R&S®FSW

Signal and Spectrum Analyzer

User Manual

1173.9411.02 — 11

Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 1.60 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)
- R&S®FSW43 (1312.8000K43)

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

- R&S FSW-B10 (1313.1622.02)
- R&S FSW-B13 (1313.0761.02)
- R&S FSW-B17 (1313.0784.02)
- R&S FSW-B21 (1313.1100.26)
- R&S FSW-B24 (1313.0832.13/26)
- R&S FSW-B25 (1313.0990.02)
- R&S FSW-B28 (1313.1645.02)
- R&S FSW-B40 (1313.0861.02) / R&S FSW-U40 (1313.52505.02)
- R&S FSW-B80 (1313.0878.02) / R&S FSW-U80 (1313.5211.02)
- R&S FSW-B160 (1313.1668.02) / R&S FSW-U160 (1313.3754.02)

The firmware of the instrument makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgement" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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

Contents

1 Preface

1.1 About this Manual

This User Manual describes general instrument functions and settings common to all applications and operating modes in the R&S FSW. Furthermore, it provides all the information specific to **RF measurements in the Spectrum application**. All other operating modes and applications are described in the specific application manuals.

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

- **Welcome to the R&S FSW**
  Introduction to and getting familiar with the instrument
- **Operating Modes and Applications**
  The concept of using multiple operating modes
- **Measurements**
  Descriptions of the individual measurements in the Spectrum application, including result types and configuration settings.
- **Common Measurement Settings**
  Description of the measurement settings common to all measurement types with their corresponding remote control commands
- **Common Measurement Analysis and Display Functions**
  Description of the settings and functions provided to analyze results independantly of the measurement type with their corresponding remote control commands
- **Data Management**
  Description of general functions to handle data files (configuration and result data, not I/Q data)
- **General Instrument Setup**
  Description of general instrument settings and functions that are independant of the current operating mode
- **Network and Remote Operation**
  Information on setting up the instrument in a network and operating it remotely.
- **Remote Commands**
  Remote commands required to configure and perform measurements in a remote environment, sorted by tasks
  Remote commands required to set up the environment and to perform common tasks on the instrument, sorted by tasks
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Maintenance**
  Information on tasks required to maintain operability of the instrument
- **Troubleshooting**
  Hints and tips on how to handle errors
- **List of Commands**

Alpahabetical list of all remote commands described in the manual

- **Index**

1.2 Documentation Overview

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

- "Getting Started" printed manual
- Online Help system on the instrument
- Documentation CD-ROM with:
  – Getting Started
  – User Manuals for base unit and options
  – 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 FSW.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD. 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.

The Getting Started manual in various languages is also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

User Manuals

User manuals are provided for the base unit and each additional (software) option.

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 FSW in general, and the Spectrum 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 parameters, refer to the data sheets. Basic information on operating the R&S FSW is not included in the application manuals.

All user manuals are also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

Service Manual

This manual is available in PDF format on the CD 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 FSW 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 R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html > Downloads > Firmware.

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

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

1.3.2 Conventions for Procedure Descriptions

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

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

2 Welcome to the R&S FSW

The R&S FSW is a new high-performance R&S®FSW signal and spectrum analyzer developed to meet demanding customer requirements. Offering low phase noise, wide analysis bandwidth and straightforward and intuitive operation, the analyzer makes measurements fast and easy.

This user manual contains a description of the functionality that the instrument provides, including remote control operation. The latest version is available for download at the product homepage (http://www2.rohde-schwarz.com/product/FSW.html).

3 Applications and Operating Modes

The R&S FSW provides several applications for different analysis tasks and different types of signals, e.g. 3G FDD, 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.

Independant vs correlating measurements

With the **conventional R&S FSW Signal and Spectrum Analyzer** you can perform several different measurements almost simultaneously. However, the individual measurements are independant 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 new operating mode has been introduced to the R&S FSW: Multi-Standard Radio Analyzer (MSRA) mode.

In **Multi-Standard Radio Analyzer mode**, data acquisition is performed once 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 WCDMA application to reveal dependencies like a change in the EVM value.

Distinct operating modes

Although the applications themselves are identical in either operating mode, 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.

