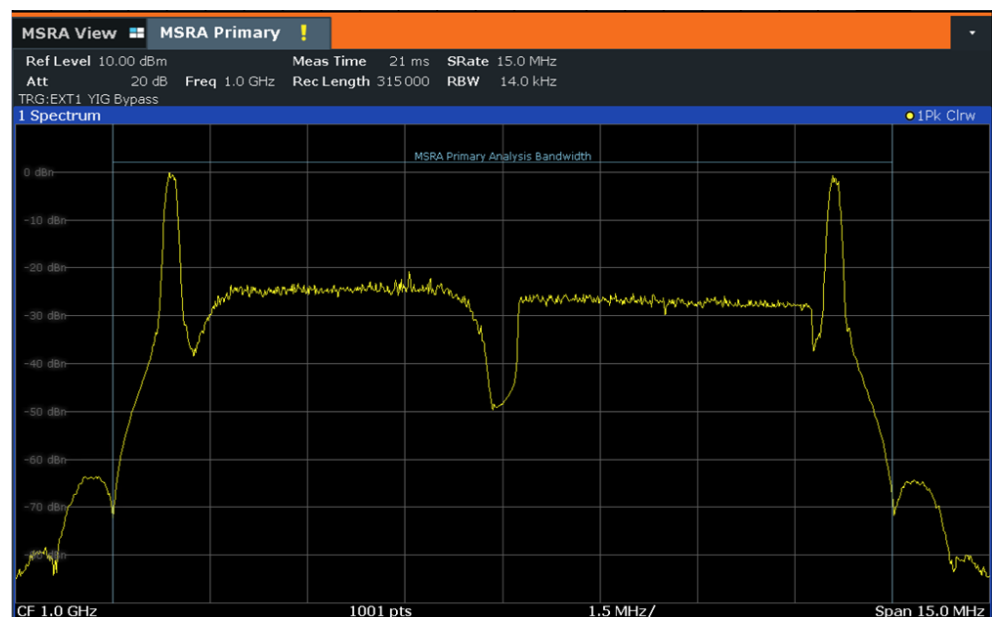
1. Press [PRESET] to reset the instrument.
2. Press [FREQ] and set the frequency to 1 GHz.

3. Press [LEVEL] and set the level to *0 dBm*.
4. Press [RF ON/OFF] to switch the RF on.
5. Press [DIAGRAM] and then select "Load Waveform" to load the signal data from the provided file. From the drive for the USB stick, select the file  
C:\R\_S\Instr\user\Waveforms\MSRA\_GSM\_WCDMA\_LTE\_GSM.wv.
6. Select the "Trigger/Marker" menu and set "Marker1" to "Restart".  
Press ESC to close the dialog box.
7. Switch "State" to "ON" to activate the waveform.

### Settings on the FSW

1. Press [PRESET] to preset the FSW.
2. Press [MODE] and select the "Multi-Standard Radio Analyzer" tab. Confirm the message to switch to MSRA mode.
3. Press [FREQ] and set the "Center Frequency" to *1 GHz*.
4. Press [AMPT] and set the reference level to *10 dBm*.
5. Press [TRIG] and select "External Trigger 1" to use the external trigger from the SMx.
6. Press [MEAS Config], select "Data Acquisition" and set the "Sample Rate" to *15 MHz*.

Since the FSW is set to continuous sweep mode by default, data acquisition is started automatically. The spectrum of the stored MSR signal from the file is displayed in the "MSRA Primary" tab.



**To analyze the GSM signal**

Activate an I/Q Analyzer to analyze the GSM signal in more detail. Only the area around the first carrier is of interest.

1. Press [MODE] and select "I/Q Analyzer".
2. Press [FREQ] and set the center frequency to *994.9 MHz*.
3. Press [MEAS Config], select "Data Acquisition" and set the "Sample Rate" to *1 MHz*.
4. Set the "Meas Time" to *5 ms*.

The I/Q Analyzer obtains an extract of the data captured by the MSRA primary application. Which spectrum of the captured data is analyzed is indicated by vertical blue lines in the "MSRA Primary" window (see [Figure 10-1](#)).

**To analyze the WCDMA signal**

Activate a measurement channel for the 3GPP FDD BTS secondary application to analyze the WCDMA signal in more detail. Now the second carrier is of interest.

1. Press [MODE] and select "3GPP FDD BTS".
2. Press [FREQ] and set the center frequency to *997.5 MHz*.

The 3GPP FDD BTS secondary application obtains an extract of the data captured by the MSRA primary application.

3. Select the "MSRA View" tab to see the captured data and the GSM and WCDMA results at once.

Which spectrum of the captured data is analyzed is indicated by vertical blue lines in the "MSRA Primary" window.



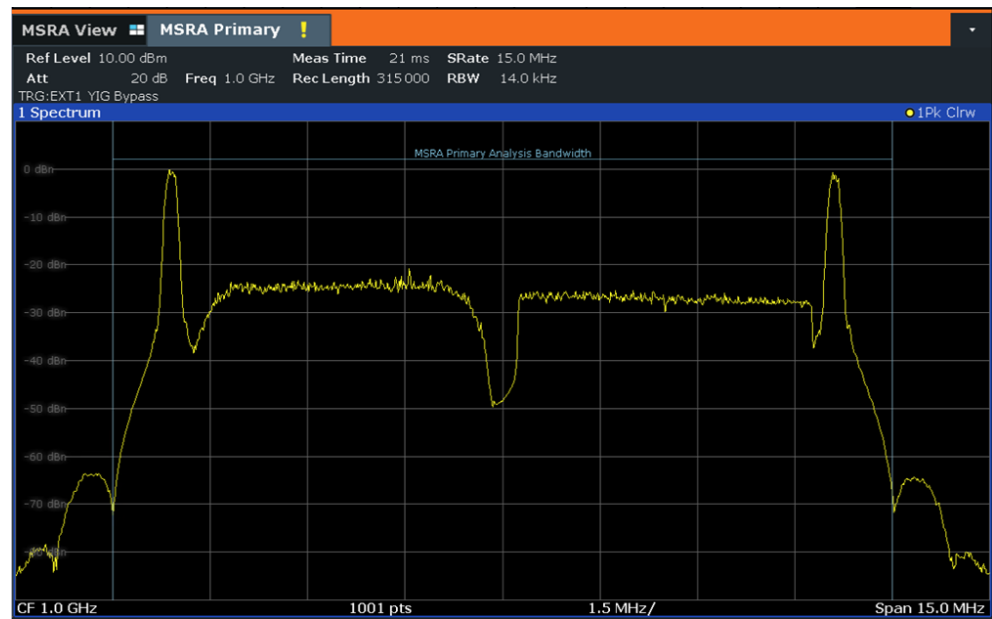


Figure 10-1: MSRA View for I/Q Analyzer and 3GPP FDD BTS secondary applications

4. Select the "3GPP FDD BTS" tab to return to the detailed WCDMA results.
5. Display the composite EVM of the WCDMA carrier:
  - a) Press [MEAS CONFIG], then select "Display Config".
  - b) Scroll through the result display buttons until you see "Composite EVM", then drag the button to the diagram area of the display.  
The "Code Domain Power" display is replaced by the "Composite EVM" display.
  - c) Select the red cross at the top of the result display list (✕) to close the Smart-Grid mode.
6. To optimize the diagram display, press [AUTO SET] and select "Auto Scale Window".

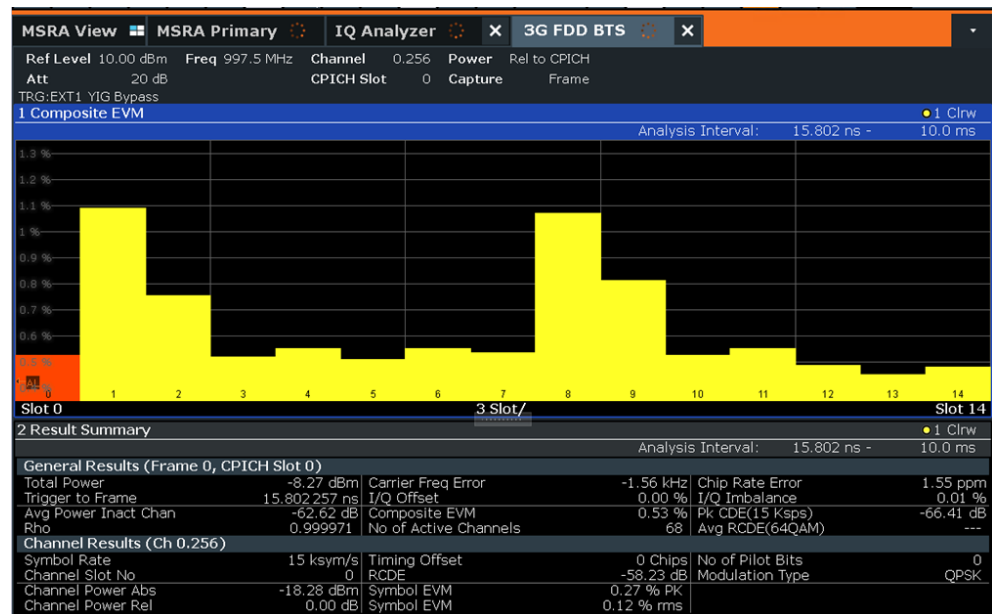


Figure 10-2: Composite EVM of the WCDMA carrier

The slots 1, 2, 8, and 9 show a much higher EVM than the other slots.

7. Analyze the EVM for the chips in these slots:
  - a) Press [MEAS CONFIG], then select "Display Config".
  - b) Drag "EVM vs Chip" over the "Result Summary" beneath the "Composite EVM" display to replace it.
  - c) Select the red cross at the top of the result display list (✕) to close the Smart-Grid mode.

The EVM vs Chip results are displayed for slot 0.

8. Take a closer look at slot 1, which had a high EVM:
  - a) Select "Evaluation Range" and set the "Slot" to 1.  
Slot 1 is highlighted red in the Composite EVM display.
  - b) Select the "EVM vs Chip" window to set the focus on it.  
The EVM for the individual chips in slot 1 is displayed.  
Note the **analysis interval** displayed in the window title bar, which indicates that the data displayed in the "EVM vs Chip" window was captured in the time interval 667  $\mu$ s to 1.3 ms (referred to the absolute time of the I/Q signal captured with the MSRA primary application).
  - c) Press [PEAK SEARCH] to place Marker1 on the chip with the highest EVM in slot 1.

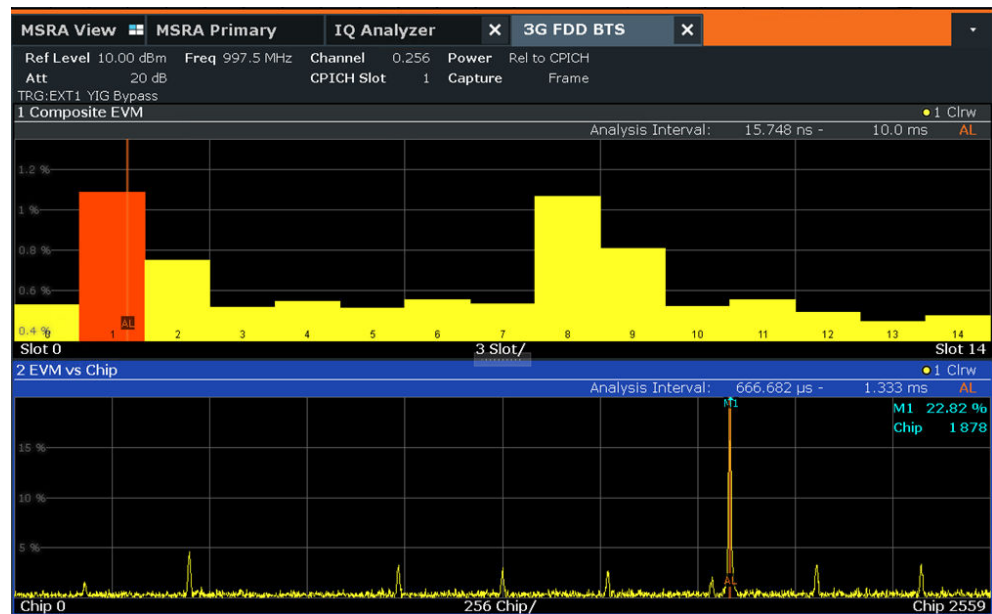


Figure 10-3: Determining the chip with the highest EVM in a WCDMA slot

#### To determine time correlations in the MSR signal

You can use the analysis line to mark an occurrence in time in one secondary application and see the same moment in time in another secondary application, and thus find the source of irregularities.

1. Select the "I/Q Analyzer" tab.
2. Select the **AL 10.0 ms** icon in the toolbar and move the analysis line (either using the rotary knob or by dragging the line on the screen) until it reaches the irregular EVM in the "EVM vs Chip" display. The new position of the analysis line in the example is *1.156ms*.

