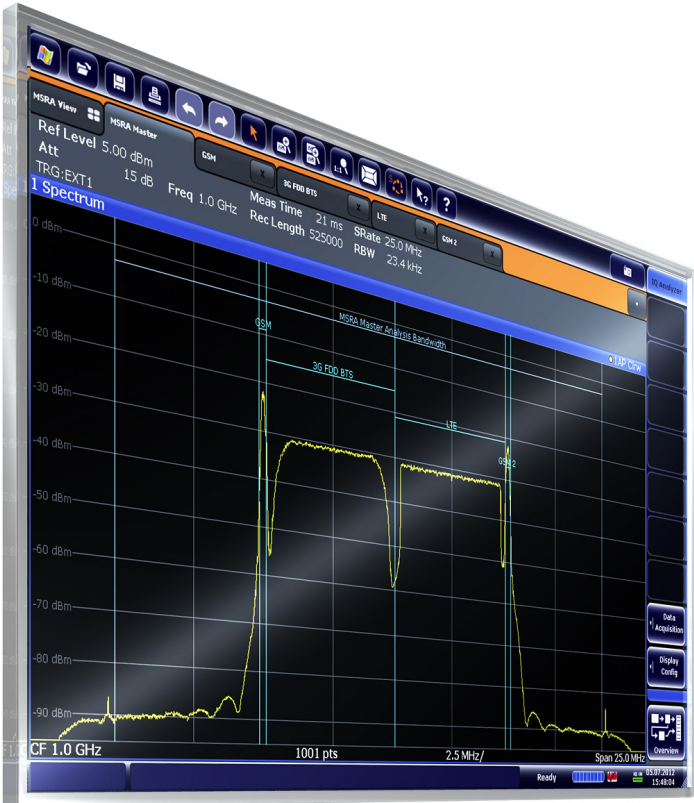# R&S®FSWP-B1
Multi-Standard Radio Analyzer
User Manual

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ROHDE&SCHWARZ

This manual describes the following R&S®FSWP models with firmware version 1.11 or higher:

- R&S®FSWP8 (1322.8003K08)
- R&S®FSWP26 (1322.8003K26)
- R&S®FSWP50 (1322.8003K50)

The MSRA mode is an integral part of the following options:

- R&S FSWP-B1 (1322.9997.08)
- R&S FSWP-B1 (1322.9997.26)
- R&S FSWP-B1 (1322.9997.50)

The following abbreviations are used throughout this manual: R&S®FSWP is abbreviated as R&S FSWP. R&S MultiView is abbreviated as MultiView. Products of the R&S®SMW family, e.g. R&S®SMW200A, are abbreviated as R&S SMW.

Contents

1 Documentation Overview

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

- Printed Getting Started manual
- Online Help system on the instrument
- Documentation CD-ROM with:
  - Getting Started
  - User Manuals for base unit and firmware applications
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. Online help is available using the ? icon on the toolbar of the R&S FSWP.

Web Help

The web help provides online access to the complete information on operating the R&S FSWP and all available options, without downloading. The content of the web help corresponds to the user manuals for the latest product version. The web help is available from the R&S FSWP product page at http://www.rohde-schwarz.com/product/ FSWP.html > Downloads > Web Help.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD-ROM. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

User Manuals

User manuals are provided for the base unit and each additional (firmware) application.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSWP in general, and the Phase Noise application in particular. Furthermore, the software functions that enhance the basic functionality for various applications are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual application manuals, the specific instrument functions of the application are described in detail. For additional information on default settings and parame-

ters, refer to the data sheets. Basic information on operating the R&S FSWP is not included in the application manuals.

All user manuals are also available for download from the Rohde & Schwarz website, on the R&S FSWP product page at http://www.rohde-schwarz.com/product/FSWP.html.

Service Manual

This manual is available in PDF format on the Documentation CD-ROM delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSWP by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

The most recent release notes are also available for download from the Rohde & Schwarz website, on the R&S FSWP product page at http://www.rohde-schwarz.com/product/FSWP.html > Downloads > Firmware.

2 Conventions Used in the Documentation

2.1 Typographical Conventions

The following text markers are used throughout this documentation:

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

2.2 Conventions for Procedure Descriptions

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

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

2.3 Notes on Screenshots

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

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

3 Welcome to the MSRA Operating Mode

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

The R&S FSWP 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

---

Availability of the Multi-Standard Radio Analyzer

The Multi-Standard Radio Analyzer becomes available when you equip the R&S FSWP with the optional Spectrum Analyzer hardware (R&S FSWP-B1).

Note that the MSRA does not support all applications (for example, the Phase Noise application is not supported by MSRA).

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 R&S FSWP User Manual. The latest version is available for download at the product homepage

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

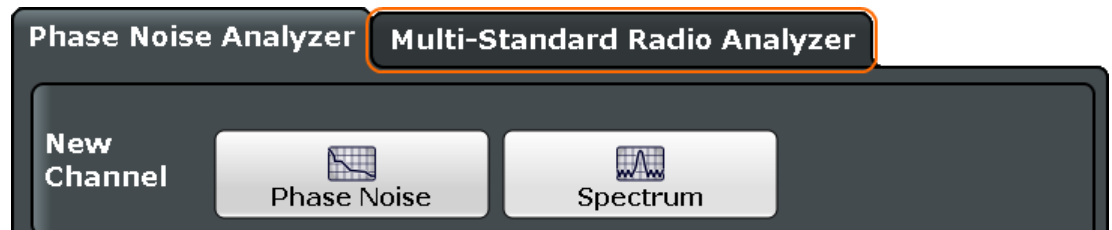## 3.1 Starting the MSRA operating mode

MSRA is a new operating mode on the R&S FSWP.

To activate the MSRA operating mode

1. Select the MODE key.

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

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

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

    The R&S FSWP closes all active measurement channels in the current operating
    mode, then opens a new measurement channel for the MSRA operating mode.
    Note: when you return to the Phase Noise Analyzer mode, the R&S FSWP opens
    a Spectrum channel.

    In addition to the "MSRA View", an "MSRA Master" tab is displayed.
    The Sequencer is automatically activated in continuous mode (see Chapter 5.3,
    "Using the Sequencer in MSRA Mode", on page 20), 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 the "Overview" softkey from any menu (see Chapter 7, "Configuration",
    on page 28).

    Remote command:

    `INST:MODE MSR`, see `INSTrument:MODE` on page 68

3.2 Understanding the Display Information

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

- The orange background of the screen behind the measurement channel tabs indi-
  cates that you are in MSRA operating mode.
- The ⬛ icon on the tab label indicates that the displayed trace (e.g. in an MSRA
  application) no longer matches the currently captured data. This may be the case,
  for example, if a data acquisition was performed in another 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 application(s) no lon-
ger match the data captured by the MSRA Master. The "IQ" disappears after the
results in the application(s) are refreshed.
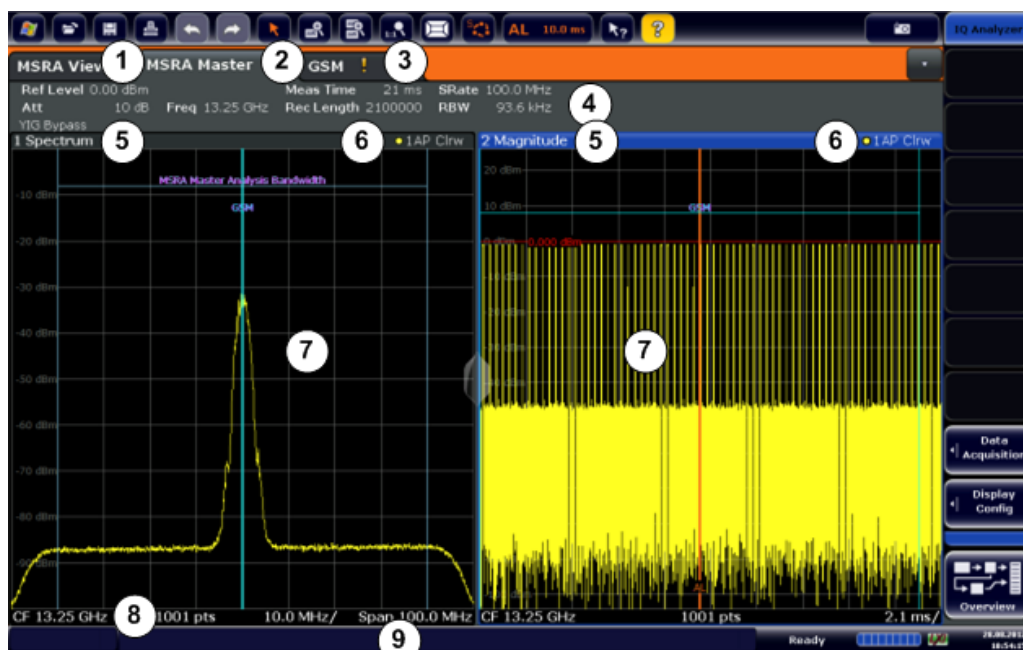
```
1   = MSRA View (overview of all active channels in MSRA mode)
2   = MSRA Master (data acquisition channel with global configuration settings)
3   = Measurement channel tab for individual MSRA application
4   = Channel bar for firmware and measurement settings of current application
5+6 = Window title bar with diagram-specific (trace) information and analysis interval (applications)
7   = Diagram area
8   = Diagram footer with diagram-specific information, depending on evaluation
9   = Instrument status bar with error messages, progress bar and date/time display
```