SCPI command:

`INST:MODE SAN`, see `INSTrument:MODE` on page 501

Switching between applications

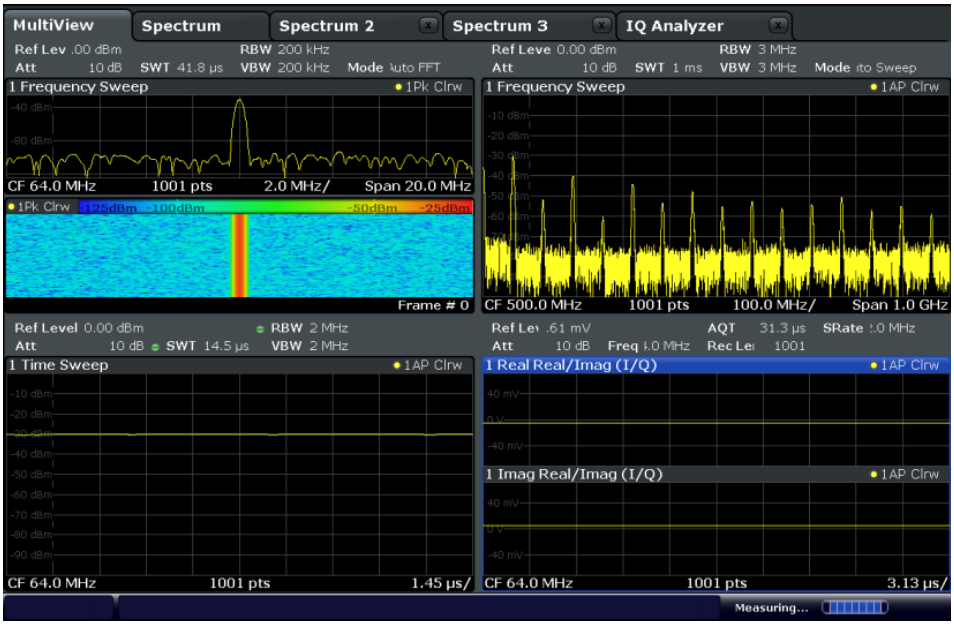
When you switch to a new application, a set of parameters is passed on from the current application to the new one:

- 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.

3.1 R&S MultiView

Each application is displayed in a separate tab. An additional tab ("MultiView") provides an overview of all currently active channels at a glance. In the "MultiView" tab, each individual window contains its own channel bar with an additional button. Tap this button to switch to the corresponding channel display quickly.



3.2 Available Applications

The R&S FSW provides some applications in the base unit while others are available only if the corresponding firmware options are installed. Not all R&S FSW applications are supported in MSRA mode. For an overview of supported MSRA applications see the R&S FSW MSRA User Manual.

Spectrogram application

Spectrogram measurements are not a separate application, but rather a trace evaluation method, thus they are available as an evaluation method for the Display Configuration, not by creating a new channel. Spectrograms are configured and activated in the "Trace" settings. See chapter 6.3.1.6, "Spectrograms", on page 287 for details.

Spectrum

In the Spectrum application the provided functions correspond to those of a conventional spectrum analyzer. The analyzer measures the frequency spectrum of the RF input signal over the selected frequency range with the selected resolution and sweep time, or, for a fixed frequency, displays the waveform of the video signal. This application is used in the initial configuration.

For details see chapter 4, "Measurements", on page 31.

SCPI command:

`INST:SEL SAN`, see `INSTrument[:SELect]` on page 502

1xEV-DO BTS

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

For details see the R&S FSW-K84/-K85 User Manual.

SCPI command:

`INST:SEL BDO`, see `INSTrument[:SELect]` on page 502

1xEV-DO MS
The 1xEV-DO MS application requires an instrument equipped with the 1xEV-DO MS Measurements option, R&S FSW-K85. This application provides test measurements for 1xEV-DO MS uplink signals (mobile signals) according to the test specification.

For details see the R&S FSW-K84/-K85 User Manual.

SCPI command:
`INST:SEL MDO`, see `INSTrument[:SELect]` on page 502

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

For details see the R&S FSW-K72/-K73 User Manual.

SCPI command:
`INST:SEL BWCD`, see `INSTrument[:SELect]` on page 502

3G FDD UE
The 3G FDD UE application requires an instrument equipped with the 3GPP User Equipment Measurements option, R&S FSW-K73. This application provides test measurements for WCDMA uplink signals (mobile signals) according to the test specification.

For details see the R&S FSW-K72/-K73 User Manual.

SCPI command:
`INST:SEL MWCD`, see `INSTrument[:SELect]` on page 502

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 FSW-K7 User Manual.