If you switch to the IQ Analyzer and regard the "Magnitude" display, you see that the analysis line is on the rising edge of the GSM burst.



*Figure 10-4: Correlating events in an MSR signal*

You can assume the GSM burst had an effect on the WCDMA carrier, causing an error.

#### **Conclusion of the measurement example**

In MSRA operating mode it is very easy to find crosstalk between different carriers by detecting time correlations between different signals, since the analysis is performed on the same recorded I/Q data. This is especially easy to detect using the analysis line in the MSRA View, as the time of a particular event is visible in the captured data and all individual secondary application windows at once.



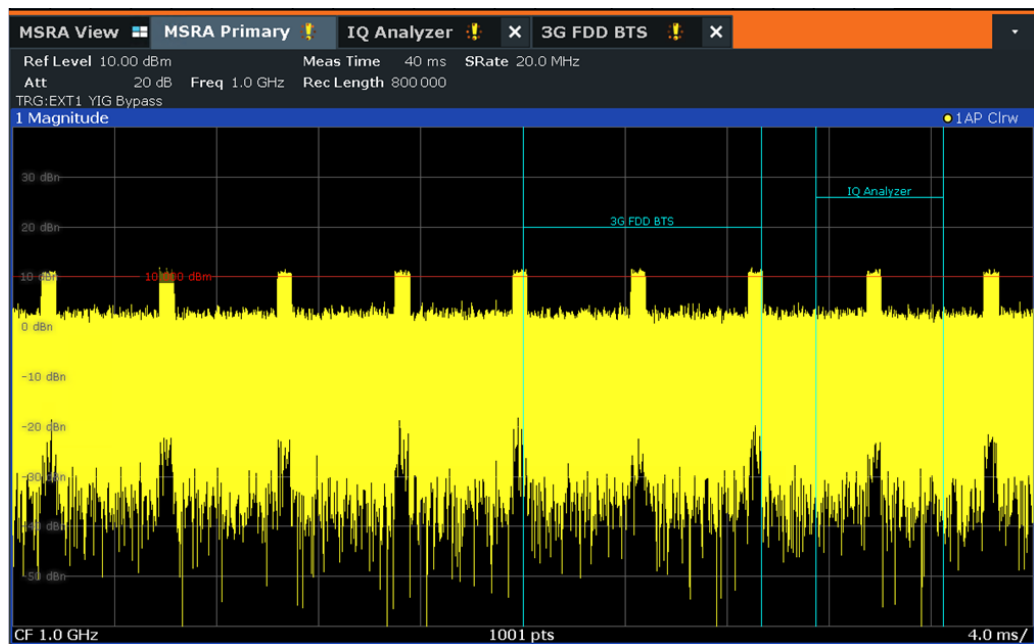
Figure 10-5: MSRA View of MSR signal with time correlations



### Capturing and analyzing long data sequences

The MSRA operating mode also allows you to capture very long data sequences. In order to examine particular areas of the large I/Q memory, each MSRA secondary application supports a "Capture Offset" setting ([TRIG] menu, or "Data acquisition"/"Signal Capture" dialog box).

In the "MSRA Primary" tab, the vertical blue lines in the "Magnitude" result display indicate which time interval of the I/Q data is analyzed by the individual secondary applications. In this example, 40 ms are captured, the 3GPP FDD BTS secondary application starts analysis at a capture offset of 20 ms (5 divisions with 4.0 ms/div), and the I/Q Analyzer starts with an offset of 31.5 ms.



# 11 Remote commands to perform measurements in MSRA mode

The following commands are specific to performing measurements in MSRA mode in a remote environment. Generally, the remote commands are identical to those used in Spectrum mode as described in the FSW User Manual. However, some restrictions or conditions may apply to specific commands (see also [Chapter 6, "MSRA basics"](#), on page 29).



You must always switch to MSRA mode before executing any MSRA-specific commands (using `INST:MODE MSR`).

It is assumed that the FSW has already been set up for remote control in a network as described in the FSW User Manual.



Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the FSW User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers



## SCPI Recorder - automating tasks with remote command scripts

The MSRA operating mode 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 MSRA mode are described here:

- [Introduction](#).....112
- [Common suffixes](#).....116
- [Activating MSRA measurements](#).....117
- [Configuring MSRA measurements](#).....122
- [Capturing data and performing sweeps](#).....216
- [Retrieving results](#).....221
- [Querying the status registers](#).....225
- [Analyzing MSRA measurements](#).....228
- [Commands specific to MSRA secondary applications](#).....228
- [Programming example: analyzing MSR signals](#).....231

## 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](#)..... 114
- [Boolean](#)..... 115
- [Character data](#)..... 116
- [Character strings](#)..... 116
- [Block data](#)..... 116

#### 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 113.

#### 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 MSRA operating mode, the following common suffixes are used in remote commands:

*Table 11-1: Common suffixes used in remote commands in the MSRA operating mode*

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
<li>	1 to 8	Limit line

## 11.3 Activating MSRA measurements

MSRA measurements requires a special operating mode on the FSW. A measurement is started immediately with the default settings.



The special MSRA primary measurement channel is of the channel type "IQ" and is referred to by the channel name "MSRA Primary". This channel cannot be replaced, deleted, or renamed.

<a href="#">INSTrument:CREate:DUPLicate</a> .....	117
<a href="#">INSTrument:CREate[:NEW]</a> .....	117
<a href="#">INSTrument:CREate:REPLace</a> .....	118
<a href="#">INSTrument:DELeTe</a> .....	118
<a href="#">INSTrument:LIST?</a> .....	119
<a href="#">INSTrument:MODE</a> .....	120
<a href="#">INSTrument:REName</a> .....	120
<a href="#">INSTrument[:SELeCt]</a> .....	120
<a href="#">SYSTem:PRESet:COMPAtible</a> .....	121
<a href="#">SYSTem:PRESet:CHANnel[:EXEC]</a> .....	122

---

### 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 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 119.
- <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".

**Manual operation:** See "[New Channel](#)" on page 27

**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 119.
- <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 119).  
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

**Manual operation:** See "[Replace Current Channel](#)" on page 27

**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

**Manual operation:** See "Closing an application" on page 27

---

### 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 MSRA mode*

Secondary application	<ChannelType> Parameter	Default Channel Name*)
1xEV-DO BTS (FSW-K84)	BDO	1xEV-DO BTS
3GPP FDD BTS (FSW-K72)	BWCD	3G FDD BTS
AM/FM/PM Modulation Analysis (FSW-K7)	ADEM	Analog Demod
cdma2000 BTS (FSW-K82)	BC2K	CDMA2000 BTS
GSM (FSW-K10)	GSM	GSM
I/Q Analyzer	IQ	IQ Analyzer
LTE (FSW-K10x)	LTE	LTE
Pulse (FSW-K6)	PULSE	Pulse
TD-SCDMA BTS (FSW-K76)	BTDS	TD-SCDMA BTS
Transient Analysis (FSW-K60)	TA	Transient Analysis
VSA (FSW-K70)	DDEM	VSA
WLAN (FSW-K91)	WLAN	WLAN
OFDM VSA (FSW-K96)	OFDMVSA	OFDM VSA

Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.

**INSTrument:MODE** <OpMode>

The operating mode of the FSW determines which applications are available and active. Whenever you change the operating mode, the currently active channels are closed. The default operating mode is Signal and Spectrum Analyzer mode, however, the presetting can be changed.

(See the "Instrument Setup" chapter in the FSW User Manual).

**Parameters:**

&lt;OpMode&gt;

**SANalyzer**

Signal and Spectrum Analyzer mode

**MSRanalyzer**

Multi-Standard Radio Analysis (MSRA) mode

**RTMStandard**

Multi-Standard Real-Time (MSRT) mode

Only available if one of the real-time options is installed.

\*RST: SAN

**Example:**

INST:MODE MSR

Switches to Multi-Standard Radio Analysis (MSRA) mode.

**Manual operation:** See ["Switching the operating mode"](#) on page 26

**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 117



**Parameters:**

&lt;ChannelType&gt;

Channel type of the new channel.

For a list of available channel types see [INSTrument:LIST?](#) on page 119.

&lt;ChannelName&gt;

String containing the name of the channel.

**Example:**

INST IQ

Activates a channel for the I/Q Analyzer application (evaluation mode).

INST 'MyIQSpectrum'

Selects the channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

**Manual operation:**See ["1xEV-DO BTS"](#) on page 22See ["3G FDD BTS"](#) on page 22See ["5G NR"](#) on page 23See ["AM/FM/PM Modulation Analysis"](#) on page 23See ["cdma2000 BTS"](#) on page 23See ["GSM"](#) on page 23See ["I/Q Analyzer"](#) on page 23See ["LTE"](#) on page 24See ["NB-IoT"](#) on page 24See ["OFDM Vector Signal Analysis \(OFDM VSA\)"](#) on page 24See ["OneWeb"](#) on page 24See ["Pulse Measurements"](#) on page 24See ["TD-SCDMA BTS"](#) on page 25See ["Transient Analysis"](#) on page 25See ["Verizon 5GTF measurement application \(V5GTF\)"](#) on page 25See ["Vector Signal Analysis \(VSA\)"](#) on page 25See ["WLAN"](#) on page 25See ["Selecting an MSRA secondary application"](#) on page 26See ["New Channel"](#) on page 27**SYSTem:PRESet:COMPAtible** <OpMode>

Defines the operating mode that is activated when you switch on the FSW or press [PRESET].

For details on operating modes see [Chapter 5, "Applications and operating modes"](#), on page 20.**Parameters:**

&lt;OpMode&gt;

**SANalyzer**

(Default:)

Defines Signal and Spectrum Analyzer operating mode as the presetting.

**MSRA**

Defines Multi-Standard Radio Analysis (MSRA) as the preset default operating mode.

**RTMS**

Defines Multi-Standard Real-Time (MSRT) as the preset default operating mode.

**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 37

## 11.4 Configuring MSRA measurements

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### 11.4.1 Configuring input/output and frontend settings

The following commands are required to define input, output and frontend settings. Any settings related to data acquisition or data output are only available for the MSRA primary application.

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- [Configuring file input](#)..... 127
- [Remote commands for external frontend control](#)..... 129
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### 11.4.1.1 RF input

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INPut:IMPedance.....	125
INPut:IMPedance:PTYPe.....	125
INPut:SELEct.....	126
INPut:TYPE.....	127

---

#### 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.

**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

##### AIQI

Analog Baseband I connector

This setting is only available if the "Analog Baseband" interface (FSW-B71) is installed and active for input. It is not available for the FSW67 or FSW85.

For more information on the "Analog Baseband" interface (FSW-B71), see the FSW I/Q Analyzer and I/Q Input User Manual.

##### RFProbe

Active RF probe

\*RST: RF

#### Example:

`INP:CONN RF`

Selects input from the RF input connector.

**Manual operation:** See "[Input Connector](#)" on page 42

**INPut:COUPling** <CouplingType>

Selects the coupling type of the RF input.

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 40

**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 41

**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 42

**INPut:FILTer:YIG[:STATE]** <State>

Enables or disables the YIG filter.

**Parameters:**

&lt;State&gt; ON | OFF | 0 | 1

**Example:** `INP:FILT:YIG OFF`  
Deactivates the YIG-preselector.

**Manual operation:** See "[YIG-Preselector](#)" on page 42

**INPut:IMPedance** <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

For input from the "Analog Baseband" interface, use the `INPut:IQ:IMPedance` command.

**Parameters:**

&lt;Impedance&gt; 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 40  
See "[Impedance](#)" on page 41

**INPut:IMPedance:PTYPe** <PadType>

Defines the type of matching pad used for impedance conversion for RF input.

For input from the "Analog Baseband" interface, use the `INPut:IQ:IMPedance:PTYPe` command.

**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 40

**INPut:SElect** <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the FSW.

For FSW85 models with two RF input connectors, you must select the input connector to configure first using `INPut:TYPE`.

**Parameters:**

<Source>            **RF**  
 Radio Frequency ("RF INPUT" connector)  
**FIQ**  
 I/Q data file  
 Not available for Input2.  
**AIQ**  
 Analog Baseband signal (only available with optional "Analog Baseband" interface)  
 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 39  
 See "[I/Q Input File State](#)" on page 43  
 See "[Digital I/Q Input State](#)" on page 56  
 See "[Analog Baseband Input State](#)" on page 58

**INPut:TYPE** <Input>

The command selects the input path.

**Parameters:**

<Input>	<b>INPUT1</b> Selects RF input 1. 1 mm [RF Input] connector
	<b>INPUT2</b> 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 39

**11.4.1.2 Configuring file input**

The following commands are required to define input from a file.