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 3-1: 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 interval
8 = Analysis line indication
```

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.

3.2.1 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 Master is displayed, i.e. the application that captures data. Beneath the MSRA Master, all active applications are displayed in individual windows. Each application has its own channel bar with the current settings as well as a button in order to switch to that application tab directly.

The MSRA View displays the following basic elements:

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

3.2.2 MSRA Master

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

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

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

Channel bar information

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

Table 3-1: Information displayed in the channel bar for the MSRA Master

Ref Level	Reference level
Att	RF attenuation
Ref Offset	Reference level offset
Freq	Center frequency
AQT	Defined measurement time, i.e. the duration of data acquisition to the capture buffer
Rec Length	Defined record length (number of samples to capture)
SRate	Defined sample rate for data acquisition
RBW	(Spectrum evaluation only) Resolution bandwidth calculated from the sample rate and record length

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

Data coverage for each active application

Each application obtains an extract of the data captured by the MSRA Master (see also Chapter 6.3, "Multi-Standard Analysis", on page 24). Generally, if a signal contains data channels for multiple standards, the individual applications are used to analyze the channel for the corresponding standard. Thus, it is of interest to know which application is analyzing which part of the captured data, or more precisely, which data channel. The MSRA Master display indicates the data covered by each application, restricted to the channel bandwidth used by the corresponding standard, by vertical blue lines labeled with the application name. For applications that support several standards (e.g. VSA, LTE) an estimated or user-defined bandwidth is indicated.

3.2.3 MSRA Applications

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

The following figure shows the screen elements specific to the MSRA application tabs.
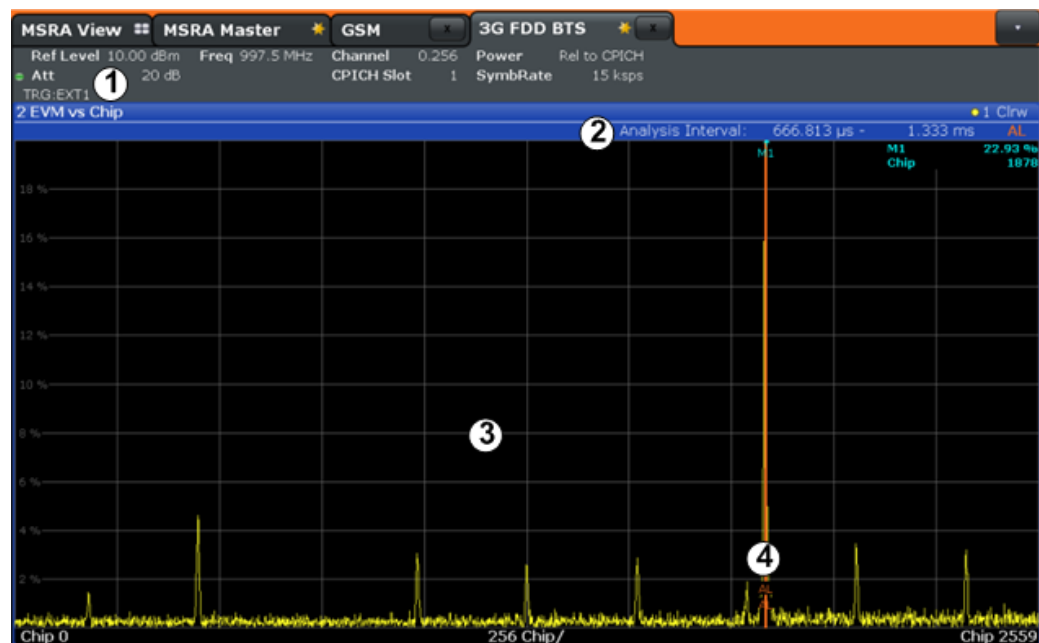
1 = Channel information bar for application
2 = Analysis interval for current evaluation
3 = Result display for analysis interval
4 = Analysis line

The display for the individual MSRA 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 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 applications whose analysis interval includes that time (see "Analysis line" on page 25).

For details on the individual application displays see the corresponding User Manuals for those 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 Master. 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 Master 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 R&S FSWP Getting Started manual.

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

See the R&S FSWP I/Q Analyzer User Manual for a description of the result displays available for the I/Q Analyzer and thus the MSRA Master.

Measurements in the time and frequency domain

The I/Q Analyzer application (*not Master*) in MSRA mode can also perform measurements on the captured I/Q data in the time and frequency domain (see also Chapter 6.5, "Measurements in the Time and Frequency Domain", on page 26).

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 R&S FSWP User Manual.

5 Applications and Operating Modes

The R&S FSWP provides several applications for different analysis tasks and different types of signals, e.g. W-CDMA, 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 may be limited further by the available memory on the instrument.

Independent vs correlating measurements

With the **conventional R&S FSWP 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.

In some cases it may 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 Analog Demodulation application. If a spur or an unexpected peak occurs, you may want to analyze the same data in the I/Q Analyzer to see the real and imaginary components of the signal and 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 that would mean the irregular signal would be lost. Therefore, a second operating mode is available in the R&S FSWP: Multi-Standard Radio Analyzer (MSRA) mode.

Multi-Standard Radio Analyzer mode

In **Multi-Standard Radio Analyzer (MSRA) mode**, data acquisition is performed once as an I/Q measurement, and the captured data is then evaluated by any number of 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 application. Using the Multi-Standard 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 R&S FSWP 3G FDD BTS (W-CDMA) application to reveal dependencies like a change in the EVM value.

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 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 68

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 Applications

The R&S FSWP provides some applications in the base unit while others are available only if the corresponding firmware options are installed.

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

- I/Q Analyzer
  (Comes with the optional Spectrum application.)
- Analog Demodulation
- Pulse measurements
- Vector Signal Analysis (VSA)

I/Q Analyzer
The I/Q Analyzer application provides measurement and display functions for digital 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 FSWP I/Q Analyzer User Manual.

Remote command:
`INST:SEL IQ`, see `INSTrument[:SELect]` on page 69

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

For details see the R&S FSWP Analog Demodulation User Manual.

Remote command:
`INST:SEL ADEM`, see `INSTrument[:SELect]` on page 69

Vector Signal Analysis (VSA)
The VSA application requires an instrument equipped with the Vector Signal Analysis option, R&S FSWP-K70. This application provides measurements and evaluations for Vector Signal Analysis.

For details see the R&S FSWP VSA User Manual.

Remote command:
`INST:SEL DDEM`, see `INSTrument[:SELect]` on page 69

5.2 Selecting the Operating Mode and Application

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

(See the "Instrument Setup" chapter in the R&S FSWP User Manual).

Both the operating mode and the application can be selected in the "Mode" dialog box which is displayed when you press the MODE key.

To switch the operating mode, select the corresponding tab (see Chapter 3.1, "Starting the MSRA operating mode", on page 8).

To select an application, select the corresponding button.

To deactivate a channel, simply close the corresponding tab.

The remote commands required to perform these tasks are described in Chapter 10.3, "Activating MSRA Measurements", on page 66.

New Channel
The applications selected on this tab are started in a new channel, i.e. a new tab in the display.

Remote command:
`INSTrument:CREate[:NEW]` on page 66
`INSTrument[:SELect]` on page 69

Replace Current Channel
The applications selected on this tab are started in the currently displayed channel, replacing the current application.

Remote command:
INSTrument:CREate:REPLace on page 67

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 R&S FSWP will continuously perform a data acquisition (MSRA Master), then evaluate the data in the active applications one after the other, then repeat the data acquisition and evaluate the new data etc. The tabs are updated after each measurement or evaluation. This behaviour is identical to Signal and Spectrum Analyzer mode (also for Single Sequence or Channel-Defined Sequence modes).

However, if you switch the Sequencer off, the behaviour of the sweep functions is slightly different to Signal and Spectrum Analyzer mode (see also "Performing sweeps" on page 23):

- If continuous sweep is active (default) and you switch to a different application, continuous sweep is aborted. This is necessary in order to evaluate the same data in different applications without overwriting the data in the capture buffer. Continuous sweep can be started again as usual.

- Only the 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 applications.

For details on the Sequencer function see the R&S FSWP 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 99
INITiate<n>:SEQuencer:IMMediate on page 97
INITiate<n>:SEQuencer:ABORt on page 97

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<n>:SEQuencer:MODE on page 97

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 applications, for example after a new sweep was performed while the Sequencer was off.

Note: To update only the displays in the currently active application, use the "Refresh" function in the "Sweep" menu for that application (see "Refresh (MSRA only)" on page 49).

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

Remote command:
INITiate<n>:SEQuencer:REFResh[:ALL] on page 98

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

Master parameters

In MSRA mode, only the MSRA Master 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 Master tab. In all application tabs, these settings are deactivated (or have a different meaning).

Typical master parameters include:

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

Channel-specific parameters

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

Typical channel-specific parameters include:

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

Conflicting parameters

Master and channel-specific parameters can be configured independantly of one another, in any order that is convenient to you. However, there are dependencies between the parameters, as the applications can only evaluate data that has been captured by the MSRA Master 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 applications where necessary.

6.2　Data Acquisition

As mentioned before, only the MSRA Master performs a data acquisition. Thus, the MSRA Master defines the center frequency, sample rate and record length of the captured I/Q data. It also defines the trigger event, thus all applications have the same trigger. However, an offset from the trigger can be defined by the individual applications (see "Trigger offset vs. capture offset" on page 25).

Performing sweeps

When you switch to MSRA mode, the Sequencer is automatically activated in continuous mode. The MSRA Master continuously performs a data acquisition. If any applications are activated, then after each measurement, the data in the active applications is evaluated one after the other. The MSRA Master 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 application, which updates the data in the capture buffer and the results in the current application. The results in the other 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 application. You can then continue sweeping from there. This is necessary in order to evaluate the same data in different 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 Master, nor for the applications. However, depending on the 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 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 application data is not available, an error message is displayed. Details on restrictions are described in Chapter 6.4, "Restrictions for Applications", on page 25.

6.3 Multi-Standard Analysis

Application data

The applications receive data for analysis from the capture buffer, if necessary resampled or with filters applied. The applications can define their own center frequency, sample rate and record length for their **application data**, which is an **extract of the capture buffer data**. The 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 applications are used to analyze the channel for the corresponding standard. Thus, it is of interest to know which 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 Master display indicates the data covered by each application, restricted to the channel bandwidth used by the corresponding standard, by vertical blue lines labeled with the application name. For applications that support several standards (e.g. VSA, LTE) an estimated or user-defined bandwidth is indicated.
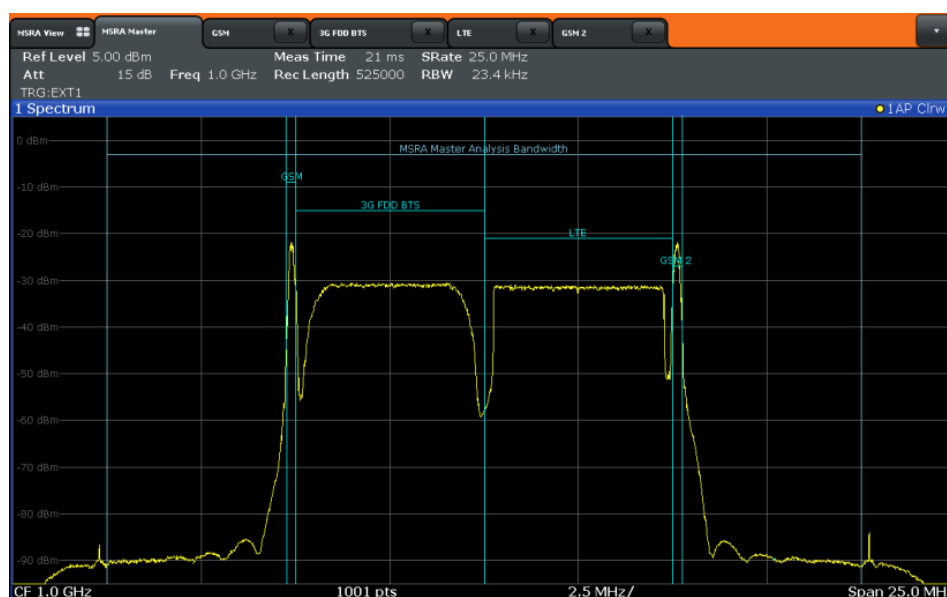

Figure 6-1: MSRA Master indicating covered bandwidth for 4 applications

Analysis interval