SCPI command:
`INST:SEL ADEM`, see `INSTrument[:SELect]` on page 502

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

For details see the R&S FSW-K82/-K83 User Manual.

SCPI command:
`INST:SEL BC2K`, see `INSTrument[:SELect]` on page 502

cdma2000 MS
The cdma2000 MS application requires an instrument equipped with the cdma2000 MS Measurements option, R&S FSW-K83. This application provides test measurements for cdma2000 MS uplink signals (mobile signals) according to the test specification.

For details see the R&S FSW-K82/-K83 User Manual.

SCPI command:

`INST:SEL MC2K`, see `INSTrument[:SELect]` on page 502

(Multi-Carrier) Group Delay

The Group Delay application requires an instrument equipped with the Multi-Carrier Group Delay Measurements option R&S FSW-K17. This application provides a Multi-Carrier Group Delay measurement.

For details see the R&S FSW-K17 User Manual.

SCPI command:

`INST:SEL MCGD`, see `INSTrument[:SELect]` on page 502

GSM

The GSM application requires an instrument equipped with the GSM Measurements option R&S FSW-K10. This application provides GSM measurements.

For details see the R&S FSW-K10 User Manual.

SCPI command:

`INST:SEL GSM`, see `INSTrument[:SELect]` on page 502

I/Q Analyzer

The I/Q Analyzer application provides measurement and display functions for I/Q data.

For details see the R&S FSW I/Q Analyzer User Manual.

SCPI command:

`INST:SEL IQ`, see `INSTrument[:SELect]` on page 502

LTE

The LTE application requires an instrument equipped with the LTE Measurements option R&S FSW-K10. This application provides LTE measurements.

For details see the R&S FSW-K10x (LTE Downlink) User Manual.

SCPI command:

`INST:SEL LTE`, see `INSTrument[:SELect]` on page 502

Noise Figure

The Noise Figure application requires an instrument equipped with the Noise Figure Measurements option R&S FSW-K30. This application provides noise figure measurements.

For details see the R&S FSW-K30 User Manual.

SCPI command:

`INST:SEL NOISE`, see `INSTrument[:SELect]` on page 502

Phase Noise

The Phase Noise application requires an instrument equipped with the Phase Noise Measurements option, R&S FSW-K40. This application provides measurements for phase noise tests.

For details see the R&S FSW-K40 User Manual.

SCPI command:
`INST:SEL PNOISE`, see `INSTrument[:SELect]` on page 502

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

For details see the R&S FSW-K6 User Manual.

SCPI command:
`INST:SEL PULSE`, see `INSTrument[:SELect]` on page 502

TD-SCDMA BTS
The TD-SCDMA BTS application requires an instrument equipped with the TD-SCDMA Base Station Measurements option, R&S FSW-K76. This application provides test measurements for TD-SCDMA downlink signals (base station signals) according to the test specification.

For details see the R&S FSW-K76/-K77 User Manual.

SCPI command:
`INST:SEL BTDS`, see `INSTrument[:SELect]` on page 502

TD-SCDMA UE
The TD-SCDMA UE application requires an instrument equipped with the TD-SCDMA User Equipment Measurements option, R&S FSW-K77. This application provides test measurements for TD-SCDMA uplink signals (mobile signals) according to the test specification.

For details see the R&S FSW-K76/-K77 User Manual.

SCPI command:
`INST:SEL MTDS`, see `INSTrument[:SELect]` on page 502

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

For details see the R&S FSW-K70 User Manual.

SCPI command:
`INST:SEL DDEM`, see `INSTrument[:SELect]` on page 502

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

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

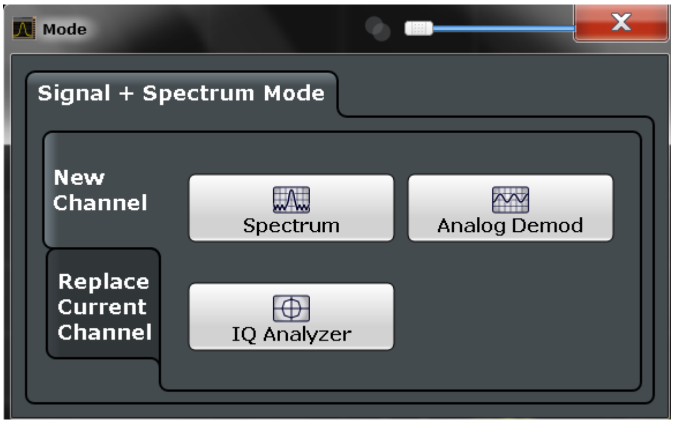
SCPI command:
`INST:SEL WLAN`, see `INSTrument[:SELect]` on page 502

3.3 Selecting the Operating Mode

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

(See chapter 8.3.4.5, "Preset", on page 402).