Useful commands for configuring file input described elsewhere:

- [INPut:SElect](#) on page 126

**Remote commands exclusive to configuring input from files:**

<a href="#">INPut:FILE:PATH</a> .....	127
<a href="#">MMEMory:LOAD:IQ:STReam</a> .....	128
<a href="#">MMEMory:LOAD:IQ:STReam:AUTO</a> .....	128
<a href="#">MMEMory:LOAD:IQ:STReam:LIST?</a> .....	129
<a href="#">TRACe:IQ:FILE:REPetition:COUNT</a> .....	129

**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.

**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 `.iq.tar`.  
For `.mat` 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:SWEep:TIME 0.001001
//Start the measurement
INIT:IMM
```

**Manual operation:** See ["Select I/Q data file"](#) on page 44

**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 44

**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 44

**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 44

**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 44

**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 126
- `[SENSe:]FREQuency:CENTer` on page 198
- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 189
- `INPut:ATTenuation:AUTO` on page 191
- `INPut:ATTenuation` on page 190
- `INPut:SANalyzer:ATTenuation` on page 193

- [INPut:SANalyzer:ATTenuation:AUTO](#) on page 193
- [Commands for initial configuration](#)..... 130
- [Commands for test, alignment, and diagnosis](#)..... 139
- [Commands for external devices](#)..... 141
- [Format of selftest result file](#)..... 146
- [Programming example: Configuring an external frontend](#)..... 150
- [Programming example 2: Configuring an external frontend with a connected amplifier](#)..... 151

### Commands for initial configuration

The following commands are required when you initially set up an external frontend.

<a href="#">[SENSe:]EFRontend:CONNection[:STATe]</a> .....	130
<a href="#">[SENSe:]EFRontend:CONNection:CONFig</a> .....	131
<a href="#">[SENSe:]EFRontend:CONNection:CSTate?</a> .....	131
<a href="#">[SENSe:]EFRontend:FREQuency:BAND:COUNT?</a> .....	132
<a href="#">[SENSe:]EFRontend:FREQuency:BAND&lt;b&gt;:LOWer?</a> .....	132
<a href="#">[SENSe:]EFRontend:FREQuency:BAND&lt;b&gt;:UPPer?</a> .....	132
<a href="#">[SENSe:]EFRontend:FREQuency:BCONfig:AUTO</a> .....	133
<a href="#">[SENSe:]EFRontend:FREQuency:BCONfig:LIST?</a> .....	133
<a href="#">[SENSe:]EFRontend:FREQuency:BCONfig:SElect</a> .....	134
<a href="#">[SENSe:]EFRontend:FREQuency:IFRequency:SIDeband?</a> .....	135
<a href="#">[SENSe:]EFRontend:FREQuency:IFRequency[:VALue]?</a> .....	135
<a href="#">[SENSe:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?</a> .....	135
<a href="#">[SENSe:]EFRontend:FREQuency:LOSCillator:MODE</a> .....	136
<a href="#">[SENSe:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?</a> .....	136
<a href="#">[SENSe:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe</a> .....	136
<a href="#">[SENSe:]EFRontend:FREQuency:REFerence</a> .....	137
<a href="#">[SENSe:]EFRontend:FREQuency:REFerence:LIST?</a> .....	137
<a href="#">[SENSe:]EFRontend:IDN?</a> .....	137
<a href="#">[SENSe:]EFRontend:NETWork</a> .....	138
<a href="#">[SENSe:]EFRontend[:STATe]</a> .....	138

---

#### **[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 131.

#### **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 46

**[SENSe:]EFRontend:CONNECTION:CONF** <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 46  
See ["IP Address/ Computer Name"](#) on page 46

**[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 46**[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 49**[SENSe:]EFRontend:FREQuency:BAND<b>:LOWer?**

Queries the start of the frequency range supported by the selected frontend frequency band.

**Suffix:**

<b> 1..n  
 Band for multi-band frontends  
 Use [\[SENSe:\]EFRontend:FREQuency:BAND:COUNT?](#)  
 on page 132 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 49**[SENSe:]EFRontend:FREQuency:BAND<b>:UPPer?**

Queries the end of the frequency range supported by the selected frontend frequency band.

**Suffix:**

<b> 1..n  
 Band for multi-band frontends  
 Use [\[SENSe:\]EFRontend:FREQuency:BAND:COUNT?](#)  
 on page 132 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 49

**[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 134.

**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 48

**[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&amp;S FE170SR/R&amp;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 48**[SENSe:]EFRontend:FREQuency:BCONfig:SElect <BandConfig>**

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

**Parameters:**

&lt;BandConfig&gt;

**"IF HIGH"**

(R&amp;S FE44S/ R&amp;S FE50DTR)

A higher intermediate frequency is used on the external frontend, resulting in a higher input frequency at the FSW.

**"IF LOW"**

(R&amp;S FE44S/ R&amp;S FE50DTR)

A lower intermediate frequency is used on the external frontend, resulting in a lower input frequency at the FSW.

**"Spur Optimized"**

(R&amp;S FE170SR/R&amp;S FE110SR only)

The selected IF range avoids unwanted spurious effects.

**"EVM Optimized"**

(R&amp;S FE170SR/R&amp;S FE110SR only)

The selected IF range provides an optimal EVM result.

**"Shared LO"**

(R&amp;S FE170SR/R&amp;S FE110SR only)

Ensures that multiple external frontends (R&amp;S FE170SR/ R&amp;S FE170ST or R&amp;S FE110SR/R&amp;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 48

---

**[SENSe:]EFRontend:FREQUENCY:IFrequency:SIDeband?**

Queries the currently used sideband for frequency conversion.

**Return values:**

<Sideband>	"USB"   "LSB"
	<b>"USB"</b>
	Upper sideband
	<b>"LSB"</b>
	Lower sideband

**Example:**            EFR:FREQ:IFR?  
                          EFR:FREQ:IFR:SID?

**Usage:**             Query only

**Manual operation:** See "[Intermediate Frequency](#)" on page 49

---

**[SENSe:]EFRontend:FREQUENCY:IFrequency[:VALue]?**

Queries the currently used intermediate frequency (IF) for frequency conversion.

**Return values:**

<IFFrequency>	numeric
---------------	---------

**Example:**            EFR:FREQ:IFR?

**Usage:**             Query only

**Manual operation:** See "[Intermediate Frequency](#)" on page 49

---

**[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 50

---

**[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 135.

**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 50

**[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 50

**[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 136.

**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 50**[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 137.

**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 49**[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 49**[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 130).

**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 52  
 See ["Subnet Mask"](#) on page 53  
 See ["DHCP"](#) on page 53  
 See ["Apply Network Settings"](#) on page 53

**[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 46

**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.....	139
[SENSe:]EFRontend:ALIGnment<ch>:STATe.....	139
[SENSe:]EFRontend:FWUPdate.....	140
[SENSe:]EFRontend<fe>:SELfTest?.....	140
[SENSe:]EFRontend<fe>:SELfTest:RESult?.....	140

**[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 50

**[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 139.

**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 50

**[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 47

**[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 51  
See ["Abort Selftest"](#) on page 52

**[SENSe:]EFRontend<fe>:SELFtest:RESult?**

Queries the results of the selftest on the frontend.

<b>Suffix:</b>	
<fe>	1 Connected frontend
<b>Return values:</b>	
<Result>	string containing xml data in double quotes
<b>Example:</b>	EFR:SELF:RES?
<b>Usage:</b>	Query only
<b>Manual operation:</b>	See " <a href="#">Selftest Results</a> " on page 52

### 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.....	141
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe.....	142
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?.....	142
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?.....	143
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFresh.....	143
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?.....	143
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?.....	144
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?.....	144
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?.....	145
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?.....	145

---

#### [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 142.

<b>Suffix:</b>	
<ch>	1..n For future use.
<di>	1..n irrelevant
<b>Parameters:</b>	
<File>	
<b>Example:</b>	SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p' SENS:EFR:CHAN:EXTD:CORR:STAT ON SENS:EFR:CHAN:EXTD:CORR:FILE:VAL?
<b>Manual operation:</b>	See " <a href="#">Load S2P File</a> " on page 55

**[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 141.

**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 55

**[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 55

**[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 54

**[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 55

**[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 54

**[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 54

**[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 55

#### [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 54

#### [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 54

### 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
<b>&lt;Sequence&gt;</b>		Main element
	<b>Name</b>	="Selftest"
	Description	Optional description of the test process
	<b>FirmwareVersion</b>	Firmware version of the controlling instrument (FSW)
	<b>FrontendLibrary-Version</b>	Version of the <code>control.dll</code> with the format <code>x.y.z</code>
	FrontendServerVersion	Version of the RRH server with the format <code>x.y.z</code> (FE44A only)
	<b>Date</b>	Date the selftest was performed, with the format <code>dd/mm/yyyy</code>
	<b>Time</b>	Time the selftest was performed, with the format <code>hh:mm:ss</code>
	<b>State</b>	Test result state, combined result of all <b>&lt;SequenceCategory&gt;</b> s: "PASSED"/ "FAILED"
	<b>Version</b>	For internal use.
Comment	Optional comment on the test process	
<b>&lt;SequenceCategory&gt;</b>		Set of test steps
	<b>Name</b>	Name of the test sequence, e.g. "Frontend voltages"
	Description	Optional description of the test sequence
	<b>State</b>	Test sequence result state, combined result of all <b>&lt;SequenceStep&gt;</b> s: "PASSED"/ "FAILED"
	<b>Version</b>	For internal use.
	Comment	Optional comment on the test sequence
<b>&lt;SequenceStep&gt;</b>		Subelement of <b>&lt;SequenceCategory&gt;</b> for an individual test step
	<b>Name</b>	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
	<b>State</b>	Test step result state:"PASSED"/ "FAILED"
	<b>Version</b>	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>
</Sequence>

```

```

</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>
</SequenceCategory>
```

```

</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:SELFTtest?
//Result: 0 (no errors)
SENSe:EFRontend:SELFTtest: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:EXTDevicel:FREQuency:MINimum?
//Result:
//110000000000
SENSe:EFRontend:EXTDevicel: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:EFRontend:EXTDevice1:CORRection:VALid?
```

#### 11.4.1.4 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 mode, external mixers are not supported.

- [Basic settings](#)..... 153
- [Mixer settings](#)..... 154
- [Conversion loss table settings](#)..... 160
- [Programming example: working with an external mixer](#)..... 164

#### Basic settings

The basic settings concern general usage of an external mixer.

<a href="#">[SENSe:]MIXer&lt;x&gt;[:STATe]</a> .....	153
<a href="#">[SENSe:]MIXer&lt;x&gt;:BIAS:HIGH</a> .....	154
<a href="#">[SENSe:]MIXer&lt;x&gt;:BIAS[:LOW]</a> .....	154
<a href="#">[SENSe:]MIXer&lt;x&gt;:LOPower</a> .....	154

---

#### [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 153).

**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 153).

**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.....	155
[SENSe:]MIXer<x>:FREQuency:STARt.....	155
[SENSe:]MIXer<x>:FREQuency:STOP.....	155

[SENSe:]MIXer<x>:HARMonic:BAND:PRESet.....	156
[SENSe:]MIXer<x>:HARMonic:BAND.....	156
[SENSe:]MIXer<x>:HARMonic:HIGH:STATe.....	157
[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue].....	157
[SENSe:]MIXer<x>:HARMonic:TYPE.....	157
[SENSe:]MIXer<x>:HARMonic[:LOW].....	158
[SENSe:]MIXer<x>:IF?.....	158
[SENSe:]MIXer<x>:LOSS:HIGH.....	158
[SENSe:]MIXer<x>:LOSS:TABLE:HIGH.....	158
[SENSe:]MIXer<x>:LOSS:TABLE[:LOW].....	159
[SENSe:]MIXer<x>:LOSS[:LOW].....	159
[SENSe:]MIXer<x>:PORTs.....	160
[SENSe:]MIXer<x>:RFOVerrange[:STATe].....	160

---

### [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 153).

#### 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 153).

**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 164.

**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.....	161
[SENSe:]CORRection:CVL:BIAS.....	161
[SENSe:]CORRection:CVL:CATalog?.....	161
[SENSe:]CORRection:CVL:CLEar.....	162
[SENSe:]CORRection:CVL:COMMent.....	162
[SENSe:]CORRection:CVL:DATA.....	162
[SENSe:]CORRection:CVL:HARMonic.....	162
[SENSe:]CORRection:CVL:MIXer.....	163
[SENSe:]CORRection:CVL:PORTs.....	163
[SENSe:]CORRection:CVL:SElect.....	163
[SENSe:]CORRection:CVL:SNUMber.....	164



**[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 163).

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 163).

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 163).

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 163).

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 163).

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 163).

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 163).

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 163).

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 163).