Each application receives an extract of the data from the capture buffer. However, the individual evaluation methods of the application need not analyze the complete data range. Some 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 applications that do not allow you to restrict the evaluation range (e.g. I/Q Analyzer, Analog Demodulation), the analysis interval is identical to the 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 Master, which means that all channels use the same trigger. However, each application might need a different trigger offset or a different number of pretrigger samples. Instead of a trigger offset, the 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 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 application data would start before the first sample of the capture buffer. The (pre-)trigger offset in the MSRA Master must be configured such that the required number of pre-trigger samples for the 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 applications. It can be positioned in any MSRA application or the MSRA Master and is then adjusted in all other applications. Thus, you can easily analyze the results at a specific time in the measurement in all applications and determine correlations (e.g. cross-talk).

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

As mentioned in various contexts before, the MSRA applications themselves are identical to Signal and Spectrum operating mode, however, the correlation between applications and the MSRA Master 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 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 applications in MSRA mode:

- **Data acquisition**: parameters related to data acquisition can only be configured by the MSRA Master
- **Application data**: only data contained in the capture buffer can be analyzed by the 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 Master
  - **Capture offset**: must be smaller than the record length of the MSRA Master
  - **Trace averaging**: only for sweep count = 0
- **AUTO SET functions**: in 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 the R&S FSWP I/Q Analyzer User Manual for details.

6.5 Measurements in the Time and Frequency Domain

The I/Q Analyzer application (*not Master*) **in multistandard mode** can also perform measurements on the captured I/Q data in the time and frequency domain. In order to do so, the I/Q Analyzer performs an FFT sweep on the captured I/Q data, providing power vs frequency results, or uses the RBW filter to obtain power vs time (zero span) results. This data is then used for the common frequency or time domain measurements provided by the R&S FSWP 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 applications. They are configured using the same settings and provide the same results. The "Magnitude" result display in the I/Q Analyzer, for instance, will principally show the same results as the zero span measurement for the same data. However, while the "Magnitude" evaluation is configured by the I/Q analysis bandwidth and the measurement time, the zero span measurement is configured by the center frequency, RBW and sweep time settings. Internally, these "time domain" settings are converted to the required I/Q settings by the I/Q Analyzer.

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

Limitations

However, since the data in the I/Q Analyzer application is captured by the Master, independently of the specific time or frequency measurement requirements concerning the RBW, filter type and number of sweep points in the 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 application.

The **maximum span** for a frequency sweep on I/Q-based data corresponds to the maximum I/Q bandwidth.

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 Configuration

MSRA is a special operating mode on the R&S FSWP, which you activate using the MODE key.

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 20), 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 Master

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

Restrictions

Note that although some restrictions apply to parameters that affect both the MSRA Master and applications (see Chapter 6.4, "Restrictions for Applications", on page 25), 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 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

Note that, as opposed to the Signal and Spectrum Analyzer mode, the I/Q data to be evaluated in MSRA mode cannot be imported to the R&S FSWP. However, the captured I/Q data from the MSRA Master can be exported for further analysis in external applications.

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

Configuring an I/Q Analyzer as an MSRA application

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

However, the I/Q Analyzer application (*not Master*) in MSRA mode can also perform measurements on the captured I/Q data in the time and frequency domain (see also Chapter 6.5, "Measurements in the Time and Frequency Domain", on page 26). Which type of measurement is to be performed - conventional I/Q data analysis or a time or frequency domain measurement - is selected in the "Select Measurement" dialog box, which is now displayed when you do one of the following:

- In the "I/Q Analyzer" menu, select the "Select Meas" softkey.

- Press the MEAS key.

The common measurements as in the Spectrum application are listed. In addition, "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 R&S FSWP User Manual. Further configuration of the I/Q Analyzer application is described in the R&S FSWP I/Q Analyzer and I/Q Input User Manual.

The following chapters describe configuration for the MSRA Master.

7.1 Configuration Overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.
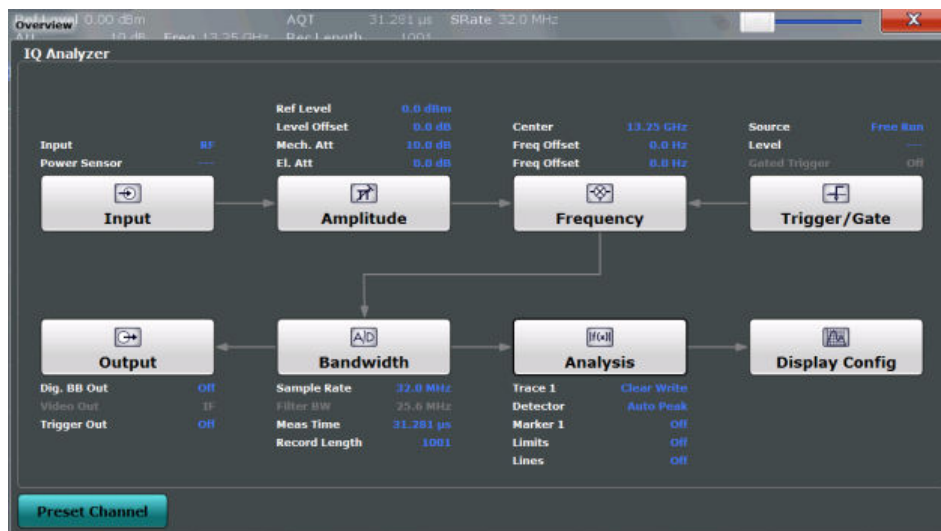
Figure 7-1: Configuration Overview for MSRA Master

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire 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 application; for detailed descriptions see the corresponding application User Manual.

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

The "Overview" for the MSRA Master 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 31

2. Amplitude settings
   See Chapter 7.3, "Amplitude", on page 33

3. Frequency settings
   See Chapter 7.4, "Frequency Settings", on page 36

4. Optionally, trigger settings
   See Chapter 7.5, "Trigger Settings", on page 38

5. Bandwidth settings
   See Chapter 7.6, "Data Acquisition and Bandwidth Settings", on page 43

6. Optionally, output settings
   See Chapter 7.7, "Output Settings", on page 50

7. Analysis settings and functions
   See Chapter 8, "Analysis", on page 55

8. Display configuration
   See Chapter 7.8, "Display Configuration", on page 52

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 57.

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

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

Remote command:
SYSTem:PRESet:CHANnel[:EXECute] on page 70

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

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

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

7.2 Input Source Settings

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

or: INPUT/OUTPUT > "Input Source Config"

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

7.2.1 Radio Frequency Input

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

or: INPUT/OUTPUT > "Input Source Config" > "Radio Frequency"

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

Radio Frequency State
Activates input from the RF INPUT connector.

Remote command:
INPut:SELect on page 72

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

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

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

Remote command:
INPut:COUPling on page 71

Impedance

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

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω 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.

Remote command:
INPut:IMPedance on page 72

High-Pass Filter 1...3 GHz

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer in order 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 filter.)

Remote command:
INPut:FILTer:HPASs[:STATe] on page 71

YIG-Preselector

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

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

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

Note:

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

● VSA

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 71

7.3 Amplitude

The amplitude is configured in the "Amplitude" dialog box. Amplitude settings are identical to the Signal and Spectrum Analyzer mode.

For background information on amplitude settings see the R&S FSWP User Manual.

7.3.1 Amplitude Settings

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

or: AMPT > "Amplitude Config"

Amplitude settings determine how the R&S FSWP must process or display the expected input power levels.

Reference Level
Defines the expected maximum reference level. Signal levels above this value may not be measured correctly. This is indicated by an "IF OVLD" status display.

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 73

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

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

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 73

RF Attenuation
Defines the attenuation applied to the RF input of the R&S FSWP.

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

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

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

Remote command:
`INPut:ATTenuation` on page 73
`INPut:ATTenuation:AUTO` on page 74

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 31.

Preamplifier ← Input Settings

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

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

For R&S FSWP26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSWP8, the following settings are available:

"Off"   Deactivates the preamplifier.

"15 dB"   The RF input signal is amplified by about 15 dB.

"30 dB"   The RF input signal is amplified by about 30 dB.

Remote command:
INPut:GAIN:STATe on page 75
INPut:GAIN[:VALue] on page 75

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"
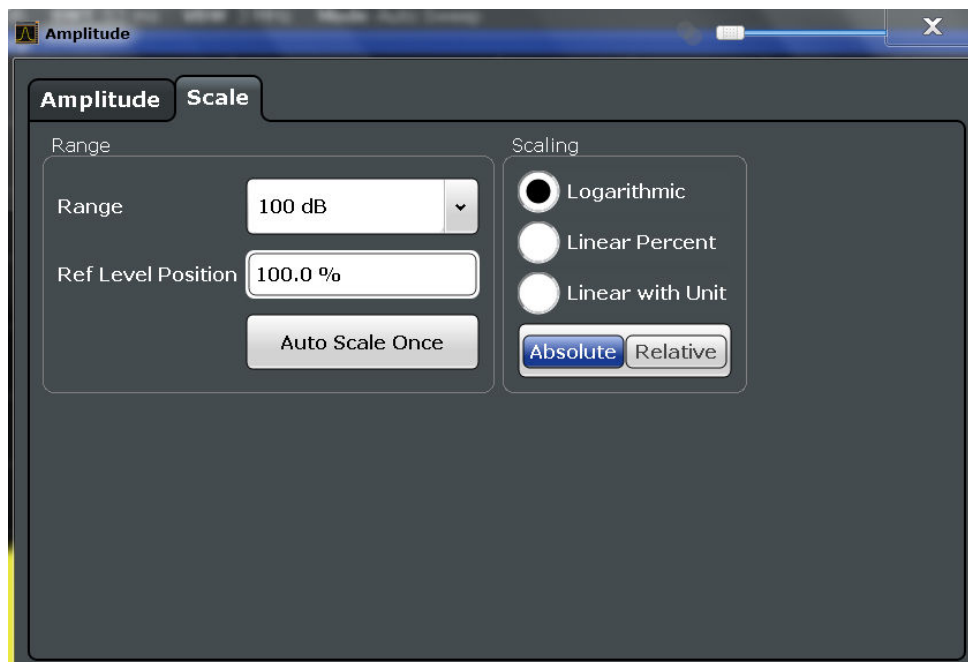
Range

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 76

Ref Level Position

Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %, where 0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Remote command:

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition on page 77

Scaling

Defines the scaling method for the y-axis.

"Logarithmic"	Logarithmic scaling (only available for logarithmic units - dB..., and A, V, Watt)
"Linear 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>]:TRACe<t>:Y:SPACing on page 77

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE on page 76

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 "IQ Vector" or "Real/Imag".

Remote command:

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 76

7.4 Frequency Settings

Access: "Overview" > "Frequency"

or: FREQ > "Frequency Config"

Center frequency
Defines the center frequency of the signal in Hertz.

Remote command:
[SENSe:]FREQuency:CENTer on page 78

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

When you use the rotary knob the center frequency changes in steps of only 1/10 of the "Center Frequency Stepsize".

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 79

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

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

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

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

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

Remote command:
[SENSe:]FREQuency:OFFSet on page 79

7.5 Trigger Settings

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

The "Capture Offset", which has a similar function to the trigger offset but is available for MSRA applications only, is described in Chapter 7.6, "Data Acquisition and Bandwidth Settings", on page 43.

Trigger settings can be configured via the TRIG key or in the "Trigger" dialog box, which is displayed when you select the "Trigger" button in the "Overview".
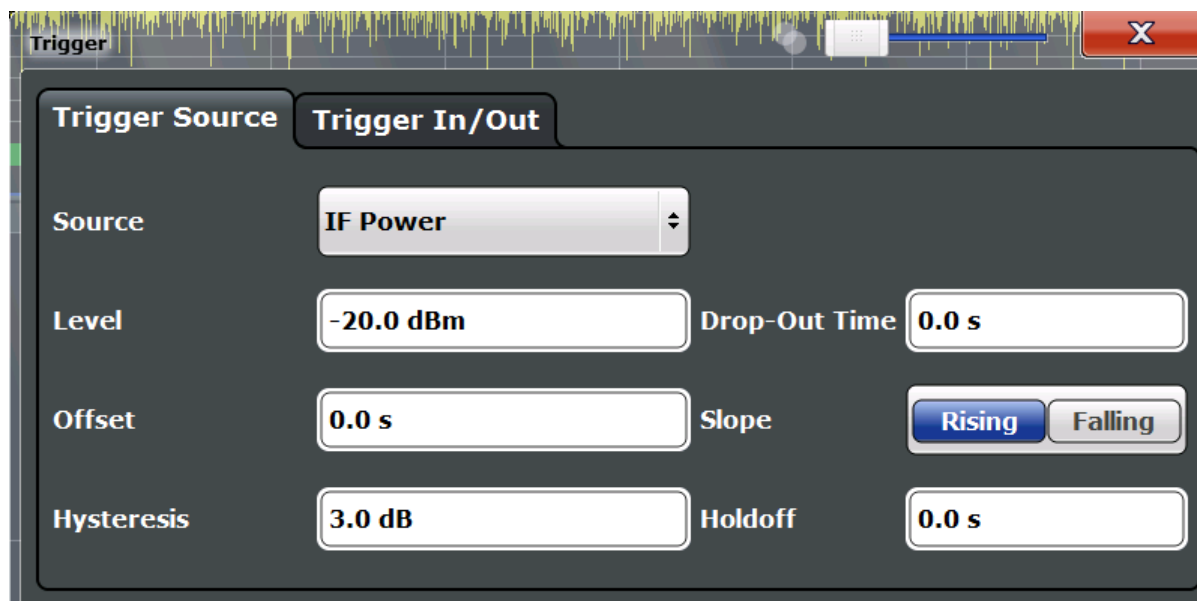
External triggers from one of the TRIGGER INPUT/OUTPUT connectors on the R&S FSWP are configured in a separate tab of the dialog box.
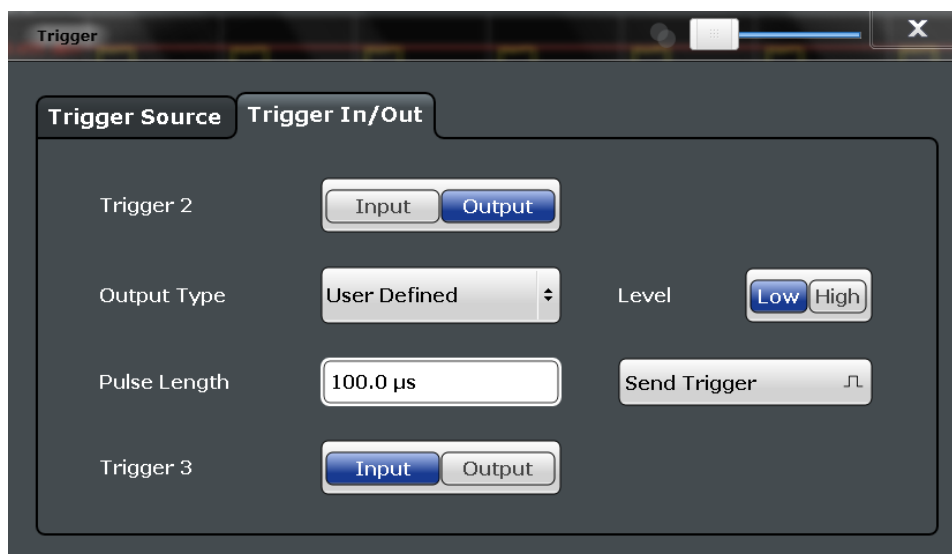
For step-by-step instructions on configuring triggered measurements, see the R&S FSWP User Manual.

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 83

Free Run ← Trigger Source ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

In its default state, the R&S FSWP performs free run measurements.

Remote command:
TRIG:SOUR IMM, see TRIGger[:SEQuence]:SOURce on page 83