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.

The remote commands required to perform these tasks are described in chapter 10.2, "Selecting the Operating Mode and Application", on page 498.

To activate the Signal and Spectrum Analyzer operating mode

1. Press the MODE key on the front panel of the R&S FSW.

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

2. Select the "Signal and Spectrum Analyzer" tab.

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

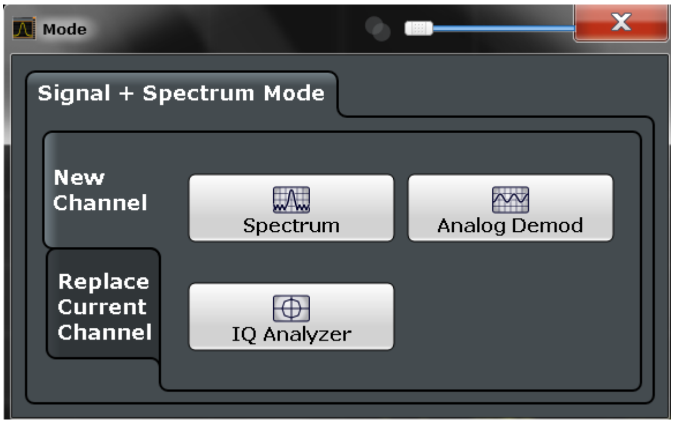
   The R&S FSW stores and closes all active measurement channels in the current operating mode, then opens a new measurement channel for the Signal and Spectrum Analyzer operating mode.
   Note: when you return to the previous operating mode, the stored configuration of all measurement channels is restored.

   The default Spectrum measurement channel is displayed and the Sequencer is automatically activated in continuous mode (see chapter 3.5, "Running a Sequence of Measurements", on page 26).

3.4 Starting an Application

The default application in Signal and Spectrum Analyzer mode is a Spectrum measurement.

The application can be selected in the "Mode" dialog box which is displayed when you press the MODE key.



To select an application, select the corresponding button.

The measurement channels are labeled with their default name. If that name already exists, a sequential number is added. In remote control, the name of the measurement channel can be changed. For details and an overview of default names see table 10-1.

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.

To deactivate a channel, simply close the corresponding tab.

The remote commands required to perform these tasks are described in chapter 10.2, "Selecting the Operating Mode and Application", on page 498.

New Channel

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

SCPI command:

`INSTrument:CREate[:NEW]` on page 499

`INSTrument[:SELect]` on page 502

Replace Current Channel

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

SCPI command:

`INSTrument:CREate:REPLace` on page 500

Duplicate Current Channel

The currently active channel can be duplicated, i.e. a new measurement channel of the same type and with the identical measurement settings is started. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "Spectrum" -> "Spectrum 2").

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

SCPI command:

`INSTrument:CREate:DUPLicate` on page 499

3.5 Running a Sequence of Measurements

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

3.5.1 The Sequencer Concept

The instrument can only be in one specific channel at any time. Thus, only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided, which changes the application of the instrument as required. If activated, the measurements configured in the currently active channels are performed one after the other in the order of the tabs. For each individual measurement, the sweep count is considered. Thus, each measurement may consist of several sweeps. The currently active measurement is indicated by a symbol in the tab label. The result displays of the individual channels are updated in the tabs (including the "MultiView") as the measurements are performed. Sequential operation itself is independant of the currently *displayed* tab.