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

```

#### 11.4.1.5 Configuring digital I/Q input and output

Useful commands for digital I/Q data described elsewhere:

- `INP:SEL DIQ` (see [INPut:SElect](#) on page 126)
- `TRIGger[:SEquence]:LEVel:BBPower` on page 202

#### Remote commands exclusive to digital I/Q data input and output

<a href="#">INPut:DIQ:CDEvice</a> .....	166
<a href="#">INPut:DIQ:RANGe:COUPling</a> .....	167
<a href="#">INPut:DIQ:RANGe[:UPPer]</a> .....	167
<a href="#">INPut:DIQ:RANGe[:UPPer]:AUTO</a> .....	167
<a href="#">INPut:DIQ:RANGe[:UPPer]:UNIT</a> .....	168
<a href="#">INPut:DIQ:SRATe</a> .....	168
<a href="#">INPut:DIQ:SRATe:AUTO</a> .....	168

---

#### 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:**

&lt;Value&gt;

**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 57**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:**

&lt;State&gt; ON | OFF | 1 | 0

\*RST: 0

**Manual operation:** See ["Adjust Reference Level to Full Scale Level"](#) on page 57**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  $\mu$ V to 7.071 V

\*RST: 1 V

Default unit: DBM

**Manual operation:** See ["Full Scale Level"](#) on page 56**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:**

&lt;State&gt; ON | OFF | 1 | 0

\*RST: 0

**Manual operation:** See ["Full Scale Level"](#) on page 56

**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 56

**INPut:DIQ:SRATe <SampleRate>**

Specifies or queries the sample rate of the input signal from the optional "Digital Baseband" interface.

**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 56

**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 56

**11.4.1.6 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 the FSW I/Q Analyzer User Manual.

Useful commands for Analog Baseband data described elsewhere:

- INP:SEL AIQ (see [INPut:SELeCt](#) on page 126)
- [[SENSe](#):] [FREQuency:CENTer](#) on page 198



Commands for the Analog Baseband calibration signal are described in the FSW User Manual.

### Remote commands exclusive to Analog Baseband data input and output

<a href="#">INPut:IQ:BALanced[:STATe]</a> .....	169
<a href="#">INPut:IQ:FULLscale:AUTO</a> .....	169
<a href="#">INPut:IQ:FULLscale[:LEVel]</a> .....	169
<a href="#">INPut:IQ:IMPedance</a> .....	170
<a href="#">INPut:IQ:IMPedance:PTYPe</a> .....	170
<a href="#">INPut:IQ:TYPE</a> .....	171
<a href="#">CALibration:AIQ:HATiming[:STATe]</a> .....	171

---

#### **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 58

---

#### **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 169  
                       \*RST:        1

**Example:**            INP:IQ:FULL:AUTO OFF

---

#### **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 169).

**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

**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 40

**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: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 40

---

### 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 58

---

### CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

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

**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 59

### 11.4.1.7 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 <sup>L</sup> anced[:STATe].....	172
INPut:IQ:OSC:CONState?.....	172
INPut:IQ:OSC:COUPling.....	173
INPut:IQ:OSC:FULLscale[:LEVel].....	173
INPut:IQ:OSC:IDN?.....	173
INPut:IQ:OSC:IMPedance.....	174
INPut:IQ:OSC:IMPedance:PTYPE.....	174
INPut:IQ:OSC:SKEW:I.....	175
INPut:IQ:OSC:SKEW:I:INVerted.....	175
INPut:IQ:OSC:SKEW:Q.....	175
INPut:IQ:OSC:SKEW:Q:INVerted.....	175
INPut:IQ:OSC:SRATE.....	176
INPut:IQ:OSC[:STATe].....	176
INPut:IQ:OSC:TCPip.....	176
INPut:IQ:OSC:TYPE.....	177
INPut:IQ:OSC:VDEvice?.....	177
INPut:IQ:OSC:VFIRmware?.....	177

---

#### INPut:IQ:OSC:BA<sup>L</sup>anced[:STATe] <State>

##### Parameters:

<State>            ON | OFF | 0 | 1  
                       **OFF | 0**  
                       Single ended  
                       **ON | 1**  
                       Differential  
                       \*RST:        1

**Example:**            INP:IQ:OSC:BA<sup>L</sup> OFF

**Manual operation:** See "Input Configuration" on page 62

---

#### 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 176).

**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  $\Omega$  coupling is the default for 50 $\Omega$  input impedance to connect, for example, active probes.

**DCLimit**

DC coupling with 1 M  $\Omega$  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 62

**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`

**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 61

**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 Dccsis 3.1 application.

\*RST: 50

Default unit: Ohm

**Example:**

```
INP:IQ:OSC:IMP 75
```

**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

---

**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 62

---

**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 62

---

**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 62

---

**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 62

**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 177).

**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 126.

**Manual operation:** See "[Oscilloscope Baseband Input State](#)" on page 61

**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 61



---

**INPut:IQ:OSC:TYPE** <Type>

Defines the format of the input signal.

**Parameters:**

&lt;Type&gt;

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 61

---

**INPut:IQ:OSC:VDEvice?**

Queries whether the connected instrument is supported for Oscilloscope Baseband Input.

For details see the specifications document.

**Return values:**

&lt;Device&gt;

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 61

---

**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:**

&lt;FirmwareState&gt;

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 61

#### 11.4.1.8 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).

**Remote commands exclusive to configuring the 2 GHz / 5 GHz bandwidth extensions:**

EXPort:WAVeform:DISPlayoff.....	178
SYSTem:COMMunicate:RDEvice:OSCilloscope[:STATe].....	179
SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:STEP<st>[:STATe].....	179
SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:DATE.....	180
SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGnment:FALignment.....	180
SYSTem:COMMunicate:RDEvice:OSCilloscope:IDN.....	180
SYSTem:COMMunicate:RDEvice:OSCilloscope:LEDState.....	180
SYSTem:COMMunicate:RDEvice:OSCilloscope:PSMMode[:STATe].....	181
SYSTem:COMMunicate:RDEvice:OSCilloscope:SRATe.....	181
SYSTem:COMMunicate:RDEvice:OSCilloscope:TCPIp.....	182
SYSTem:COMMunicate:RDEvice:OSCilloscope:VDEvice?.....	182
SYSTem:COMMunicate:RDEvice:OSCilloscope:VFIRmware?.....	182
TRIGger[:SEQuence]:OSCilloscope:COUPLing.....	183

#### 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 64

**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 66

**SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGNment:DATE** <Date>

Returns the date of alignment of the "IF OUT 2 GHz/ IF OUT 5 GHz" to the oscilloscope for the optional 2 GHz / 5 GHz bandwidth extension (FSW-B2000/B5000).

**Parameters:**

<Date> Returns the date of alignment.

**Example:**