Ext. Trigger 1/2 ← Trigger Source ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT / OUTPUT connector on the front panel.

For details see the "Instrument Tour" chapter in the R&S FSWP Getting Started manual.

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT / OUTPUT connector. (front panel)

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector. (rear panel)

Remote command:
TRIG:SOUR EXT, TRIG:SOUR EXT2
See TRIGger[:SEQuence]:SOURce on page 83

IF Power ← Trigger Source ← Trigger Source
The R&S FSWP starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger bandwidth at the third IF depends on the RBW and sweep type.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

For details on available trigger levels and trigger bandwidths see the data sheet.

Remote command:
TRIG:SOUR IFP, see TRIGger[:SEQuence]:SOURce on page 83

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 input signal must be in the frequency range between 500 MHz and 8 GHz.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels see the instrument's data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement may be aborted and a message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
TRIG:SOUR RFP, see TRIGger[:SEQuence]:SOURce on page 83

I/Q Power ← Trigger Source ← Trigger Source
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 83

Trigger Level ← Trigger Source
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the data sheet.

Remote command:
TRIGger[:SEQuence]:LEVel[:EXTernal<port>] on page 82

Drop-Out Time ← Trigger Source
Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
TRIGger[:SEQuence]:DTIMe on page 81

Trigger Offset ← Trigger Source
Defines the time offset between the trigger event and the start of the sweep for the MSRA Master.

This setting is not available in MSRA application measurement channels. For applications, use the "Capture Offset" on page 47 instead.

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

Remote command:
TRIGger[:SEQuence]:HOLDoff[:TIME] on page 81

Hysteresis ← Trigger Source

Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Settting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote command:
TRIGger[:SEQuence]:IFPower:HYSTeresis on page 81

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 81

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 83

Trigger 1/2

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

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

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

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

"Input"	The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The R&S FSWP sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

Remote command:
OUTPut:TRIGger<port>:LEVel on page 85
OUTPut:TRIGger<port>:DIRection on page 84

Output Type ← Trigger 1/2

Type of signal to be sent to the output

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

"Trigger Armed"	Sends a (high level) trigger when the R&S FSWP 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 user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 85

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

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 85

Pulse Length ← Output Type ← Trigger 1/2
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 86

Send Trigger ← Output Type ← Trigger 1/2
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, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

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

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 86

7.6 Data Acquisition and Bandwidth Settings

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

7.6.1 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.

► To display this dialog box, do one of the following:

● Select the "Bandwidth" button in the configuration "Overview"
● Select the BW key and then the "Data Acquisition" softkey.
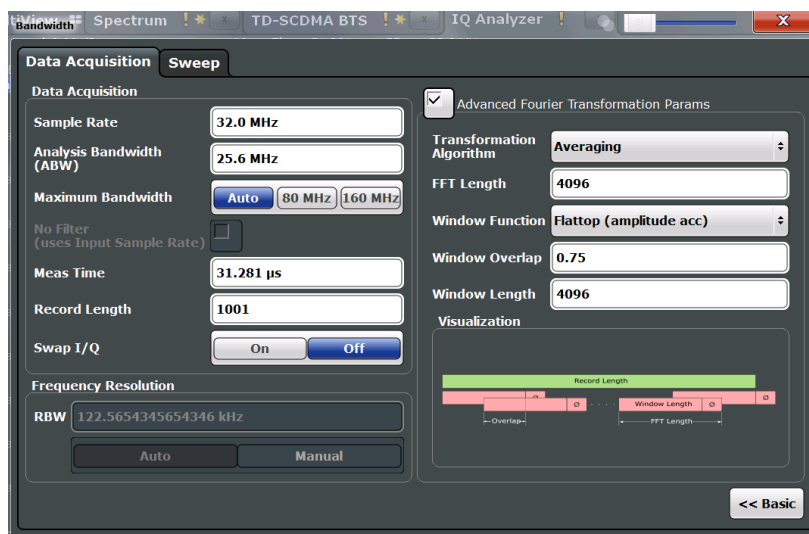● Select the "Data Acquisition" softkey in the "I/Q Analyzer" menu.

Figure 7-2: Data acquisition settings with advanced FFT parameters

Configuring data acquisition is only possible for the MSRA Master channel. In I/Q Analyzer application channels, these settings define the analysis interval (see Chapter 6.3, "Multi-Standard Analysis", on page 24). Be sure to select the correct measurement channel before changing these settings.

Sample Rate

Defines the I/Q data sample rate of the R&S FSWP. This value is dependent on the defined Analysis Bandwidth and the defined signal source.

The following rule applies:

sample rate = analysis bandwidth / 0.8

For details on the dependencies see Chapter A.3, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 112.

Remote command:
TRACe:IQ:SRATe on page 90

Analysis Bandwidth

Defines the flat, usable bandwidth of the final I/Q data. This value is dependent on the defined Sample Rate and the defined signal source.

The following rule applies:

*analysis bandwidth = 0.8 * sample rate*

Remote command:
TRACe:IQ:BWIDth on page 89

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 A.3, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 112.

Remote command:
[SENSe:]SWEep:TIME on page 99

Record Length

Defines the number of I/Q samples to record. By default, the number of measurement 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 ("Measurement Points"). Thus, the measurement points are not editable for this result display. If the "Record Length" is edited, the measurement points are adapted automatically. For record lengths outside the valid range of measurement points, i.e. less than 101 points or more than 100001 points, the diagram does not show valid results.

Remote command:
TRACe:IQ:RLENgth on page 90

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 R&S FSWP I/Q Analyzer and I/Q Input User Manual.

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

Remote command:

[SENSe:]IQ:BANDwidth|BWIDth:MODE on page 86

[SENSe:]IQ:BANDwidth|BWIDth:RESolution on page 87

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 FFT Length is larger than the record length, zeros are appended to the captured data.
"Averaging"	Several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record. The number of FFTs to be averaged is determined by the Window Overlap and the Window Length.

Remote command:

[SENSe:]IQ:FFT:ALGorithm on page 87

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 88

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 89

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 89

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 45.)

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 88

Capture Offset
This setting is only available for 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 application data.

In MSRA mode, the offset must be a positive value, as the capture buffer starts at the trigger time = 0.

For more information see "Trigger offset vs. capture offset" on page 25.

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

Remote command:
[SENSe:]MSRA:CAPTure:OFFSet on page 109

7.6.2 Sweep Settings

The sweep settings are configured via the SWEEP key or in the "Sweep" tab of the "Bandwidth" dialog box.
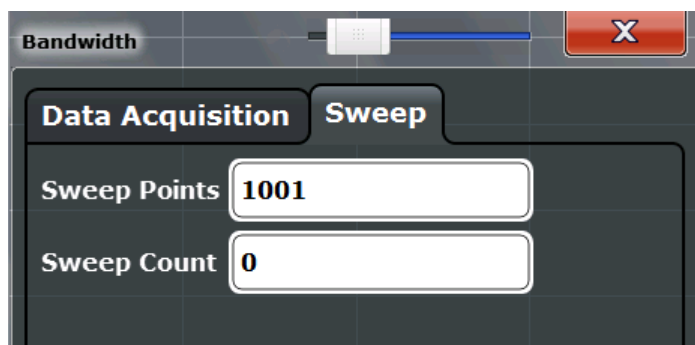
► To display this dialog box, do one of the following:

- Select the "Bandwidth" button in the configuration "Overview" and switch to the "Sweep" tab.
- Select the SWEEP key and then the "Sweep Config" softkey.

For background information on performing sweeps in MSRA mode see Chapter 6.2, "Data Acquisition", on page 23.

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 32001 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:POINts on page 99

Refresh (MSRA only)
This function is only available if the Sequencer is deactivated and only for **MSRA applications**.

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

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

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

Remote command:
INITiate<n>:REFResh on page 108

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, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only 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, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
INITiate<n>:CONTinuous on page 96

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, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only 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, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
INITiate<n>[:IMMediate] on page 96

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, the "Continue Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
INITiate<n>:CONMeas on page 95

7.7 Output Settings

Access: INPUT/OUTPUT > "Output"

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

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

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

Noise Source

Switches the supply voltage for an external noise source on or off.

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

Remote command:
DIAGnostic:SERVice:NSOurce on page 80

Trigger 1/2

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

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

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

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

"Input"	The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The R&S FSWP sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

Remote command:

OUTPut:TRIGger<port>:LEVel on page 85

OUTPut:TRIGger<port>:DIRection on page 84

Output Type ← Trigger 1/2

Type of signal to be sent to the output

"Device Triggered"	(Default) Sends a trigger when the R&S FSWP triggers.
"Trigger Armed"	Sends a (high level) trigger when the R&S FSWP 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 user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

Remote command:

OUTPut:TRIGger<port>:OTYPe on page 85

Level ← Output Type ← Trigger 1/2

Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:

OUTPut:TRIGger<port>:LEVel on page 85

Pulse Length ← Output Type ← Trigger 1/2

Defines the length of the pulse sent as a trigger to the output connector.

Remote command:

OUTPut:TRIGger<port>:PULSe:LENGth on page 86

Send Trigger ← Output Type ← Trigger 1/2

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, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

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

Remote command:
OUTPut:TRIGger<port>:PULSe:IMMediate on page 86

7.8 Display Configuration

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:

- Select the ▣ "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the "Overview".
- Press the MEAS key.
- Select the "Display Config" softkey in the main application menu.

Up to 6 evaluations can be displayed in the I/Q Analyzer and thus in the MSRA Master 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

Some settings can be adjusted by the R&S FSWP automatically according to the current measurement settings.

To activate the automatic adjustment of a setting, select the corresponding function in the AUTO SET menu or in the configuration dialog box for the setting, where available.

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

Adjusting all Determinable Settings Automatically (Auto All)
Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Level

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

Remote command:
[SENSe:]ADJust:ALL on page 91

Adjusting the Center Frequency Automatically (Auto Freq)
The R&S FSWP 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 92

Setting the Reference Level Automatically (Auto Level)
Automatically determines a reference level which ensures that no overload occurs at the R&S FSWP for the current input data. At the same time, the internal attenuators are adjusted so 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 R&S FSWP.

If necessary, you can optimize the reference level further by manually decreasing the attenuation level to the lowest possible value before an overload occurs, then decreasing 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 (Meastime Manual)" on page 53).

Remote command:
[SENSe:]ADJust:LEVel on page 94

Resetting the Automatic Measurement Time (Meastime Auto)
Resets the measurement duration for automatic settings to the default value.

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 92

Changing the Automatic Measurement Time (Meastime Manual)
This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 92
[SENSe:]ADJust:CONFigure:DURation on page 92

Upper Level Hysteresis
When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer on page 93

Lower Level Hysteresis

When the reference level is adjusted automatically using the Auto Level function, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer on page 93