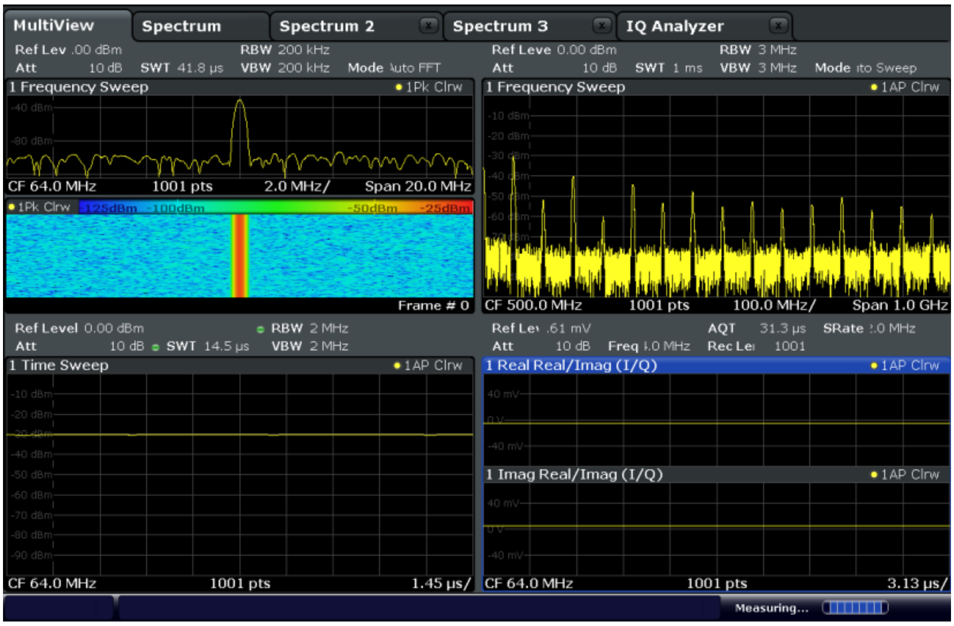
Sequencer modes

Three different Sequencer modes are available:

- **Single Sequence**
  Similar to single sweep mode; each measurement is performed once, until all measurements in all active channels have been performed.
- **Continuous Sequence**
  Similar to continuous sweep mode; 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 continuously.

Example: Sequencer procedure

Assume the following active channel definition:



Tab name	application	Sweep mode	Sweep count
Spectrum	Spectrum	Cont. Sweep	5
Spectrum 2	Spectrum	Single Sweep	6

Tab name	application	Sweep mode	Sweep count
Spectrum 3	Spectrum	Cont. Sweep	2
IQ Analyzer	IQ Analyzer	Single Sweep	7

For **single Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer

For **continuous Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

...

For **channel-defined Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

5x Spectrum, 2 x Spectrum 3,

5x Spectrum, 2 x Spectrum 3,

...

RUN SINGLE/RUN CONT and Single Sweep/Sweep Continuous keys

While the Sequencer is active, the RUN SINGLE and RUN CONT keys on the front panel control the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode, while RUN CONT starts the Sequencer in continuous mode.

The "Single Sweep" and "Continuous Sweep" softkeys control the sweep mode for the currently selected channel only; 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. A channel in continuous sweep mode is swept repeatedly.

3.5.2 Sequencer Settings

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.

SCPI command:

`SYSTem:SEQuencer` on page 505

`INITiate:SEQuencer:IMMediate` on page 503

`INITiate:SEQuencer:ABORt` on page 503

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

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

SCPI command:

`INITiate:SEQuencer:MODE` on page 504

3.5.3 How to Set Up the Sequencer

In order to perform the configured measurements consecutively, a Sequencer function is provided.

1. Configure a channel for each measurement configuration as required, including the sweep mode.
2. In the toolbar, select the "Sequencer" icon.

   The "Sequencer" menu is displayed.
3. Toggle the "Sequencer" softkey to "On".

   A continuous sequence is started immediately.
4. To change the Sequencer mode and start a new sequence immediately, select the corresponding mode softkey, or press the RUN SINGLE or RUN CONT key.

   The measurements configured in the currently active channels are performed one after the other in the order of the tabs until the Sequencer is stopped.
   The result displays in the individual channels are updated as the measurements are performed.

To stop the Sequencer

► To stop the Sequencer temporarily, press the highlighted RUN SINGLE or RUN CONT key (not for a channel-defined sequence). To continue the Sequencer, press the key again.

To stop the Sequencer permanently, select the "Sequencer" icon in the toolbar and toggle the "Sequencer" softkey to "Off".

4 Measurements

In the Spectrum application, the R&S FSW provides a variety of different measurement functions.

- **Basic measurements** - measure the spectrum of your signal or watch your signal in time domain
- **Power measurements** - calculate the powers involved in modulated carrier signals
- **Emission measurements** - detect unwanted signal emission
- **Statistic measurements** - evaluate the spectral distribution of the signal
- **Special measurements** - provide characteristic values of the signal

The individual functions are described in detail in the following chapters.

Measurements on I/Q-based data

As of firmware version 1.60, 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.