```
SYST:COMM:RDEV:OSC:ALIG:DATE?
//Result: 2014-02-28
```

**Manual operation:** See "[Alignment](#)" on page 66

**SYSTem:COMMunicate:RDEvice:OSCilloscope:ALIGNment: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 66

**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 64

**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 182).

**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.

**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 65

**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 65

---

#### **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 64

---

#### **SYSTem:COMMunicate:RDEvice:OSCilloscope:VDEvice?**

Queries whether the connected instrument is supported by the 2 GHz / 5 GHz bandwidth extension option(B2000/B5000).

**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
	<b>DC</b>
	Direct connection with 50 $\Omega$ termination, passes both DC and AC components of the trigger signal.
	<b>CDLimit</b>
	Direct connection with 1 M $\Omega$ termination, passes both DC and AC components of the trigger signal.
	<b>AC</b>
	Connection through capacitor, removes unwanted DC and very low-frequency components.
*RST:	DC

**11.4.1.9 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?	183
[SENSe:]PROBe<pb>:ID:SRNumber?	184
[SENSe:]PROBe<pb>:SETup:ATTRatio	184
[SENSe:]PROBe<pb>:SETup:CMOFfset	184
[SENSe:]PROBe<pb>:SETup:DMOFfset	185
[SENSe:]PROBe<pb>:SETup:MODE	186
[SENSe:]PROBe<pb>:SETup:NAME?	186
[SENSe:]PROBe<pb>:SETup:NMOFfset	186
[SENSe:]PROBe<pb>:SETup:PMODE	187
[SENSe:]PROBe<pb>:SETup:PMOFfset	187
[SENSe:]PROBe<pb>:SETup:STATe?	188
[SENSe:]PROBe<pb>:SETup:TYPE?	188

**[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:**

&lt;PartNumber&gt;

**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:**

&lt;SerialNo&gt;

**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 126).

**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

#### 11.4.1.10 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](#)..... 189
- [Configuring the attenuation](#)..... 190
- [Configuring a preamplifier](#)..... 194
- [Scaling the Y-axis](#)..... 195

#### Amplitude settings

Useful commands for amplitude configuration described elsewhere:

- [\[SENSe:\]ADJust:LEVel](#) on page 216

Remote commands exclusive to amplitude configuration:

<a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNction:REFerence</a> .....	189
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALe]:RLEVel</a> .....	189
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALe]:RLEVel:OFFSet</a> .....	190

---

#### 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.

---

#### 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 ≠ 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 72

**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 73

**Configuring the attenuation**

INPut:ATTenuation.....	190
INPut:ATTenuation:AUTO.....	191
INPut:ATTenuation:AUTO:MODE.....	191
INPut:EATT.....	192
INPut:EATT:AUTO.....	192
INPut:EATT:STATe.....	192
INPut:SANalyzer:ATTenuation.....	193
INPut:SANalyzer:ATTenuation:AUTO.....	193

**INPut:ATTenuation** <Attenuation>

Defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

If an external frontend is active (see [\[SENSe:\]EFRontend\[:STATe\]](#) on page 138), you can configure the attenuation of the external frontend and the analyzer separately. See also [INPut:SANalyzer:ATTenuation:AUTO](#) on page 193 and [INPut:SANalyzer:ATTenuation](#) on page 193.

**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 73  
 See ["Attenuation Mode / Value"](#) on page 73

**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 138), you can configure the attenuation of the external frontend and the analyzer separately. See also [INPut:SANalyzer:ATTenuation:AUTO](#) on page 193 and [INPut:SANalyzer:ATTenuation](#) on page 193.

**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 73  
 See ["Attenuation Mode / Value"](#) on page 73

**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`

**INPut:EATT <Attenuation>**

Defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see [INPut:EATT:AUTO](#) on page 192).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

**Parameters:**

<Attenuation>           attenuation in dB  
 Range:           see 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 74

**INPut:EATT:AUTO <State>**

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

**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 74

**INPut:EATT:STATe <State>**

Turns the electronic attenuator on and off.

**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 74**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 73**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 191 and [INPut:ATTenuation](#) on page 190.**Parameters:**

&lt;State&gt;      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 193.**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 73

### Configuring a preamplifier

<a href="#">INPut:EGain[::STATe]</a> .....	194
<a href="#">INPut:GAIN:STATe</a> .....	194
<a href="#">INPut:GAIN[::VALue]</a> .....	195

---

#### 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
	<b>OFF   0</b>
	No data correction is performed based on the external preamplifier
	<b>ON   1</b>
	Performs data corrections based on the external preamplifier
*RST:	0

**Example:** INP:EGA ON

**Manual operation:** See "[Ext. PA Correction](#)" on page 75

---

#### 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.

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 75**INPut:GAIN[:VALue] <Gain>**Selects the "gain" if the preamplifier is activated (INP:GAIN:STAT ON, see [INPut:GAIN:STATe](#) on page 194).

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.  
 For FSW85 models:  
 FSW43 or higher:  
 30 dB  
 Default unit: DB

**Example:**

INP:GAIN:STAT ON

INP:GAIN:VAL 30

Switches on 30 dB preamplification.

**Manual operation:** See "Preamplifier" on page 75**Scaling the Y-axis**

<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]</a> .....	195
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]:AUTO ONCE</a> .....	196
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]:MODE</a> .....	196
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]:PDIVision</a> .....	196
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]:RPOSition</a> .....	197
<a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y:SPACing</a> .....	197

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE] <Range>**

Defines the display range of the y-axis (for all traces).

**Suffix:**

<n> [Window](#)

<w> subwindow  
 Not supported by all applications

<t> irrelevant

**Example:** DISP:TRAC:Y 110dB

**Manual operation:** See "[Range](#)" on page 76  
See "[Y-Axis Max](#)" on page 77

#### 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 77

#### 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.

**Suffix:**

<n> [Window](#)

<w> subwindow  
Not supported by all applications

<t> irrelevant

**Example:**

DISP:TRAC:Y:RPOS 50PCT

**Manual operation:** See "[Ref Level Position](#)" on page 76

**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 77

#### 11.4.1.11 Frequency

<a href="#">[SENSe:]FREQUENCY:CENTer</a> .....	198
<a href="#">[SENSe:]FREQUENCY:CENTer:STEP</a> .....	198
<a href="#">[SENSe:]FREQUENCY:OFFSet</a> .....	199

---

#### **[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 60  
See ["Center Frequency"](#) on page 78

---

#### **[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 198.

**Parameters:**

<StepSize> For  $f_{max}$ , refer to the specifications document.

Range: 1 to  $f_{MAX}$

\*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 78

**[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 78.

**Note:** In MSRA mode, the setting command is only available for the MSRA primary application. For MSRA 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 78

**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 11.4.2.2, "Configuring the trigger output"](#), on page 205.

[DIAGnostic:SERVice:NSOource](#)..... 199  
[SYSTem:SPEaker:VOLume](#)..... 199

**DIAGnostic:SERVice:NSOource <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 94

**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.

## 11.4.2 Triggering

The following remote commands are required to configure a triggered measurement in a remote environment. These commands are only available for the MSRA primary channel. More details are described for manual operation in [Chapter 7.5, "Trigger settings"](#), on page 79.



\*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](#).....200
- [Configuring the trigger output](#).....205

### 11.4.2.1 Configuring the triggering conditions

The following commands are required to configure a triggered measurement.

<a href="#">TRIGger[:SEquence]:DTIME</a> .....	200
<a href="#">TRIGger[:SEquence]:HOLDoff[:TIME]</a> .....	201
<a href="#">TRIGger[:SEquence]:IFPower:HOLDoff</a> .....	201
<a href="#">TRIGger[:SEquence]:IFPower:HYSteresis</a> .....	201
<a href="#">TRIGger[:SEquence]:LEVel:BBPower</a> .....	202
<a href="#">TRIGger[:SEquence]:LEVel[:EXternal&lt;port&gt;]</a> .....	202
<a href="#">TRIGger[:SEquence]:LEVel:IFPower</a> .....	202
<a href="#">TRIGger[:SEquence]:LEVel:RFPower</a> .....	203
<a href="#">TRIGger[:SEquence]:SLOPe</a> .....	203
<a href="#">TRIGger[:SEquence]:SOURce</a> .....	203
<a href="#">TRIGger[:SEquence]:TIME:RINTerval</a> .....	205

---

#### **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 83

**TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>**

Defines the time offset between the trigger event and the start of the sweep.

**Parameters:**

<Offset> \*RST: 0 s  
 Default unit: S

**Example:** TRIG:HOLD 500us

**Manual operation:** See "[Trigger Offset](#)" on page 83

**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).

**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 84

**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 83

---

#### 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 83

---

#### TRIGger[:SEQuence]:LEVel[:EXTeRnal<port>] <TriggerLevel>

Defines the level the external signal must exceed to cause a trigger event.

#### Suffix:

<port>                   Selects the trigger port.  
                               1 = trigger port 1 (TRIGGER INPUT connector on front panel)  
                               2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)  
                               (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 83

---

#### 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

**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

**TRIGger[:SEQuence]:SLOPe <Type>****Parameters:**

<Type> POSitive | NEGative

**POSitive**

Triggers when the signal rises to the trigger level (rising edge).

**NEGative**

Triggers when the signal drops to the trigger level (falling edge).

\*RST: POSitive

**Example:**

TRIG:SLOP NEG

**Manual operation:** See "[Slope](#)" on page 84

**TRIGger[:SEQuence]:SOURce <Source>**

Selects the trigger source.

**Note on external triggers:**

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure that this situation is avoided in your remote control programs.

**Parameters:**

<Source> **IMMediate**  
Free Run

**EXTernal**

Trigger signal from the "Trigger Input" connector.

**EXT2**

Trigger signal from the "Trigger Input/Output" connector.

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.

**BBPower**

Baseband power

For input from the optional "Analog Baseband" interface.

For input from the optional "Digital Baseband" interface.

**PSEN**

External power sensor

**GP0 | GP1 | GP2 | GP3 | GP4 | GP5**

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. The parameter specifies which general-purpose bit (0 to 5) provides the trigger data.

The assignment of the general-purpose bits used by the Digital IQ trigger to the LVDS connector pins is provided in ["Digital I/Q"](#) on page 81.

\*RST: IMMEDIATE

**Example:** TRIG:SOUR EXT  
Selects the external trigger input as source of the trigger signal

**Manual operation:** See "Trigger Source" on page 80  
See "Free Run" on page 80  
See "External Trigger 1/2/3" on page 80  
See "Baseband Power" on page 81  
See "Digital I/Q" on page 81  
See "IF Power" on page 81  
See "RF Power" on page 82  
See "I/Q Power" on page 82  
See "Power Sensor" on page 82

---

**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 83

#### 11.4.2.2 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.....	205
OUTPut:TRIGger<tp>:LEVel.....	206
OUTPut:TRIGger<tp>:OTYPe.....	206
OUTPut:TRIGger<tp>:PULSe:IMMEDIATE.....	207
OUTPut:TRIGger<tp>:PULSe:LENGTh.....	207

---

**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 84

**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 85

**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:**

&lt;OutputType&gt;

**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 85**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 85**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:**

&lt;Length&gt;

Pulse length in seconds.

Default unit: S

**Example:**

OUTP:TRIG2:PULS:LENG 0.02

**Manual operation:** See "[Pulse Length](#)" on page 85

### 11.4.3 Configuring data acquisition

The following commands are required to configure the actual data acquisition.

Configuring data acquisition is only possible for the MSRA primary channel. In MSRA secondary application channels, these commands define the analysis interval (see [Chapter 11.9, "Commands specific to MSRA secondary applications"](#), on page 228). Be sure to select the correct measurement channel before executing these commands.

[SENSe:]IQ:BWIDth:MODE.....	208
[SENSe:]IQ:BWIDth:RESolution.....	209
[SENSe:]IQ:FFT:ALGorithm.....	209
[SENSe:]IQ:FFT:LENGth.....	209
[SENSe:]IQ:FFT:WINDow:LENGth.....	210
[SENSe:]IQ:FFT:WINDow:OVERlap.....	210
[SENSe:]IQ:FFT:WINDow:TYPE.....	210
TRACe:IQ:BWIDth.....	211
TRACe:IQ:RLENGth.....	211
TRACe:IQ:SRATE.....	211
TRACe:IQ:TPISample?.....	212
TRACe:IQ:WBANd[:STATe].....	212
TRACe:IQ:WBANd:MBWIDth.....	213

---

#### [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 89



---

**[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.

**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 89

---

**[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 89

---

**[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 90

**[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 90

**[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 90

**[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 90**TRACe:IQ:BWIDth**

Defines or queries the bandwidth of the resampling filter.

The bandwidth of the resampling filter depends on the sample rate.

**Parameters:**

&lt;Bandwidth&gt; Default unit: HZ

**Manual operation:** See "[Analysis Bandwidth](#)" on page 87**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:**

&lt;NoOfSamples&gt; Number of samples to record.

\*RST: 1001

**Example:** TRAC:IQ:RLEN 256**Manual operation:** See "[Record Length](#)" on page 88**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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237.

In order to ensure a minimum usable I/Q bandwidth use the TRACe:IQ:WBAND:MBWIDth on page 213 command.

**Parameters:**

<SampleRate> The valid sample rates are described in [Chapter C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237.

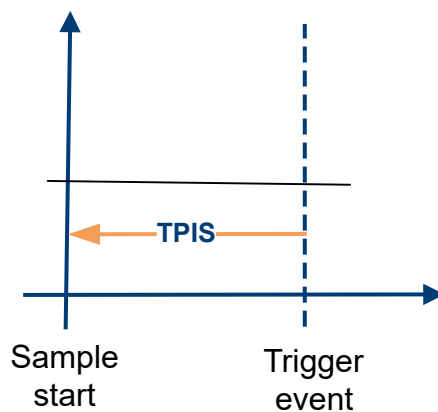
\*RST: 32 MHz

Default unit: HZ

**Manual operation:** See "[Sample Rate](#)" on page 87

**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  $\mu$ 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 88**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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237).

**Parameters:**

&lt;Limit&gt;

**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 C, "Sample rate and maximum usable I/Q bandwidth for RF input"](#), on page 237).

`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 88

### 11.4.4 Adjusting settings automatically

The following remote commands are required to adjust settings automatically in a remote environment. These commands are only available for the MSRA primary channel. The tasks for manual operation are described in [Chapter 7.9, "automatic settings"](#), on page 95.



Settings related to data acquisition (measurement time, hysteresis) can only be adjusted in the MSRA primary application, not in the secondary applications.

[SENSe:]ADJust:ALL.....	214
[SENSe:]ADJust:CONFigure:LEVel:DURation.....	214
[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE.....	215
[SENSe:]ADJust:FREQuency.....	215
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer.....	215
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer.....	216
[SENSe:]ADJust:LEVel.....	216

---

#### [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 95

---

#### [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 96

**[SENSe:]ADJJust: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:**

&lt;Mode&gt;

**AUTO**

The FSW determines the measurement length automatically according to the current input data.

**MANual**

The FSW uses the measurement length defined by [\[SENSe:\]ADJJust:CONFigure:LEVel:DURation](#) on page 214.

\*RST: AUTO

**Manual operation:** See ["Resetting the Automatic Measurement Time \(Meas Time Auto\)"](#) on page 96  
See ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 96

**[SENSe:]ADJJust: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 95

**[SENSe:]ADJJust:CONFigure:HYSTeresis:LOWer <Threshold>**

When the reference level is adjusted automatically using the [\[SENSe:\]ADJJust:LEVel](#) on page 216 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.

This setting can only be adjusted in the MSRA primary application, not in the secondary applications.

**Parameters:**

&lt;Threshold&gt;

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 96

**[SENSe:]ADJ:CONF:HYST:UPPer <Threshold>**

When the reference level is adjusted automatically using the [\[SENSe:\]ADJ:LEVel](#) on page 216 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.

This setting can only be adjusted in the MSRA primary application, not in the secondary applications.

**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 96

**[SENSe:]ADJ: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 95

## 11.5 Capturing data and performing sweeps

The only true measurement in MSRA mode in which I/Q data from the input signal is captured and stored is performed by the MSRA primary application. This data acquisition is performed as in the I/Q Analyzer application, i.e. a specified frequency span of the input signal is swept for a specified measurement time.



As soon as data has been stored to the capture buffer successfully, a status bit (#9) in the `STAT:OPER` register is set (see [Chapter 11.7.1, "STATus:OPERation register"](#), on page 226). Once the bit has been set, the device under test can already be reconfigured while the FSW performs analysis on the captured data. For measurements that require long measurement times and comprehensive analysis tasks, using the "capture finished" information can reduce the overall measurement time significantly.



See also:

- [INITiate<n>:REFresh](#) on page 230

<a href="#">ABORt</a> .....	217
<a href="#">INITiate&lt;n&gt;:CONMeas</a> .....	218
<a href="#">INITiate&lt;n&gt;:CONTinuous</a> .....	218
<a href="#">INITiate&lt;n&gt;[:IMMEDIATE]</a> .....	219
<a href="#">INITiate:SEQuencer:ABORt</a> .....	219
<a href="#">INITiate:SEQuencer:IMMEDIATE</a> .....	219
<a href="#">INITiate:SEQuencer:MODE</a> .....	219
<a href="#">INITiate:SEQuencer:REFresh[:ALL]</a> .....	220
<a href="#">[SENSe:]SWEep[:WINDow&lt;n&gt;]:POINts</a> .....	220
<a href="#">[SENSe:]SWEep:TIME</a> .....	221
<a href="#">SYSTem:SEQuencer</a> .....	221

## 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 `ABOR` 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

**Usage:** Asynchronous command

**Manual operation:** See "[Continue Single Sweep](#)" on page 93

---

### 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 219), 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 92

---

**INITiate<n>[:IMMEDIATE]**

Starts a (single) new 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

**Usage:** Asynchronous command

**Manual operation:** See "[Single Sweep/ RUN SINGLE](#)" on page 92

---

**INITiate:SEQuencer:ABORT**

Stops the currently active sequence of measurements.

You can start a new sequence any time using [INITiate:SEQuencer:IMMEDIATE](#) on page 219.

**Usage:** Event

**Manual operation:** See "[Sequencer State](#)" on page 28

---

**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 221).

**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.

**Manual operation:** See "[Sequencer State](#)" on page 28

---

**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 \*OPE, \*OPE? 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

**Manual operation:** See "[Sequencer Mode](#)" on page 28

**INITiate:SEQuencer:REFResh[:ALL]**

Is only available if the Sequencer is deactivated (`SYSTem:SEQuencer` `SYST:SEQ:OFF`) and only in MSRA mode.

The data in the capture buffer is re-evaluated by all active MSRA 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.

**Manual operation:** See "[Refresh All](#)" on page 28

**[SENSe:]SWEep[:WINDow<n>]:POINts <SweepPoints>**

This command defines the number of sweep points to analyze after a sweep.

**Suffix:**

<n>

**Example:**

`SWE:POIN 251`

**Manual operation:** See "[Sweep Points](#)" on page 91

**[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 88

**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
```

**Manual operation:** See "[Sequencer State](#)" on page 28

## 11.6 Retrieving results

The measurement results are output in the form of a list, three different formats can be selected for this list (see [TRACe:IQ:DATA:FORMat](#) on page 223).

For details on formats refer to [Chapter A, "Reference: format description for I/Q data files"](#), on page 234.



The applications can only receive data that is available in the capture buffer. As soon as data has been stored to the capture buffer successfully, a status bit (#9) in the `STAT:OPER` register is set (see [Chapter 11.7.1, "STATus:OPERation register"](#), on page 226).