8   Analysis

The data that was captured by the MSRA Master 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 Master is in effect an I/Q Analyzer application and has the same analysis functions and settings.

See the R&S FSWP I/Q Analyzer User Manual for a description of the analysis functions and settings available for the I/Q Analyzer and thus the MSRA master.

Configuring the application data extract and analysis interval

The settings required to configure the application data extract or analysis intervals vary depending on the 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 43. In MSRA application channels, they define the analysis interval. Be sure to select the correct measurement channel before executing these commands.

Exporting I/Q Data

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

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

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

8.1   Configuring the Analysis Line

To hide or show and position the analysis line, a dialog box is available. To display the "Analysis Line" dialog box, select the "AL" icon in the toolbar (only available in MSRA mode). The current position of the analysis line is indicated on the icon.
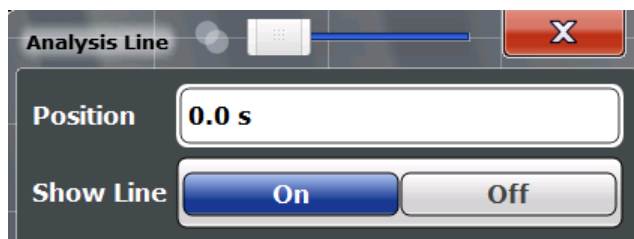
Position

Defines the position of the analysis line in the time domain. The position must lie within the measurement time of the multistandard measurement.

Remote command:
CALCulate<n>:MSRA:ALINe[:VALue] on page 108

Show Line

Hides or displays the analysis line in the time-based windows. By default, the line is displayed.

Note: even if the analysis line display is off, the indication whether or not the currently defined line position lies within the analysis interval of the active application remains in the window title bars.

Remote command:
CALCulate<n>:MSRA:ALINe:SHOW on page 107

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 the MODE key and select the "MSRA" operating mode.
    Confirm the message.

2. Select the "Overview" softkey to display the "Overview" for an MSRA measurement.

3. Select the "Input" button to select the input signal source.

4. Select the "Amplitude" button to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.

5. Select the "Frequency" button to define the input signal's center frequency.

6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an IQ Power trigger to start capturing data only when a specific power is exceeded.

7. Select the "Bandwidth" button and define the bandwidth parameters for data acquisition:

    ● "Sample rate" or "Analysis Bandwidth:" the span of the input signal to be captured for analysis, or the rate at which samples are captured (both values are correlated)
    ● Optionally, if 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 the "Display Config" button 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 the RUN SINGLE key.

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 the "I/Q Export" softkey.
    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 applications at the same time.

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

1. Press the MODE key and select an MSRA application.

2. Select the "Overview" softkey to display the "Overview" for the MSRA application.

3. Define the application data extract, i.e. the range of the capture buffer you want to analyze in this application.

4. Define the analysis interval, i.e. the frame number or similar within the application data you want to analyze in this application (not necessary for I/Q Analyzer or Analog Demodulation applications).

5. Select the "Frequency" button and define the center frequency for the analysis interval.

6. Select the "Display Config" button 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 applications.

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

1. Perform a single I/Q data aquisition measurement as described in "How to capture I/Q data in MSRA mode" on page 57.

2. Activate measurement channels for the MSRA applications you require as described in "How to analyze the captured I/Q data in MSRA applications" on page 58.

3. Select the MSRA View to get an overview of the captured data and the configured applications.
   Determine the individual data ranges that are relevant for a specific standard. If necessary, adapt the application data and analysis interval settings for the 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 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 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 application, the two effects may be correlated.

e) Select the possibly dependant standard application.

f) Define an analysis interval for the conspicuous data range (as described in "How to analyze the captured I/Q data in MSRA applications" on page 58).

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 Master as described in "How to capture I/Q data in MSRA mode" on page 57.

2. Activate an "I/Q Analyzer" channel as an MSRA application as described in "How to analyze the captured I/Q data in MSRA applications" on page 58.

3. In the I/Q Analyzer application, press the MEAS key.

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 R&S FSWP User Manual.

   The I/Q data captured by the MSRA Master 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 the MEAS key and select the "IQ Analyzer" measurement.

10 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 R&S FSWP User Manual. However, some restrictions or conditions may apply to specific commands (see also Chapter 6, "MSRA Basics", on page 22).

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

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

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

In particular, this includes:

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

The following tasks specific to MSRA mode are described here:

10.1 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSWP.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

10.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSWP follow the SCPI syntax rules.

- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.

- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.

- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.

- **Manual operation**

If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

10.1.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

10.1.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

10.1.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

10.1.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both key-words to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

10.1.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

10.1.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

10.1.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

10.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see Chapter 10.1.2, "Long and Short Form", on page 62.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

10.1.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

10.1.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

10.2 Common Suffixes

The following common suffixes are used in remote commands specific to MSRA mode:

Suffix	Value range	Description
<m>	1..16	Marker
<n>	1..6	Window
<t>	1..6	Trace

10.3 Activating MSRA Measurements

MSRA measurements requires a special operating mode on the R&S FSWP. A measurement is started immediately with the default settings.

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

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer2").

The channel to be duplicated must be selected first using the INST:SEL command.

This command is not available if the MSRA Master channel is selected.

Example:	INST:SEL 'PhaseNoise' INST:CRE:DUPL Duplicates the channel named 'PhaseNoise' and creates a new measurement channel named 'PhaseNoise 2'.
Usage:	Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType>   Channel type of the new channel.
                  For a list of available channel types see INSTrument:LIST?
                  on page 68.

<ChannelName>	String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel. Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see INSTrument:LIST? on page 68).
Example:	INST:CRE PNO, 'PhaseNoise 2' Adds an additional phase noise channel named "PhaseNoise 2".
Manual operation:	See "New Channel" on page 19

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1>	String containing the name of the measurement channel you want to replace.
<ChannelType>	Channel type of the new channel. For a list of available channel types see INSTrument:LIST? on page 68.
<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 68).
Example:	INST:CRE:REPL 'PhaseNoise',PNO,'PNO2' Replaces the channel named 'PhaseNoise' by a new measurement channel of type 'Phase Noise' named 'PNO2'.
Usage:	Setting only
Manual operation:	See "Replace Current Channel" on page 19

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Phase Noise" channel is activated.

Parameters:

<ChannelName>	String containing the name of the channel you want to delete. A measurement channel must exist in order to be able delete it.
Example:	INST:DEL 'PhaseNoise' Deletes the channel with the name 'PhaseNoise'.
Usage:	Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName>	For each channel, the command returns the channel type and channel name (see tables below). Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 2 measurement channels:
`'PNO','PhaseNoise','PNO','PhaseNoise2'`

Usage: Query only

Table 10-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Phase Noise	PNOISE	Phase Noise
Spectrum (R&S FSWP-B1)	SANALYZER	Spectrum
I/Q Analyzer (R&S FSWP-B1)	IQ	IQ Analyzer
Analog Demodulation (R&S FSWP-K7)	ADEM	Analog Demod
Noise Figure Measurements (R&S FSWP-K30)	NOISE	Noise
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 R&S FSWP determines which applications are available and active. Whenever you change the operating mode, the currently active measurement channels are stored. The default operating mode is Signal and Spectrum Analyzer mode, however, the presetting can be changed.

Parameters:

<OpMode>	**SANalyzer** Signal and Spectrum Analyzer mode **MSRanalyzer** Multi-Standard Radio Analysis (MSRA) mode *RST: SAN

Example: `INST:MODE MSR`
Switches to MSRA mode.

Usage: SCPI confirmed

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1>   String containing the name of the channel you want to rename.

<ChannelName2>   String containing the new channel name.
                  Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: INST:REN 'PhaseNoise','PNO'
               Renames the channel with the name 'PhaseNoise' to 'PNO'.

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

Also see

- INSTrument:CREate[:NEW] on page 66

Parameters:

<ChannelType>   Channel type of the new channel.
                 For a list of available channel types see INSTrument:LIST? on page 68.

<ChannelName>   String containing the name of the channel.

Example: INST IQ
               Activates a measurement channel for the I/Q Analyzer application (evaluation mode).
               INST 'MyIQSpectrum'
               Selects the measurement channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

Usage: SCPI confirmed

Manual operation: See "I/Q Analyzer" on page 18
                        See "Analog Demodulation" on page 18
                        See "Vector Signal Analysis (VSA)" on page 19
                        See "New Channel" on page 19

SYSTem:PRESet:COMPatible <OpMode>

This command defines the operating mode that is activated when you switch on the R&S FSWP or press the PRESET key.

For details on operating modes see Chapter 5, "Applications and Operating Modes", on page 17.

Parameters:

<OpMode>	**SANalyzer**
	(Default:) Defines Signal and Spectrum Analyzer operating mode as the presetting.
	*RST: SAN

Usage: Event

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example:	`INST 'Spectrum2'`
	Selects the channel for "Spectrum2".
	`SYST:PRES:CHAN:EXEC`
	Restores the factory default settings to the "Spectrum2" channel.
Usage:	Event
Manual operation:	See "Preset Channel" on page 30

10.4 Configuring MSRA Measurements

10.4.1 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 Master.

10.4.1.1 RF Input

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occured and the protection mechanism intervened. The error status bit (bit 3 in the STAT:QUES:POW status register) and the INPUT OVLD message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:
<CouplingType> **AC**
AC coupling
DC
DC coupling
*RST: AC

Example: INP:COUP DC

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 31

INPut:FILTer:HPASs[:STATe] <State>