The measurements are configured using the same settings as described here for the Spectrum application.

The results, however, may differ slightly as hardware settings are not adapted automatically as for the Spectrum application. Additionally, the analysis interval used for the measurement is indicated as in all MSRA applications.

For more information see the R&S FSW MSRA User Manual.

4.1 Available Measurement Functions

The measurement function determines which settings, functions and evaluation methods are available in the R&S FSW. The various measurement functions are described in detail here. They are selected in the "Select Measurement" dialog box that is displayed when you press the MEAS key or tap "Select Measurement" in the configuration "Overview".

When you select a measurement function, the measurement is started with its default settings immediately and the corresponding measurement configuration menu is displayed. The measurement configuration menu can be displayed at any time by pressing the MEAS CONFIG key.

The easiest way to configure measurements is using the configuration "Overview", see chapter 5.1, "Configuration Overview", on page 181.

In addition to the measurement-specific parameters, the general parameters can be configured as usual, see chapter 5, "Common Measurement Settings", on page 181. Many measurement functions provide special result displays or evaluation methods; however, in most cases the general evaluation methods are also available, see chapter 6, "Common Analysis and Display Functions", on page 273.

After a preset, the R&S FSW performs a basic frequency sweep.

Frequency Sweep

A common frequency sweep of the input signal over a specified span. Can be used for general purposes to obtain basic measurement results such as peak levels and spectrum traces. The "Frequency" menu is displayed. This is the default measurement if no other function is selected.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 5, "Common Measurement Settings", on page 181).

SCPI command:

`[SENSe:]FREQuency:STARt` on page 630, `[SENSe:]FREQuency:STOP` on page 630

`INITiate[:IMMediate]` on page 510

`INITiate:CONTinuous` on page 509

Zero Span

A sweep in the time domain at the specified (center) frequency, i.e. the frequency span is set to zero. The display shows the time on the x-axis and the signal level on the y-axis, as on an oscilloscope. On the time axis, the grid lines correspond to 1/10 of the current sweep time.

The "Frequency" menu is displayed. Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 5, "Common Measurement Settings", on page 181).

Most result evaluations can also be used for zero span measurements, although some functions (e.g. markers) may work slightly differently and some may not be available. If so, this will be indicated in the function descriptions (see chapter 6, "Common Analysis and Display Functions", on page 273).

SCPI command:

[SENSe:]FREQuency:SPAN on page 629

INITiate[:IMMediate] on page 510

INITiate:CONTinuous on page 509

Ch Power ACLR

Measures the active channel or adjacent-channel power for one or more carrier signals, depending on the current measurement configuration, and opens a submenu to configure the channel power measurement.

For details see chapter 4.2, "Channel Power and Adjacent-Channel Power (ACLR) Measurement", on page 36.

SCPI command:

CALC:MARK:FUNC:POW:SEL ACP, see CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516

Results:

CALC:MARK:FUNC:POW:RES? ACP, see CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514

chapter 10.3.3, "Measuring the Channel Power and ACLR", on page 518

C/N, C/No

Measures the carrier/noise ratio and opens a submenu to configure the measurement. Measurements without (C/N) and measurements with reference to the bandwidth (C/No) are possible.

Carrier/noise measurement is only possible in the frequency domain (span > 0).

For details see chapter 4.3, "Carrier-to-Noise Measurements", on page 85.

SCPI command:

CALC:MARK:FUNC:POW:SEL CN | CN0CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516

Results:

CALC:MARK:FUNC:POW:RES? CN | CN0, see CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514

chapter 10.3.4, "Measuring the Carrier-to-Noise Ratio", on page 545

OBW

Measures the occupied bandwidth, i.e. the bandwidth which must contain a defined percentage of the power, and opens a submenu to configure the measurement. For details see chapter 4.4, "Occupied Bandwidth Measurement (OBW)", on page 89.

OBW measurement is only possible in the frequency domain (span > 0).

SCPI command:

`CALC:MARK:FUNC:POW:SEL OBW`CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516

Results:

`CALC:MARK:FUNC:POW:RES? OBW`, see CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514

chapter 10.3.5, "Measuring the Occupied Bandwidth", on page 546

Spectrum Emission Mask

Activates a Spectrum Emission Mask (SEM) measurement, which monitors compliance with a spectral mask, and opens a submenu to configure the measurement.

For details see chapter 4.5, "Spectrum Emission Mask (SEM) Measurement", on page 95.