<code>FORMat[:DATA]</code> .....	222
<code>TRACe:IQ:DATA?</code> .....	222
<code>TRACe:IQ:DATA:FORMat</code> .....	223
<code>TRACe:IQ:DATA:MEMory?</code> .....	224

---

### **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: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.

**Return values:**

<Results> Measured voltage for I and Q component for each sample that has been captured during the measurement. For more information on I/Q data processing modes see the FSW I/Q Analyzer and I/Q Input User Manual.  
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 A, "Reference: format description for I/Q data files"](#), on page 234.

**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,...Q,Q,Q,Q,Q,Q)

**IQPair**  
One pair of I/Q values after the other is listed  
(I,Q,I,Q,I,Q...).

\*RST: IQBL

**TRACe:IQ:DATA:MEMory?** [<OffsetSamples>,<NoOfSamples>]

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.)

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:

$$\langle \text{SampleRate} \rangle * \langle \text{CaptureTime} \rangle$$

**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 222.

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

## 11.7 Querying the status registers

The R&S FSW-I/Q Analyzer uses the standard status registers of the FSW.

The MSRA operating mode uses an additional bit in the `STATus:OPERation` register.

This register and the commands required to query its contents are described here.

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.

- [STATus:OPERation register](#).....226
- [Commands to query the STATus:OPERation register](#)..... 226

### 11.7.1 STATUS:OPERation register

The `STATUS:OPERation` register contains information on current activities of the FSW. It also contains information on activities that have been executed since the last read out.

You can read out the register with `STATUS:OPERation:CONDition?` on page 227 or `STATUS:OPERation[:EVENT]?` on page 227.

**Table 11-4: Meaning of the bits used in the STATUS:OPERation register**

Bit No.	Meaning
0	<code>CALibrating</code> This bit is set as long as the instrument is performing a self-alignment.
1-2	Not used
3	<code>SWEeping</code> Sweep is being performed in base unit (applications are not considered); identical to bit 4 In applications, this bit is not used.
4	<code>MEASuring</code> Measurement is being performed in base unit (applications are not considered); identical to bit 3 In applications, this bit is not used.
5	<code>Waiting for TRigger</code> Instrument is ready to trigger and waiting for trigger signal.
6-7	Not used
8	<code>HardCOpy in progress</code> This bit is set while the instrument is printing a hardcopy.
9	For data acquisition in MSRA mode only: <code>Multi-Standard capture finish</code> This bit is set if a data acquisition measurement was completed successfully in MSRA operating mode and data is available for evaluation. 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.
11-14	Not used
15	This bit is always 0.

### 11.7.2 Commands to query the STATUS:OPERation register

The following commands are required to query the contents of the `STATUS:OPERation` register.

<code>STATUS:OPERation:CONDition?</code> .....	227
<code>STATUS:OPERation:ENABLE</code> .....	227
<code>STATUS:OPERation:NTRansition</code> .....	227
<code>STATUS:OPERation:PTRansition</code> .....	227
<code>STATUS:OPERation[:EVENT]?</code> .....	227

**STATus:OPERation:CONDition?** <ChannelName>

This comand 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:OPERation:ENABLE** <SumBit>,<ChannelName>**Parameters:**

<SumBit>

**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.

---

**STATus:OPERation:NTRansition** <SumBit>,<ChannelName>**Parameters:**

<SumBit>

**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.

---

**STATus:OPERation:PTRansition** <SumBit>,<ChannelName>**Parameters:**

<SumBit>

**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.

---

**STATus:OPERation[:EVENT]?** <ChannelName>

Queries the contents of the EVENT section of the status register.

A query 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.

**Return values:**

<RegisterContents> Range: 0 to 32767

**Usage:** Query only

## 11.8 Analyzing MSRA measurements

The data that was captured by the MSRA primary application can be analyzed in various different applications.

The analysis settings and functions available in MSRA mode are those described for the individual applications. The MSRA primary application is in effect an I/Q Analyzer application and has the same analysis functions and settings.

See the FSW I/Q Analyzer User Manual for a description of the analysis functions and settings available for the I/Q Analyzer and thus the MSRA primary application.



The commands required to configure the MSRA-specific analysis line are described in [Chapter 11.9, "Commands specific to MSRA secondary applications"](#), on page 228.

## 11.9 Commands specific to MSRA secondary applications

Most commands for the MSRA secondary applications are identical to those described for the individual secondary applications. However, some specific commands are available for the MSRA secondary applications only.

### Configuring the analysis interval

The commands required to configure the secondary application data extracts and analysis intervals vary depending on the secondary application. See the corresponding application manuals for details.

For the I/Q Analyzer, the commands are the same as those used to define the actual data acquisition (see [Chapter 11.4.3, "Configuring data acquisition"](#), on page 208). In MSRA secondary application channels, these commands define the analysis interval. 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 211
- [TRACe: IQ: BWIDth](#) on page 211
- [TRACe: IQ: RLENgth](#) on page 211
- [\[SENSe:\] SWEep: TIME](#) on page 221

**Remote commands exclusive to MSRA secondary applications**

The following commands are only available for MSRA secondary application channels:

CALCulate<n>:IQ:MODE.....	229
CALCulate<n>:MSRA:ALINE:SHOW.....	229
CALCulate<n>:MSRA:ALINE[:VALue].....	230
CALCulate<n>:MSRA:WINDow<n>:IVAL.....	230
INITiate<n>:REFresh.....	230
[SENSe:]MSRA:CAPTure:OFFSet.....	231

**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.

**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 98

---

**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 98

---

**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

**Manual operation:** See "[Refresh \(MSRA only\)](#)" on page 92

---

**[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 90

## 11.10 Programming example: analyzing MSR signals

The following programming example demonstrates the use of the most important remote commands in MSRA mode. The example is based on the measurement example for manual operation described in [Chapter 10, "Measurement example: analyzing MSR signals"](#), on page 102.

```
//Preset
*RST

//Select Trace data output format: ASCII
FORM ASCII

//Switch to MSRA mode
INST:MODE MSR

//Set Sequencer in single mode
INIT:SEQ:MODE SING

//Preconfigure MSRA primary application for general I/Q data acquisition

//Set initial center frequency
FREQ:CENT 1000MHz

//Set Level
DISP:WIND:TRAC:Y:SCAL:RLEV 10 dBm

//Set Trigger to External 1
:TRIG:SOUR EXT

//Set Sample Rate to 15MHz
```

```
:TRACe:IQ:SRATe 15E6

//Set Record Length to 1Msample -> AQT 21 ms
:TRACe:IQ:RLENgth 315000

//Create new measurement channel for I/Q Analyzer
INST:CRE IQ, 'IQ Analyzer'

//Set initial center frequency
FREQ:CENt 994.9 MHz

//Set Sample Rate to 1MHz
:TRACe:IQ:SRATe 1E6

//Set Record Length to 1Msample -> AQT 5 ms
:TRACe:IQ:RLENgth 5000

//Create measurement channel for 3GPP FDD BTS application
INST:CRE BWCD, '3GPP FDD BTS'

//Set initial center frequency
FREQ:CENt 997.5MHz

//Select Composite EVM vs slot in Window 1, EVM vs Chip in Window 3
//Result Summary remains in Window 2 as default
LAY:REPL:WIND '1',CEVM
LAY:ADD:WIND? '2',BEL,EVMC
//Result: new window is '5'

//Meas all tabs with synchronisation in MSRA mode
INIT:SEQ:IMM;*OPC?

//Retrieve Results of IQ Analyzer
INST:SEL 'IQ Analyzer'

//Check for Rising edge
:CALCulate:MARKer:X 1.14ms
:CALCulate:MARKer:Y?
:CALCulate:MARKer:X 1.156ms
:CALCulate:MARKer:Y?

//Retrieve Results from WCMDA
INST:SEL '3GPP FDD BTS'

//Retrieve Composite EVM results
TRAC1:DATA? TRACe1

//Select Slot No 1
CDP:SLOT 1
```



```
//Search Peak value of Marker in EVM vs Chip  
:CALC5:MARK1 ON  
:CALC5:MARK1:MAX:PEAK  
  
//Retrieve Chip and max EVM value  
:CALC5:MARK1:X?;Y?
```

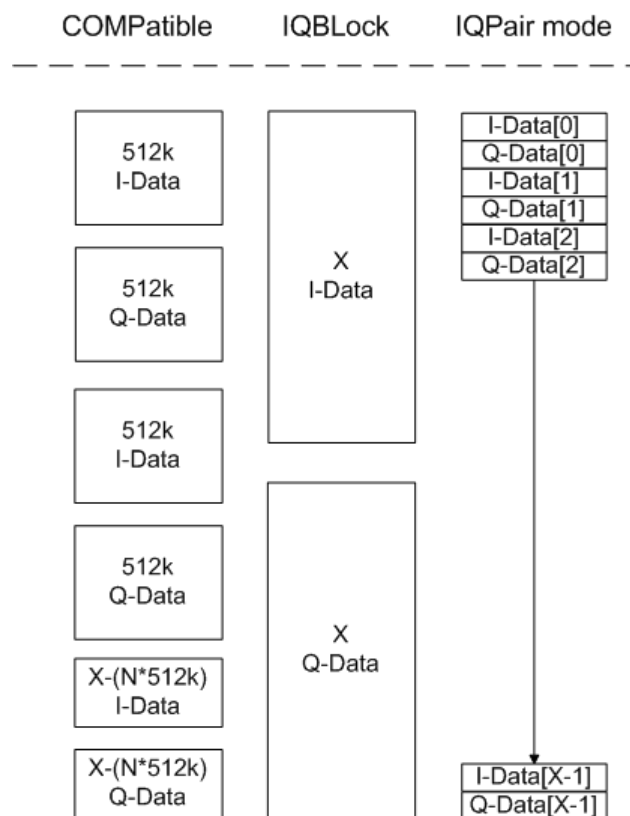
## Annex

# A 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 236.

For details on the format of I/Q export files (using the "I/Q Export" function), see the FSW User Manual.



**Figure A-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:

$$\# \text{ of } I\text{-Data} = \# \text{ of } Q\text{-Data} = \frac{\# \text{ of } DataBytes}{8}$$

For the format "QBlock", the offset of Q-data in the output buffer can be calculated as follows:

$$Q\text{-Data-Offset} = \frac{(\# \text{ of } DataBytes)}{2} + LengthIndicatorDigits$$

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  $512 + 6 = 518$ .

## 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 222. 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:

<Length of length>	Number of digits of the following number of data bytes
<Length of data>	Number of following data bytes
<Value>	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 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](#)..... 238
- [Relationship between sample rate, record length and usable I/Q bandwidth](#)..... 238
- [FSW without additional bandwidth extension options](#)..... 240
- [FSW with I/Q bandwidth extension option B40 or U40](#)..... 241
- [FSW with I/Q bandwidth extension option B80 or U80](#)..... 241
- [FSW with activated I/Q bandwidth extension option B160 or U160](#)..... 241
- [FSW with activated I/Q bandwidth extension option B320/U320](#)..... 242
- [FSW with activated I/Q bandwidth extension option B512](#)..... 244
- [FSW with activated I/Q bandwidth extension option B1200](#)..... 245

Relationship between sample rate, record length and usable I/Q bandwidth

- FSW with activated I/Q bandwidth extension option B2001..... 247
- FSW with activated I/Q bandwidth extension option B2000..... 249
- FSW with activated I/Q bandwidth extension option B5000..... 250

## C.1 Available bandwidth extension options

*Table C-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 <b>or</b> B40+U80
160 MHz	B160	U40+U80+U160 <b>or</b> B40+U80+U160 <b>or</b> B80+U160
320 MHz	B320	U40+U80+U160+U320 <b>or</b> B40+U80+U160+U320 <b>or</b> B80+U160+U320 <b>or</b> B160+U320
512 MHz	B512	U40+U80+U512 <b>or</b> B40+U80+U512 <b>or</b> B80+U512 <b>or</b>
1200 MHz	B1200	B40 + U80 + U1200 <b>or</b> B80 + U1200
2000 MHz	B2001	U2001