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

This function requires an additional high-pass filter hardware option.

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

Parameters:
<State> ON | OFF
*RST: OFF

Example: INP:FILT:HPAS ON
Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 32

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Prese-lector" on page 32.

Parameters:

<State>	ON | OFF | 0 | 1
	*RST: OFF

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

Manual operation:	See "YIG-Preselector" on page 32

INPut:IMPedance <Impedance>

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

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance>	50 | 75
	*RST: 50 Ω

Example:	INP:IMP 75

Usage:	SCPI confirmed

Manual operation:	See "Impedance" on page 32

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSWP.

Parameters:

<Source>	**RF**
	Radio Frequency ("RF INPUT" connector)
	*RST: RF

Manual operation:	See "Radio Frequency State" on page 31

10.4.1.2 Configuring the Vertical Axis (Amplitude, Scaling)

The following commands are required to configure the amplitude and vertical axis settings in a remote environment.

Amplitude Settings

Remote commands exclusive to amplitude configuration:

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

This command matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Example:	CALC:MARK2:FUNC:REF
	Sets the reference level to the level of marker 2.

Usage: Event

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces, <t> is irrelevant).

Example: DISP:TRAC:Y:RLEV –60dBm

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 33

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces, <t> is irrelevant).

Parameters:
<Offset>	Range:	-200 dB to 200 dB
	*RST:	0dB

Example: DISP:TRAC:Y:RLEV:OFFS –10dB

Manual operation: See "Shifting the Display (Offset)" on page 34

Configuring the Attenuation

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

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

Parameters:

<Attenuation>	Range:	see data sheet
	Increment:	5 dB
	*RST:	10 dB (AUTO is set to ON)

Example: INP:ATT 30dB

Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 34

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSWP determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State>	ON | OFF | 0 | 1
	*RST: 1

Example: INP:ATT:AUTO ON

Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 34

INPut:EATT <Attenuation>

This command defines an electronic attenuation manually. Automatic mode must be switched off (INP:EATT:AUTO OFF, see INPut:EATT:AUTO on page 75).

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

Parameters:

<Attenuation>	attenuation in dB	
	Range:	see data sheet
	Increment:	1 dB
	*RST:	0 dB (OFF)

Example: INP:EATT:AUTO OFF

INP:EATT 10 dB

INPut:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

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

Parameters:

<State>	1 | 0 | ON | OFF
	1 | ON
	0 | OFF
	*RST: 1

Example: INP:EATT:AUTO OFF

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

Parameters:

<State>	1 | 0 | ON | OFF
	1 | ON
	0 | OFF
	*RST: 0

Example: INP:EATT:STAT ON
                   Switches the electronic attenuator into the signal path.

Configuring a Preamplifier

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifiier hardware.

Parameters:

<State>	ON | OFF
	*RST: OFF

Example: INP:GAIN:STAT ON
                   Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 35

INPut:GAIN[:VALue] <Gain>

This command selects the gain level if the preamplifier is activated (INP:GAIN:STAT ON, see INPut:GAIN:STATe on page 75).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain>   15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSWP.
R&S FSWP8: 15dB and 30 dB
R&S FSWP26 or higher: 30 dB

*RST: OFF

Example: INP:GAIN:VAL 30
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 35

Scaling the Y-Axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces, <t> is irrelevant).

Example: DISP:TRAC:Y 110dB

Usage: SCPI confirmed

Manual operation: See "Range" on page 36
See "Y-Axis Max" on page 36

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces, <t> is irrelevant).

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis (for all traces, <t> is irrelevant).

When the display update during remote control is off, this command has no immediate effect.

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 36

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

The suffix <t> is irrelevant.

Parameters:

<Value>   numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

               *RST: depends on the result display

Example: DISP:TRAC:Y:PDIV 10

Sets the grid spacing to 10 units (e.g. dB) per division

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid (for all traces, <t> is irrelevant).

The R&S FSWP adjusts the scaling of the y-axis accordingly.

Example: DISP:TRAC:Y:RPOS 50PCT

Usage: SCPI confirmed

Manual operation: See "Ref Level Position" on page 36

DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis (for all traces, <t> is irrelevant).

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 %.
Usage:	SCPI confirmed
Manual operation:	See "Scaling" on page 36

10.4.1.3 Frequency

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency>	The allowed range and f_{max} is specified in the data sheet.
	UP Increases the center frequency by the step defined using the [SENSe:]FREQuency:CENTer:STEP command.
	DOWN Decreases the center frequency by the step defined using the [SENSe:]FREQuency:CENTer:STEP command.
	*RST: fmax/2 Default unit: Hz

Example:	FREQ:CENT 100 MHz FREQ:CENT:STEP 10 MHz FREQ:CENT UP Sets the center frequency to 110 MHz.
Usage:	SCPI confirmed
Manual operation:	See "Center frequency" on page 37

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the SENS:FREQ UP AND SENS:FREQ DOWN commands, see [SENSe:]FREQuency: CENTer on page 78.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

                     Range: 1 to fMAX
                     *RST: 0.1 x span
                     Default unit: Hz

Example: FREQ:CENT 100 MHz
                     FREQ:CENT:STEP 10 MHz
                     FREQ:CENT UP
                     Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency Stepsize" on page 37

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

This command couples or decouples the center frequency step size to the span.

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

<State>   ON | OFF | 0 | 1
                     *RST: 1

Example: FREQ:CENT:STEP:AUTO ON
                     Activates the coupling of the step size to the span.

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

See also "Frequency Offset" on page 37.

Note: In MSRA mode, the setting command is only available for the MSRA Master. For MSRA applications, only the query command is available.

Parameters:

<Offset>   Range: -100 GHz to 100 GHz
                     *RST: 0 Hz

Example: FREQ:OFFS 1GHZ

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 37

10.4.1.4   Configuring the Outputs

Configuring trigger input/output is described in Chapter 10.4.2.2, "Configuring the Trigger Output", on page 84.

DIAGnostic:SERVice:NSOurce <State>

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

Parameters:

<State>	ON | OFF
	*RST: OFF

Example: DIAG:SERV:NSO ON

Manual operation: See "Noise Source" on page 50

10.4.2   Triggering

The following remote commands are required to configure a triggered measurement in a remote environment. These commands are only available for the MSRA Master channel. More details are described for manual operation in Chapter 7.5, "Trigger Settings", on page 38.

*OPC should be used after requesting data. This will hold off any subsequent changes to the selected trigger source, until after the sweep is completed and the data is returned.

10.4.2.1   Configuring the Triggering Conditions

The following commands are required to configure a triggered measurement.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime>   Dropout time of the trigger.

                       Range: 0 s to 10.0 s
                       *RST: 0 s

Manual operation: See "Drop-Out Time" on page 41

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

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

Parameters:

<Offset>   *RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 41

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

This command defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period>   Range: 0 s to 10 s
                       *RST: 0 s

Example: `TRIG:SOUR EXT`
                       Sets an external trigger source.
                       `TRIG:IFP:HOLD 200 ns`
                       Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 42

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis>   Range: 3 dB to 50 dB
                       *RST: 3 dB

Example: TRIG:SOUR IFP

Sets the IF power trigger source.

TRIG:IFP:HYST 10DB

Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 42

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:

<port>   Selects the trigger port.

1 = trigger port 1 (TRIGGER INPUT connector on front panel)

2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on rear panel)

Parameters:

<TriggerLevel>   Range: 0.5 V to 3.5 V

*RST: 1.4 V

Example: TRIG:LEV 2V

Manual operation: See "Trigger Level" on page 41

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:

<TriggerLevel>   For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -10 dBm

Example: TRIG:LEV:IFP –30DBM

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<TriggerLevel>   Range: -130 dBm to 30 dBm

*RST: -20 dBm

Example: TRIG:LEV:IQP –30DBM

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

This command defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Parameters:

<TriggerLevel>   For details on available trigger levels and trigger bandwidths see the data sheet.

                            *RST: -20 dBm

Example: TRIG:LEV:RFP -30dBm

TRIGger[:SEQuence]:SLOPe <Type>

This command selects the trigger slope.

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 42

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

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

Parameters:

<Source>   **IMMediate**
                        Free Run

                        EXT | EXT2
                        Trigger signal from one of the TRIGGER INPUT/OUTPUT con-
                        nectors.
                        Note: Connector must be configured for "Input".

                        RFPower
                        First intermediate frequency

                        IFPower
                        Second intermediate frequency

                        IQPower
                        Magnitude of sampled I/Q data
                        For applications that process I/Q data, such as the I/Q Analyzer
                        or optional applications.

                        PSEN
                        External power sensor

                        *RST: IMMediate

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

Manual operation: See "Trigger Source" on page 39
                        See "Free Run" on page 40
                        See "Ext. Trigger 1/2" on page 40
                        See "IF Power" on page 40
                        See "RF Power" on page 40
                        See "I/Q Power" on page 41

10.4.2.2 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 R&S FSWP.

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction for trigger ports that serve as an input as
well as an output.

Suffix:

<port>   Selects the used trigger port.
                        <2>: selects trigger port 2 (on the rear panel).

Parameters:

<Direction>   **INPut**
                 Port works as an input.

                 OUTPut
                 Port works as an output.

                 *RST: INPut

Manual operation: See "Trigger 1/2" on page 42

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the signal generated at the trigger output.

This command works only if you have selected a user defined output with `OUTPut: TRIGger<port>:OTYPe`.

Suffix:

<port>   Selects the trigger port to which the output is sent.
                 2 = trigger port 2 (rear)

Parameters:

<Level>   **HIGH**
                 TTL signal.

                 LOW
                 0 V

                 *RST: LOW

Manual operation: See "Trigger 1/2" on page 42
                        See "Level" on page 43

OUTPut:TRIGger<port>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Suffix:

<port>   Selects the trigger port to which the output is sent.
                 2 = trigger port 2 (rear panel)

Parameters:

<OutputType>   **DEVice**