SCPI command:

`SENS:SWE:MODE ESP`, see [SENSe:]SWEep:MODE on page 549

Results:

`CALC:MARK:FUNC:POW:RES? CPOW | PPOW`, see CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514

`CALC:LIM:FAIL?`, see CALCulate<n>:LIMit<k>:FAIL on page 754

TRACe<n>[:DATA] on page 702

TRACe<n>[:DATA]:X? on page 704

chapter 10.3.6, "Measuring the Spectrum Emission Mask", on page 548

Spurious Emissions

Activates the Spurious Emissions measurement, which monitors unwanted RF products outside the assigned frequency band generated by an amplifier. A submenu to configure the measurement is opened.

For details see chapter 4.6, "Spurious Emissions Measurement", on page 126.

SCPI command:

`SENS:SWE:MODE LIST`, see [SENSe:]SWEep:MODE on page 549

Results:

`TRAC:DATA? SPUR`, see TRACe<n>[:DATA] on page 702

chapter 10.3.7, "Measuring Spurious Emissions", on page 574

APD

Measures the amplitude probability density (APD) and opens a submenu to configure the measurement.

For details see chapter 4.7, "Statistical Measurements (APD, CCDF)", on page 139.

SCPI command:

CALCulate<n>:STATistics:APD[:STATe] on page 587

Results:

CALCulate:STATistics:RESult<t>? on page 593

CCDF

Measures the complementary cumulative distribution function (CCDF) and opens a submenu to configure the measurement.

For details see chapter 4.7, "Statistical Measurements (APD, CCDF)", on page 139.

SCPI command:

`CALCulate<n>:STATistics:CCDF[:STATe]` on page 587

Results:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 593

`CALCulate:STATistics:RESult<t>?` on page 593

Time Domain Power

Measures the power in zero span and opens a submenu to configure the measurement. For details see chapter 4.12, "Basic Measurements", on page 176.

A time domain power measurement is only possible for zero span.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe]` on page 597

chapter 10.3.9, "Measuring the Time Domain Power", on page 595

TOI

Measures the third order intercept point and opens a submenu to configure the measurement.

For details see chapter 4.10, "Third Order Intercept (TOI) Measurement", on page 164.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe]` on page 607

`CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?` on page 607

chapter 10.3.11, "Measuring the Third Order Intercept Point", on page 606

AM Mod Depth

Measures the AM modulation depth and opens a submenu to configure the measurement. An AM-modulated carrier is required in the window to ensure correct operation.

For details see chapter 4.11, "AM Modulation Depth Measurement", on page 173.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe]` on page 609

`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?` on page 609

chapter 10.3.12, "Measuring the AM Modulation Depth", on page 608

Harmonic Distortion

Measures the harmonic distortion, including the total harmonic distortion, and opens a submenu to configure the measurement.

For details see chapter 4.9, "Harmonic Distortion Measurement", on page 158.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe]` on page 603

First harmonic: `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 627.

THD: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion?` on page 605

List of harmonics: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?` on page 605

chapter 10.3.10, "Measuring the Harmonic Distortion", on page 603

Marker Functions

In addition to the measurement functions, some special marker functions are available. See chapter 6.4.2.3, "Marker Function Configuration", on page 334.

All Functions Off

Switches off all measurement functions and returns to a basic frequency sweep.

4.2 Channel Power and Adjacent-Channel Power (ACLR) Measurement

Measuring the power in channels adjacent to the carrier or transmission channel is useful to detect interference. The results are displayed as a bar chart for the individual channels.

4.2.1 About Channel Power Measurements

Measuring channel power and adjacent channel power is one of the most important tasks for a signal analyzer with the necessary test routines in the field of digital transmission. While, theoretically, channel power could be measured at highest accuracy with a power meter, its low selectivity means that it is not suitable for measuring adjacent channel power as an absolute value or relative to the transmit channel power. The power in the adjacent channels can only be measured with a selective power meter.

A signal analyzer cannot be classified as a true power meter, because it displays the IF envelope voltage. However, it is calibrated such as to correctly display the power of a pure sine wave signal irrespective of the selected detector. This calibration cannot be applied for non-sinusoidal signals. Assuming that the digitally modulated signal has a Gaussian amplitude distribution, the signal power within the selected resolution bandwidth can be obtained using correction factors. These correction factors are normally used by the signal analyzer's internal power measurement routines in order to determine the signal power from IF envelope measurements. These factors apply if and only if the assumption of a Gaussian amplitude distribution is correct.