## C.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.

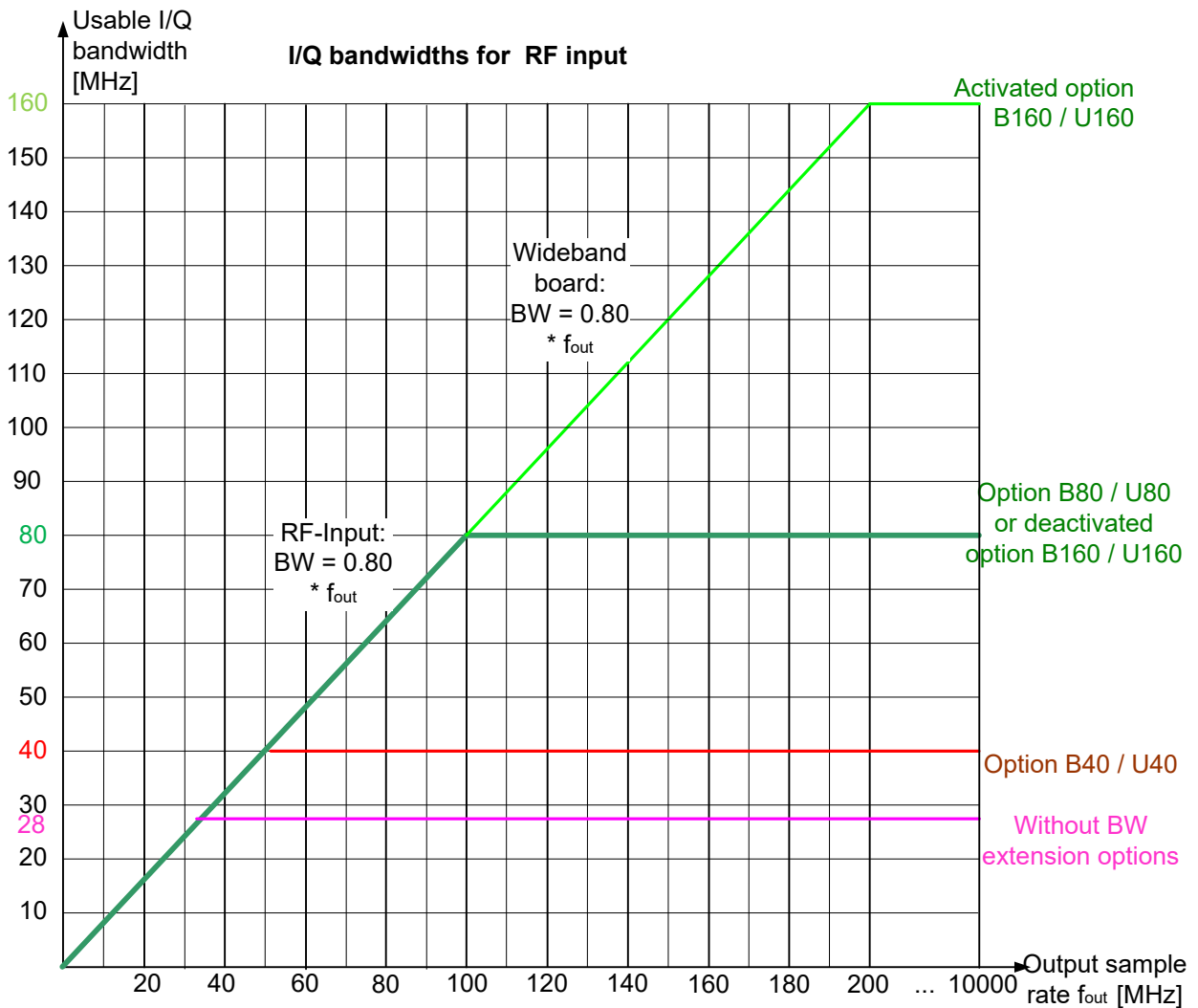
Relationship between sample rate, record length and usable I/Q bandwidth

For activated option B320 or U320, see [Table C-9](#).

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

**Table C-2: Maximum record length (without I/Q bandwidth extension options FSW-B160/-B320/-B512)**

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



**Figure C-1: 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 parame-

ters, 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 "[Maximum Bandwidth](#)" on page 88). 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.

## C.3 FSW without additional bandwidth extension options

Sample rate: 100 Hz - 20 GHz

Maximum I/Q bandwidth: 28 MHz

*Table C-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.



## C.4 FSW with I/Q bandwidth extension option B40 or U40

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 40 MHz

**Table C-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.

## C.5 FSW with I/Q bandwidth extension option B80 or U80

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 80 MHz

**Table C-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.

## C.6 FSW with activated I/Q bandwidth extension option B160 or U160

Sample rate: 100 Hz - 20 GHz

Maximum bandwidth: 160 MHz

**Table C-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 C-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
	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.

## C.7 FSW with activated I/Q bandwidth extension option B320/U320

**Table C-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

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

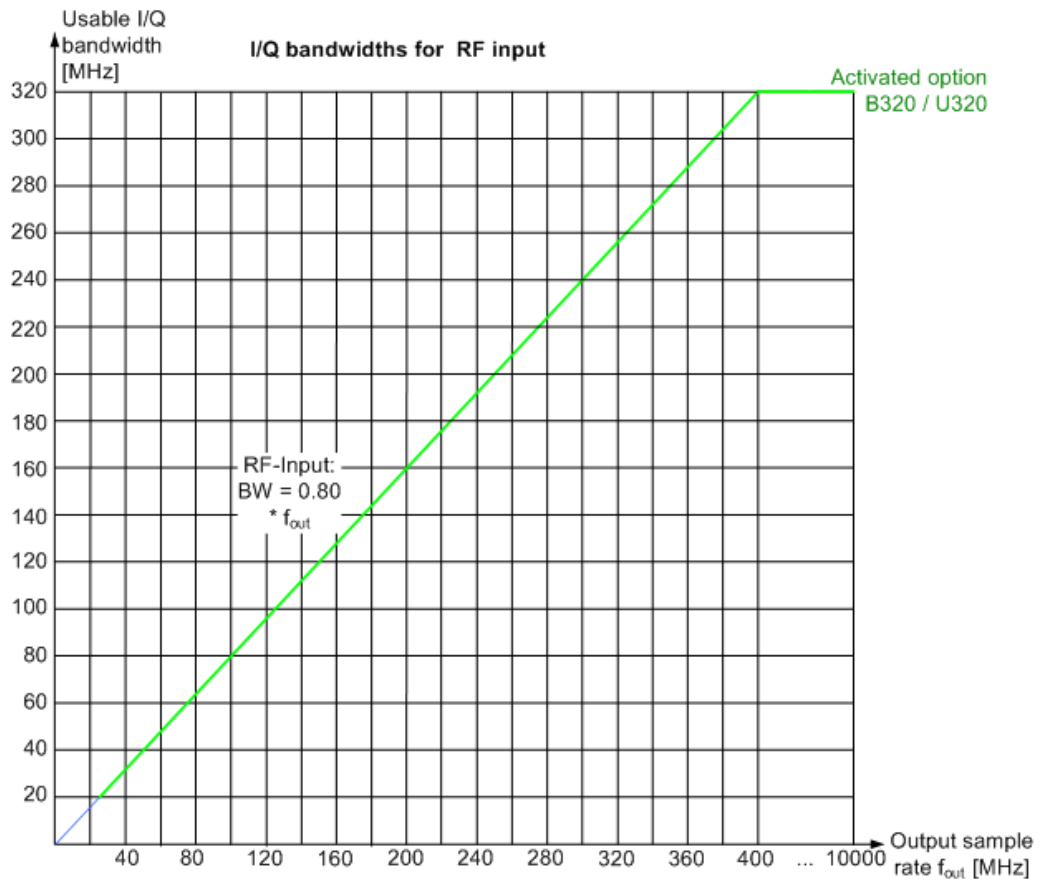


Figure C-2: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B320

Table C-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**

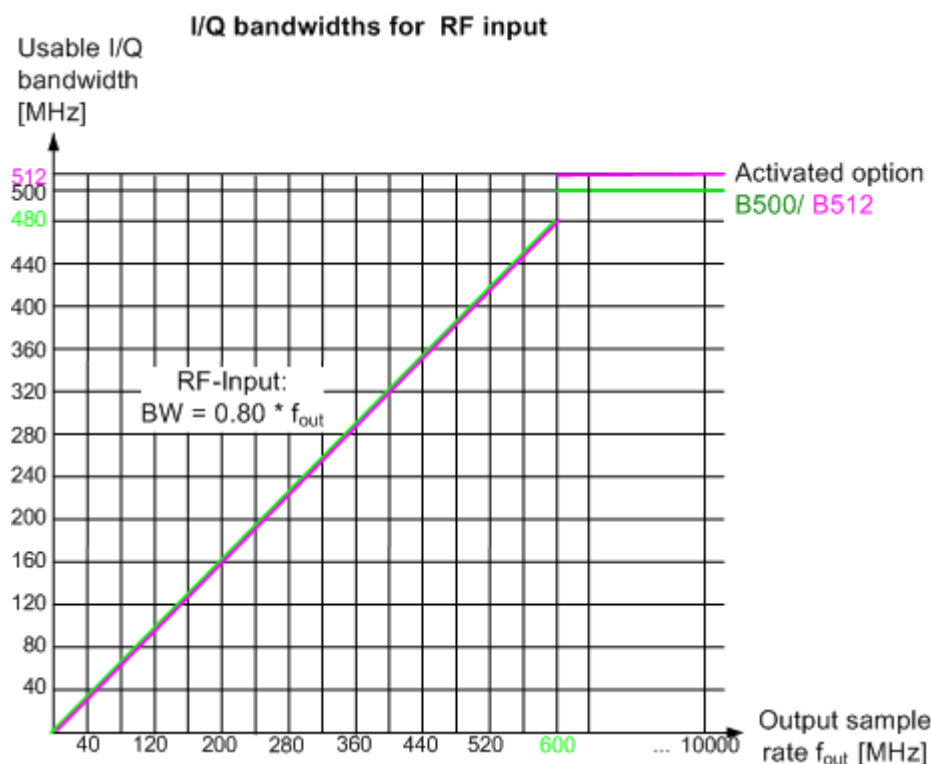
- In MSRA operating mode, the MSRA primary is restricted to a sample rate of 600 MHz.

## C.8 FSW with activated I/Q bandwidth extension option B512

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

**Table C-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 C-3: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B512**

**Table C-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  $\leq 480$  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:

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

## C.9 FSW with activated I/Q bandwidth extension option B1200

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

**Table C-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	

FSW with activated I/Q bandwidth extension option B1200

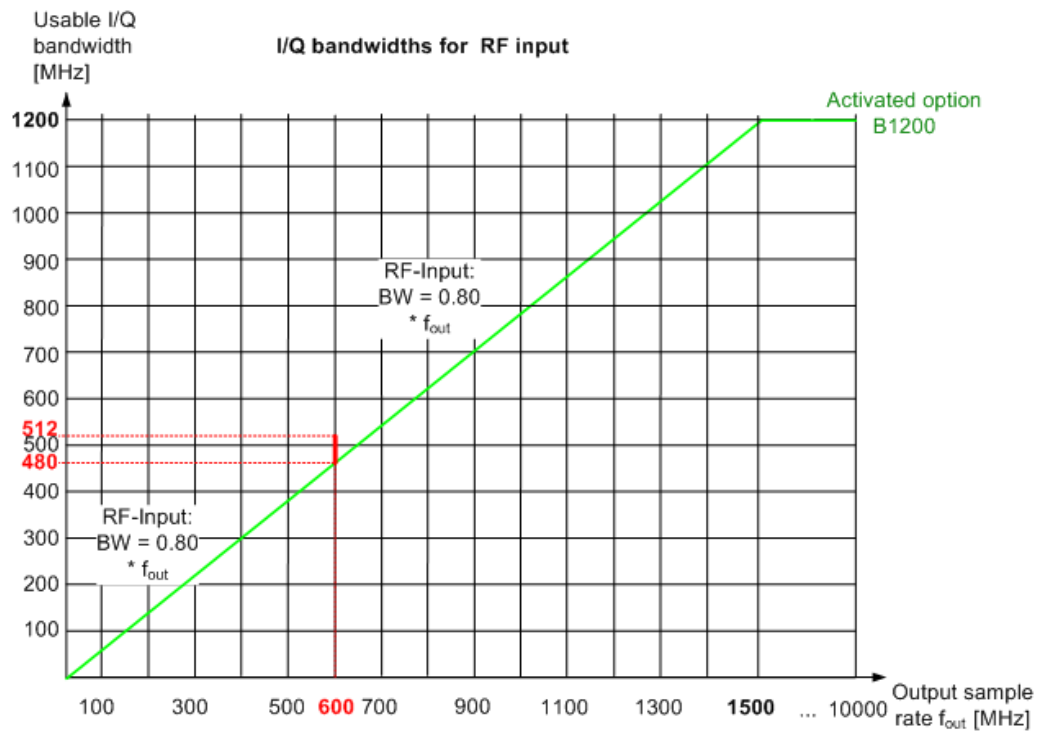


Figure C-4: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B1200

Table C-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
600 MHz to 1250 MHz	480 Msamples * (sample rate / 1250 MHz); max. 440 Msamples
1250 MHz to 20 GHz	max. 440 Msamples



#### Notes and restrictions for FSW-B1200

- The memory extension option FSW-B106 is not available together with the B1200 option.
- 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  $\leq 480$  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:

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

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:

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

## C.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 C-14: 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 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