                 Sends a trigger signal when the R&S FSWP has triggered inter-
                 nally.

                 TARMed
                 Sends a trigger signal when the trigger is armed and ready for
                 an external trigger event.

                 UDEFined
                 Sends a user defined trigger signal. For more information see
                 `OUTPut:TRIGger<port>:LEVel`.

                 *RST: DEVice

Manual operation: See "Output Type" on page 42

OUTPut:TRIGger\<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

\<port>   Selects the trigger port to which the output is sent.
                          2 = trigger port 2 (rear)

Usage: Event

Manual operation: See "Send Trigger" on page 43

OUTPut:TRIGger\<port>:PULSe:LENGth \<Length>

This command defines the length of the pulse generated at the trigger output.

Suffix:

\<port>   Selects the trigger port to which the output is sent.
                          2 = trigger port 2 (rear)

Parameters:

\<Length>   Pulse length in seconds.

Manual operation: See "Pulse Length" on page 43

10.4.3 Configuring Data Acquisition

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

Configuring data acquisition is only possible for the MSRA Master channel. In MSRA application channels, these commands define the analysis interval (see Chapter 10.9, "Commands Specific to MSRA Applications", on page 106). Be sure to select the correct measurement channel before executing these commands.

[SENSe:]IQ:BANDwidth|BWIDth:MODE \<Mode>

This command defines how the resolution bandwidth is determined.

Parameters:

<Mode>	AUTO | MANual | FFT

AUTO

(Default) The RBW is determined automatically depending on the sample rate and record length.

MANual

The user-defined RBW is used and the (FFT) window length (and possibly the sample rate) are adapted accordingly. The RBW is defined using the `[SENSe:]IQ:BANDwidth|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.
Usage:	SCPI confirmed
Manual operation:	See "RBW" on page 45

[SENSe:]IQ:BANDwidth|BWIDth:RESolution <Bandwidth>

This command defines the resolution bandwidth manually if `[SENSe:]IQ:BANDwidth|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 data sheet
	*RST: RBW: AUTO mode is used
Example:	`IQ:BAND:MODE MAN`
	Switches to manual RBW mode.
	`IQ:BAND:RES 120000`
	Sets the RBW to 120 kHz.
Usage:	SCPI confirmed
Manual operation:	See "RBW" on page 45

[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`

Usage: SCPI confirmed

Manual operation: See "Transformation Algorithm" on page 46

[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`

Usage: SCPI confirmed

Manual operation: See "FFT Length" on page 46

[SENSe:]IQ:FFT:WINDow:LENGth <NoOfFFT>

Defines the number of samples to be included in a single FFT window when multiple
FFT windows are used.

Parameters:

<NoOfFFT>   integer value

                          Range: 3 to 1001
                          *RST: 1001

Example: `IQ:FFT:WIND:LENG 500`

Usage: SCPI confirmed

Manual operation: See "Window Length" on page 47

[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.

Usage: SCPI confirmed

Manual operation: See "Window Overlap" on page 47

[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

Usage: SCPI confirmed

Manual operation: See "Window Function" on page 46

TRACe:IQ:BWIDth

This command defines or queries the bandwidth of the resampling filter.

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

Parameters:

<Bandwidth>	For details on the maximum bandwidth see Chapter A.3, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 112.

Manual operation: See "Analysis Bandwidth" on page 45

TRACe:IQ:RLENgth <NoOfSamples>

This command sets the record length for the acquired I/Q data.

Increasing the record length also increases the measurement time.

Note: Alternatively, you can define the measurement time using the SENS:SWE:TIME command.

Parameters:

<NoOfSamples>   Number of samples to record.

                          *RST: 1001

Example: TRAC:IQ:RLEN 256

Manual operation: See "Record Length" on page 45

TRACe:IQ:SRATe <SampleRate>

This command sets the final user sample rate for the acquired I/Q data. Thus, the user sample rate can be modified without affecting the actual data capturing settings on the R&S FSWP.

Note: The smaller the user sample rate, the smaller the usable I/Q bandwidth, see Chapter A.3, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 112.

Parameters:

<SampleRate>   The valid sample rates are described in Chapter A.3, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 112.

                          *RST: 32 MHz

Manual operation: See "Sample Rate" on page 44

TRACe:IQ:TPISample?

This command queries the time offset between the sample start and the trigger event (trigger point in sample = TPIS). Since the R&S FSWP usually samples with a much higher sample rate than the specific application actually requires, the trigger point determined internally is much more precise than the one determined from the (down-sampled) data in the application. Thus, the TPIS indicates the offset between the sample start and the actual trigger event.
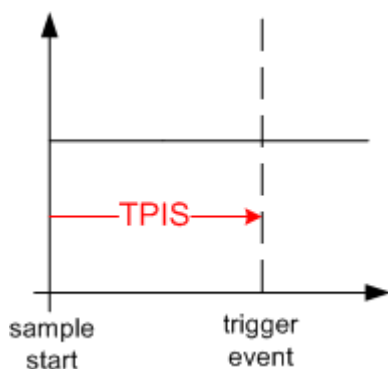
This value can only be determined in triggered measurements using external or IFPower triggers, otherwise the value is 0.

Example: TRAC:IQ:TPIS?

Result for a sample rate of 1 MHz: between 0 and 1/1 MHz, i.e. between 0 and 1 µs (the duration of 1 sample).

Usage: Query only

10.4.4 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 Master channel. The tasks for manual operation are described in Chapter 7.9, "Automatic Settings", on page 52.

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

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

● Reference level

Example: ADJ:ALL

Usage: Event

Manual operation: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 52

[SENSe:]ADJust:CONFigure:DURation <Duration>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:DURation:MODE` is set to `MANual`.

Parameters:

<Duration>   Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 53

[SENSe:]ADJust:CONFigure:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command selects the way the R&S FSWP determines the length of the measurement .

Parameters:

<Mode>   **AUTO**
The R&S FSWP determines the measurement length automatically according to the current input data.
MANual
The R&S FSWP uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 92.

*RST: AUTO

Manual operation: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 53
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 53

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Usage: Event

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 53

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 94 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

This setting can only be adjusted in the MSRA Master, not in the applications.

Parameters:

<Threshold>   Range: 0 dB to 200 dB
                     *RST: +1 dB
                     Default unit: dB

Example: SENS:ADJ:CONF:HYST:LOW 2
                     For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See "Lower Level Hysteresis" on page 54

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 94 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

This setting can only be adjusted in the MSRA Master, not in the 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 will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See "Upper Level Hysteresis" on page 53

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSWP or limiting the dynamic range by an S/N ratio that is too small.

Example:	`ADJ:LEV`
Usage:	Event
Manual operation:	See "Setting the Reference Level Automatically (Auto Level)" on page 53

10.5 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 Master. 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 10.7.1, "STATus:OPERation Register", on page 103. Once the bit has been set, the device under test can already be reconfigured while the R&S FSWP 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 108

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSWP User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSWP is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSWP on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example:	`ABOR;:INIT:IMM` Aborts the current measurement and immediately starts a new one.

Example:	`ABOR;*WAI`
	`INIT:IMM`
	Aborts the current measurement and starts a new one once abortion has been completed.

Usage:	Event SCPI confirmed

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single measurement mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:

<n>	irrelevant

Usage:	Event

Manual operation:　　See "Continue Single Sweep" on page 50

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSWP User Manual.

If the measurement mode is changed for a measurement channel while the Sequencer is active the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:

<n>　　　　　　　　　irrelevant

Parameters:

<State>　　　　　　　ON | OFF | 0 | 1

　　　　　　　　　　　ON | 1
　　　　　　　　　　　Continuous measurement

　　　　　　　　　　　OFF | 0
　　　　　　　　　　　Single measurement

　　　　　　　　　　　*RST:　　　　1

Example:　　　　　`INIT:CONT OFF`
　　　　　　　　　　　Switches the measurement mode to single measurement.
　　　　　　　　　　　`INIT:CONT ON`
　　　　　　　　　　　Switches the measurement mode to continuous measurement.

Manual operation:　　See "Continuous Sweep/RUN CONT" on page 49

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

Suffix:

<n>　　　　　　　　　irrelevant

Usage:　　　　　　Event

Manual operation:　　See "Single Sweep/ RUN SINGLE" on page 49

INITiate\<n\>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 97.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 99.

Suffix:

\<n\>   irrelevant

Usage: Event

Manual operation: See "Sequencer State" on page 20

INITiate\<n\>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 99).

Suffix:

\<n\>   irrelevant

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

Manual operation: See "Sequencer State" on page 20

INITiate\<n\>:SEQuencer:MODE \<Mode\>

This command selects the way the R&S FSWP application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 99).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSWP User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSWP User Manual.

Suffix:

<n>	irrelevant

Parameters:

<Mode>   **SINGle**
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Manual operation: See "Sequencer Mode" on page 20

INITiate<n>:SEQuencer:REFResh[:ALL]

This function 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 applications.

(The suffix <n> is irrelevant.)

Example: `SYST:SEQ:OFF`
Deactivates the scheduler
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a new data measurement and waits for the end of the sweep.
`INIT:SEQ:REFR`
Refreshes the display for all channels.

Usage: Event

Manual operation: See "Refresh All" on page 21

[SENSe:]SWEep:POINts <SweepPoints>

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

Example: SWE:POIN 251

Usage: SCPI confirmed

Manual operation: See "Sweep Points" on page 48

[SENSe:]SWEep:TIME <Time>

This command defines the measurement time.

Parameters:
<Time>   refer to data sheet

                     *RST: depends on current settings (determined automatically)

Example: SWE:TIME 10s

Usage: SCPI confirmed

Manual operation: See "Meas Time" on page 45

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (INIT:SEQ...) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSWP User Manual.

Parameters:
<State>   ON | OFF | 0 | 1

                     ON | 1
                     The Sequencer is activated and a sequential measurement is started immediately.

                     OFF | 0
                     The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (INIT:SEQ...) are not available.

                     *RST: 0

Example: SYST:SEQ ON
                      Activates the Sequencer.
                      INIT:SEQ:MODE SING
                      Sets single Sequencer mode so each active measurement will
                      be performed once.
                      INIT:SEQ:IMM
                      Starts the sequential measurements.
                      SYST:SEQ OFF

Manual operation: See "Sequencer State" on page 20

10.6 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 102).

For details on formats refer to Chapter A.1, "Reference: Format Description for I/Q
Data Files", on page 110.

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 10.7.1, "STATus:OPERation Register",
on page 103).

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from
the R&S FSWP to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSWP. The
R&S FSWP automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format>	**ASCii**
	ASCii format, separated by commas.
	This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.
	REAL,32
	32-bit IEEE 754 floating-point numbers in the "definite length block format".
	The format setting REAL is used for the binary transmission of trace data.
	For I/Q data, 8 bytes per sample are returned for this format setting.
	*RST: ASCII

Example:	FORM REAL,32

Usage:	SCPI confirmed

TRACe:IQ:DATA?

This command queries the captured data from measurements with the I/Q Analyzer.

To get the results, the command also initiates a measurement with the current settings of the R&S FSWP.

Return values:

<Results>	Measured voltage for I and Q component for each sample that has been captured during the measurement.
	The data format depends on TRACe:IQ:DATA:FORMat on page 102.
	Default unit: V

Example:	TRAC:IQ:STAT ON
	Enables acquisition of I/Q data
	TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096
	Measurement configuration:
	Sample Rate = 32 MHz
	Trigger Source = External
	Trigger Slope = Positive
	Pretrigger Samples = 0
	Number of Samples = 4096
	FORMat REAL,32
	Selects format of response data
	TRAC:IQ:DATA?
	Starts measurement and reads results

Usage:	Query only

TRACe:IQ:DATA:FORMat <Format>

This command selects the order of the I/Q data.

For details see Chapter A.1, "Reference: Format Description for I/Q Data Files", on page 110.

Parameters:

<Format>   COMPatible | IQBLock | IQPair

COMPatible
I and Q values are separated and collected in blocks: A block (512k) of I values is followed by a block (512k) of Q values, followed by a block of I values, followed by a block of Q values etc. (I,I,I,I,Q,Q,Q,Q,I,I,I,I,Q,Q,Q,Q...)

IQBLock
First all I-values are listed, then the Q-values (I,I,I,I,I,I,...Q,Q,Q,Q,Q,Q)

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

*RST: IQBL

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

This command queries the I/Q data currently stored in the memory of the R&S FSWP.

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.

Parameters:

<OffsetSamples>   Selects an offset at which the output of data should start in relation to the first data. If omitted, all captured samples are output, starting with the first sample.

Range: 0 to <# of samples> – 1, with <# of samples> being the maximum number of captured values
*RST: 0

<NoOfSamples>   Number of samples you want to query, beginning at the offset you have defined. If omitted, all captured samples (starting at offset) are output.

Range: 1 to <# of samples> - <offset samples> with <# of samples> maximum number of captured values
*RST: <# of samples>

Return values:

<IQData>   Measured value pair (I,Q) for each sample that has been recorded.
The data format depends on `FORMat[:DATA]`.

Default unit: V

Example:	`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)
Usage:	Query only

10.7 Querying the Status Registers

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

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 R&S FSWP status registers refer to the description of remote control basics in the R&S FSWP User Manual.

*RST does not influence the status registers.

10.7.1 STATus:OPERation Register

The `STATus:OPERation` register contains information on current activities of the R&S FSWP. 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 104 or `STATus:OPERation[:EVENt]?` on page 106.

Table 10-2: Meaning of the bits used in the STATus:OPERation register

Bit No.	Meaning
0	`CALibrating` This bit is set as long as the instrument is performing a calibration.
1-2	Not used
3	`SWEeping` Sweep is being performed in base unit (applications are not considered); identical to bit 4 Available in the optional Spectrum application.
4	`MEASuring` Measurement is being performed in base unit (applications are not considered); identical to bit 3 Available in the optional Spectrum application.
5	`Waiting for TRIgger` Instrument is ready to trigger and waiting for trigger signal. Available in the optional Spectrum application.
6-7	Not used
8	`HardCOPy` in progress This bit is set while the instrument is printing a hardcopy.
9	Not used
10	`Range completed` This bit is set when a range in the sweep list has been completed if "Stop after Range" has been activated. Available in the optional Spectrum application.
11-14	Not used
15	This bit is always 0.

10.7.2 Commands to Query the STATus:OPERation Register

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

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>

This command controls the ENABle part of the register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<SumBit>　　　　　Range:　　　0 to 65535

<ChannelName>　　　String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage:　　　　　Query only

STATus:OPERation:NTRansition? <SumBit>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit>　　　　　Range:　　　0 to 65535

<ChannelName>　　　String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage:　　　　　Query only

STATus:OPERation:PTRansition? <SumBit>,<ChannelName>

This command controls the Positive TRansition part of the register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit>　　　　　Range:　　　0 to 65535

<ChannelName>	String containing the name of the channel. The parameter is optional. If you omit it, the command works for the currently active channel.
Usage:	Query only

STATus:OPERation[:EVENt]? <ChannelName>

This command 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

10.8 Analyzing MSRA Measurements

The data that was captured by the MSRA Master 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 Master is in effect an I/Q Analyzer application and has the same analysis functions and settings.

See the R&S FSWP I/Q Analyzer User Manual for a description of the analysis functions and settings available for the I/Q Analyzer and thus the MSRA Master.

The commands required to configure the MSRA-specific analysis line are described in

10.9 Commands Specific to MSRA Applications

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

Configuring the analysis interval

The commands required to configure the application data extracts and analysis intervals vary depending on the 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 10.4.3, "Configuring Data Acquisition", on page 86. In MSRA 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 90
- TRACe:IQ:BWIDth on page 89
- TRACe:IQ:RLENgth on page 90
- [SENSe:]SWEep:TIME on page 99

Remote commands exclusive to MSRA applications

The following commands are only available for MSRA application channels:

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 (<n> is irrelevant).

It is currently only available for I/Q Analyzer applications in multistandard mode (not the MSRA Master).

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

This command defines whether or not the analysis line is displayed in all time-based windows in all MSRA applications and the MSRA Master.

(<n> is irrelevant.)

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 application remains in the window title bars.

Parameters:

<State>   ON | OFF

                             *RST: ON

Manual operation: See "Show Line" on page 56

CALCulate<n>:MSRA:ALINe[:VALue] <Position>

This command defines the position of the analysis line for all time-based windows in all MSRA applications and the MSRA Master.

(<n> is 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 56

CALCulate<n>:MSRA:WINDow<n>:IVAL?

This command queries the analysis interval for the window specified by the WINDow suffix <n> (the CALC suffix is irrelevant). This command is only available in application measurement channels, not the MSRA View or MSRA Master.

Return values:

<IntStart>   Start value of the analysis interval in seconds

                             Default unit: s

<IntStop>   Stop value of the analysis interval in seconds

Usage: Query only

INITiate<n>:REFResh

This function is only available if the Sequencer is deactivated (SYSTem:SEQuencer SYST:SEQ:OFF) and only for applications in MSRA mode, not the MSRA Master.

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

The application channel must be selected before this command can be executed (see INSTrument[:SELect] on page 69).

(The suffix <n> is irrelevant.)

Example:	`SYST:SEQ:OFF`
	Deactivates the scheduler
	`INIT:CONT OFF`
	Switches to single sweep mode.
	`INIT;*WAI`
	Starts a new data measurement and waits for the end of the sweep.
	`INST:SEL 'IQ ANALYZER'`
	Selects the IQ Analyzer channel.
	`INIT:REFR`
	Refreshes the display for the I/Q Analyzer channel.
Usage:	Event
Manual operation:	See "Refresh (MSRA only)" on page 49

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for applications in MSRA mode, not for the MSRA Master. It has a similar effect as the trigger offset in other measurements.

Parameters:

<Offset>	This parameter defines the time offset between the capture buffer start and the start of the extracted application data. The offset must be a positive value, as the application can only analyze data that is contained in the capture buffer.
	Range: 0 to <Record length>
	*RST: 0
Manual operation:	See "Capture Offset" on page 47

Annex

A Annex

A.1 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` on page 102 command).

For details on the format of the individual values, see Chapter A.2, "Formats for Returned Values: ASCII Format and Binary Format", on page 111.

For details on the format of I/Q export files (using the "I/Q Export" function), see the R&S FSWP User Manual.
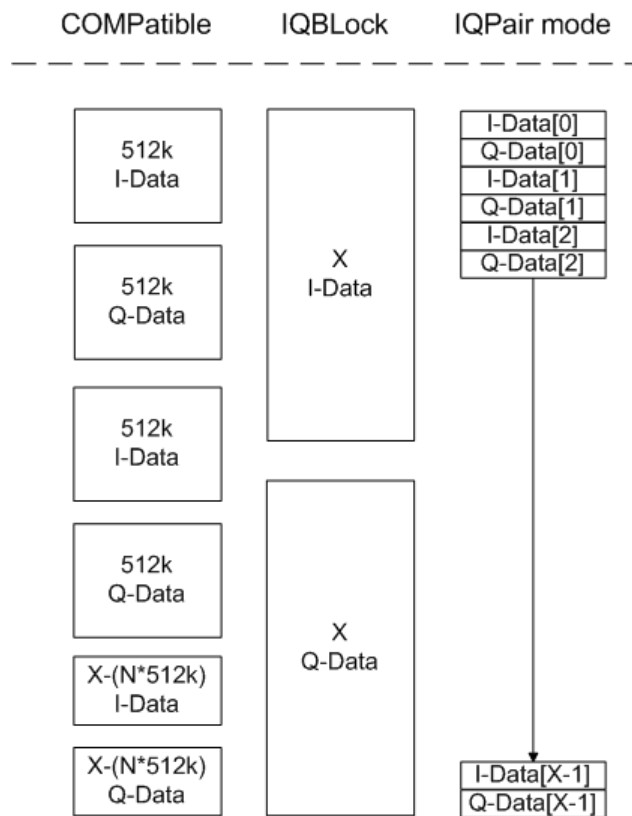
Figure A-1: I/Q data formats

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:

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

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

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

with "LengthIndicatorDigits" being the number of digits of the length indicator including the #. In the example above (#41024…), this results in a value of 6 for "LengthIndicatorDigits" and the offset for the Q-data results in 512 + 6 = 518.

A.2 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]`. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,32):
  The data is stored as binary data (Definite Length Block Data according to IEEE 488.2), each measurement value being formatted in 32 Bit IEEE 754 Floating-Point-Format.
  The schema of the result string is as follows:
  `#41024<value1><value2>…<value n>` with

#4	number of digits (= 4 in the example) of the following number of data bytes
1024	number of following data bytes (= 1024 in the example)
<Value>	4-byte floating point value

Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

A.3 Sample Rate and Maximum Usable I/Q Bandwidth for RF Input

Definitions

- **Input sample rate (ISR)**: the sample rate of the useful data provided by the device connected to the input of the R&S FSWP

- (User, Output) **Sample rate (SR)**: the sample rate that is defined by the user (e.g. in the "Data Aquisition" dialog box in the "I/Q Analyzer" application) and which is used as the basis for analysis or output

- **Usable I/Q (Analysis) bandwidth**: the bandwidth range in which the signal remains undistorted in regard to amplitude characteristic and group delay; this range can be used for accurate analysis by the R&S FSWP

- **Record length**: Number of I/Q samples to capture during the specified measurement time; calculated as the measurement time multiplied by the sample rate

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

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.

A.3.1 Bandwidth Extension Options

Max. usable I/Q BW	Required B-option
80 MHz	B80

A.3.2 Relationship Between Sample Rate, Record Length and Usable I/Q Bandwidth

Up to the maximum bandwidth, the following rule applies:

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

Regarding the record length, the following rule applies:

*Record length = Measurement time * sample rate*

Maximum record length for RF input

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

Table A-1: Maximum record length

Sample rate	Maximum record length
100 Hz to 200 MHz	440 MSamples (precisely: 461373440 (= 440*1024*1024) samples)
200 MHz to 600 MHz	220 MSamples

A.3.3 R&S FSWP without additional bandwidth extension options

sample rate: 100 Hz - 600 MHz

maximum I/Q bandwidth: 10 MHz

Table A-2: Maximum I/Q bandwidth

Sample rate	Maximum I/Q bandwidth
100 Hz to 10 MHz	proportional up to maximum 10 MHz
10 MHz to 600 MHz	10 MHz

A.3.4 R&S FSWP with option B80 (I/Q Bandwidth Extension):

sample rate: 100 Hz - 600 MHz

maximum bandwidth: 80 MHz

Sample rate	Maximum I/Q bandwidth
100 Hz to 100 MHz	proportional up to maximum 80 MHz
100 MHz to 600 MHz	80 MHz

List of Remote Commands (MSRA)

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