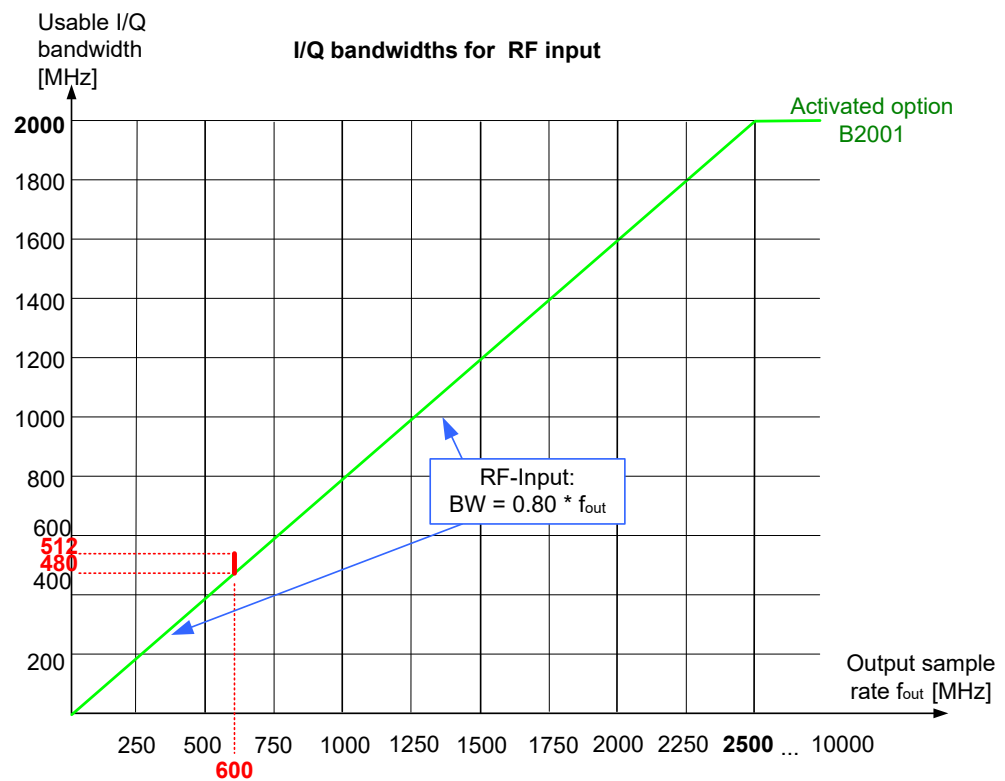


Figure C-5: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B2001

**Notes and restrictions for FSW-B2001**

- The memory extension option FSW-B106 is not available together with the B2001 option.
- 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  $\leq 480$  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:

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

## C.11 FSW with activated I/Q bandwidth extension option B2000

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

**Table C-15: Maximum I/Q bandwidth**

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

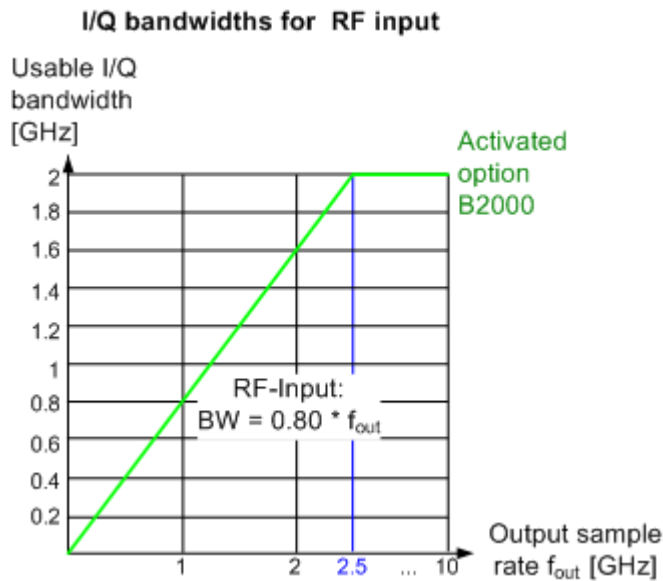


Figure C-6: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B2000



#### 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.
- 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.

## C.12 FSW with activated I/Q bandwidth extension option B5000

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

Table C-16: Maximum I/Q bandwidth

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

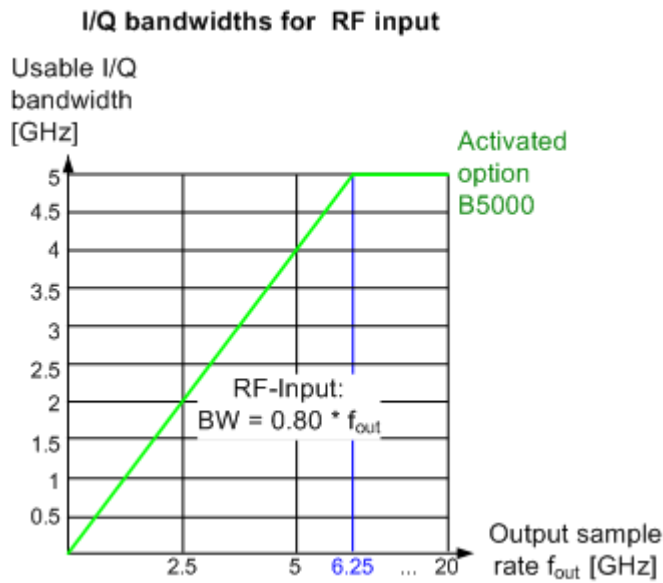


Figure C-7: Relationship between maximum usable I/Q bandwidth and output sample rate for active FSW-B5000



#### 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.
- 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.

## D 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

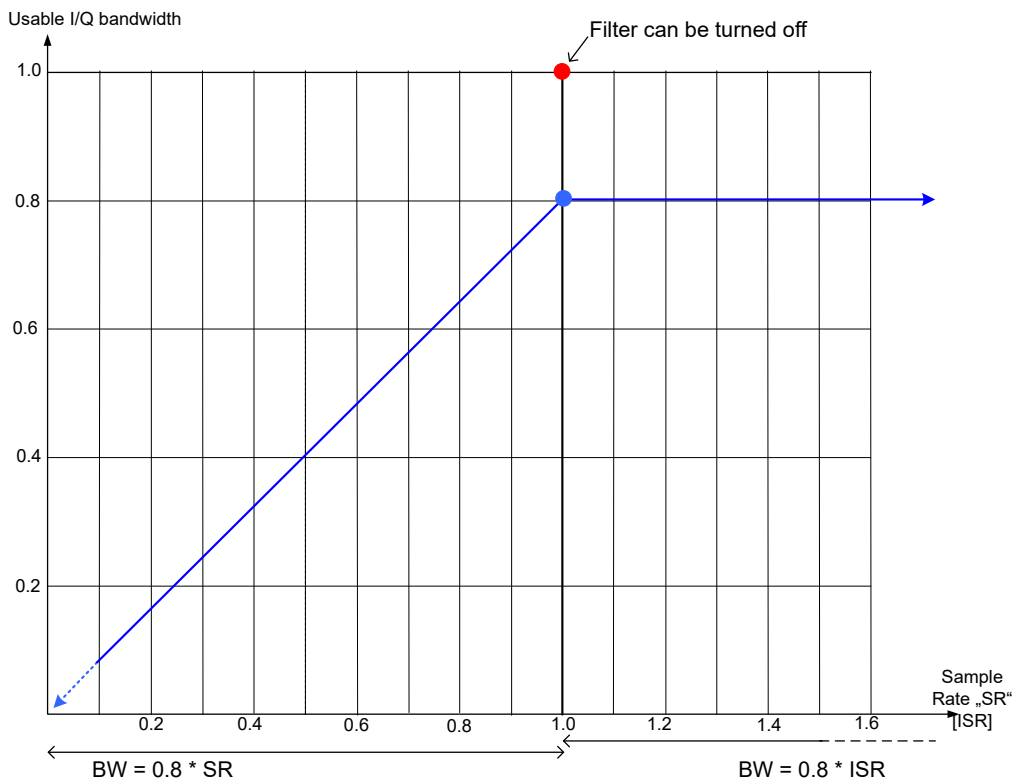
The following table describes the restrictions for digital in- and output:

**Table D-1: 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)
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)	

**Bandwidths**

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



**Figure D-1: Bandwidths depending on sample rate for active digital input**

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[SENSe:]ADJust:ALL.....	214
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer.....	215
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer.....	216
[SENSe:]ADJust:CONFigure:LEVel:DURation.....	214
[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE.....	215
[SENSe:]ADJust:FREQuency.....	215
[SENSe:]ADJust:LEVel.....	216
[SENSe:]CORRection:CVL:BAND.....	161
[SENSe:]CORRection:CVL:BIAS.....	161
[SENSe:]CORRection:CVL:CATalog?.....	161
[SENSe:]CORRection:CVL:CLEar.....	162
[SENSe:]CORRection:CVL:COMMeNt.....	162
[SENSe:]CORRection:CVL:DATA.....	162
[SENSe:]CORRection:CVL:HARMonic.....	162
[SENSe:]CORRection:CVL:MIXer.....	163
[SENSe:]CORRection:CVL:PORTs.....	163
[SENSe:]CORRection:CVL:SELEct.....	163
[SENSe:]CORRection:CVL:SNUMber.....	164
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[SENSe:]EFRontend:ALIGNment<ch>:STATe.....	139
[SENSe:]EFRontend:CONNection:CONFig.....	131
[SENSe:]EFRontend:CONNection:CSTATe?.....	131
[SENSe:]EFRontend:CONNection[:STATe].....	130
[SENSe:]EFRontend:FREQuency:BAND:COUNT?.....	132
[SENSe:]EFRontend:FREQuency:BAND<b>:LOWer?.....	132
[SENSe:]EFRontend:FREQuency:BAND<b>:UPPer?.....	132
[SENSe:]EFRontend:FREQuency:BCONfig:AUTO.....	133
[SENSe:]EFRontend:FREQuency:BCONfig:LIST?.....	133
[SENSe:]EFRontend:FREQuency:BCONfig:SELEct.....	134
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[SENSe:]EFRontend:FREQuency:REFerence:LIST?.....	137
[SENSe:]EFRontend:FWUPdate.....	140
[SENSe:]EFRontend:IDN?.....	137
[SENSe:]EFRontend:NETWork.....	138
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE.....	141
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe.....	142
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?.....	142
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?.....	143
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?.....	144
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?.....	144
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?.....	143

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[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFresh	143
[SENSe:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?	145
[SENSe:]EFRontend[:STATe]	138
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[SENSe:]IQ:FFT:LENGth	209
[SENSe:]IQ:FFT:WINDow:LENGth	210
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[SENSe:]IQ:FFT:WINDow:TYPE	210
[SENSe:]MIXer<x>:BIAS:HIGH	154
[SENSe:]MIXer<x>:BIAS[:LOW]	154
[SENSe:]MIXer<x>:FREQuency:HANDover	155
[SENSe:]MIXer<x>:FREQuency:STARt	155
[SENSe:]MIXer<x>:FREQuency:STOP	155
[SENSe:]MIXer<x>:HARMonic:BAND	156
[SENSe:]MIXer<x>:HARMonic:BAND:PRESet	156
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[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue]	157
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[SENSe:]MIXer<x>:HARMonic[:LOW]	158
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[SENSe:]MIXer<x>:LOPower	154
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[SENSe:]MIXer<x>:LOSS:TABLE:HIGH	158
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[SENSe:]PROBe<pb>:SETup:TYPE?	188
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INPut:COUPling.....	124
INPut:DIQ:CDEVice.....	166
INPut:DIQ:RANGe:COUPling.....	167
INPut:DIQ:RANGe[:UPPer].....	167
INPut:DIQ:RANGe[:UPPer]:AUTO.....	167
INPut:DIQ:RANGe[:UPPer]:UNIT.....	168
INPut:DIQ:SRATe.....	168
INPut:DIQ:SRATe:AUTO.....	168
INPut:DPATH.....	124
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INPut:EATT:AUTO.....	192
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INPut:FILE:PATH.....	127
INPut:FILTer:HPASs[:STATe].....	124
INPut:FILTer:YIG[:STATe].....	125
INPut:GAIN:STATe.....	194
INPut:GAIN[:VALue].....	195



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INPut:IMPedance:PTYPE.....	125
INPut:IQ:BALanced[:STATe].....	169
INPut:IQ:FULLscale:AUTO.....	169
INPut:IQ:FULLscale[:LEVel].....	169
INPut:IQ:IMPedance.....	170
INPut:IQ:IMPedance:PTYPE.....	170
INPut:IQ:OSC:BALanced[:STATe].....	172
INPut:IQ:OSC:CONState?.....	172
INPut:IQ:OSC:COUPling.....	173
INPut:IQ:OSC:FULLscale[:LEVel].....	173
INPut:IQ:OSC:IDN?.....	173
INPut:IQ:OSC:IMPedance.....	174
INPut:IQ:OSC:IMPedance:PTYPE.....	174
INPut:IQ:OSC:SKEW:I.....	175
INPut:IQ:OSC:SKEW:I:INVerted.....	175
INPut:IQ:OSC:SKEW:Q.....	175
INPut:IQ:OSC:SKEW:Q:INVerted.....	175
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