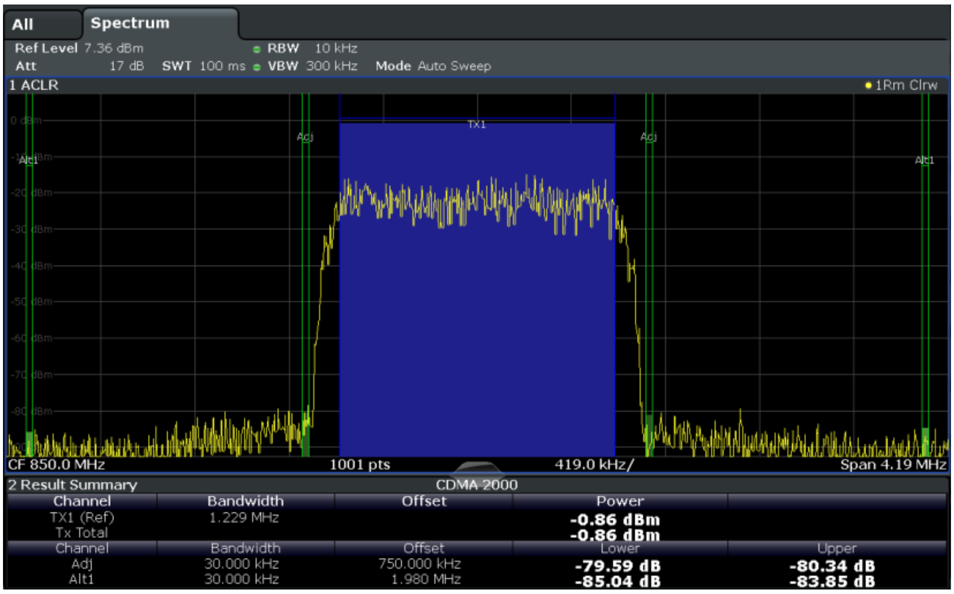
Apart from this common method, the R&S FSW also has a true power detector, i.e. an RMS detector. It displays the power of the test signal within the selected resolution bandwidth correctly, irrespective of the amplitude distribution, without additional correction factors being required.

As of firmware version 1.60, the R&S FSW allows you to perform ACLR measurements on input containing multiple signals for different communication standards. A new measurement standard is provided that allows you to define multiple discontiguous transmit channels at specified frequencies, independant from the selected center frequency. The ACLR measurement determines the power levels of the individual transmit, adjacent, and CACLR channels, as well as the total power for each subblock of transmit channels.

A detailed measurement example is provided in chapter 4.2.7, "Measurement Examples", on page 78.

4.2.2 Channel Power Results

For channel or adjacent-channel power measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel ("Adj", "Alt1", "TX1", etc. or a user-defined name) is indicated above the bar (separated by a line which has no further meaning). For "Fast ACLR" measurements, which are performed in the time domain, the power versus time is shown for each channel.



Results are provided for the TX channel and the number of defined adjacent channels *above and below* the TX channel. If more than one TX channel is defined, the carrier channel to which the relative adjacent-channel power values should be referenced must be defined. By default, this is the TX channel with the maximum power.

Table 4-1: Measurements performed depending on the number of adjacent channels

0	Only the channel powers are measured.
1	The channel powers and the power of the upper and lower adjacent channel are measured.
2	The channel powers, the power of the upper and lower adjacent channel, and of the next higher and lower channel (alternate channel 1) are measured.
3	The channel power, the power of the upper and lower adjacent channel, the power of the next higher and lower channel (alternate channel 1), and of the next but one higher and lower adjacent channel (alternate channel 2) are measured.
...	...
12	The channel power, the power of the upper and lower adjacent channel, and the power of all the higher and lower channels (alternate channels 1 to 11) are measured.

In the R&S FSW's display, only the first neighboring channel of the carrier (TX) channel is labelled "Adj" (adjacent) channel; all others are labelled "Alt" (alternate) channels. In this manual, "adjacent" refers to both adjacent and alternate channels.

The measured power values for the TX and adjacent channels are also output as a table in the second window. Which powers are measured depends on the number of configured channels.

For each channel, the following values are displayed:

Label	Description
Channel	Channel name as specified in the "Channel Settings" (see "Channel Names" on page 59).
Bandwidth	Configured channel bandwidth (see "Channel Bandwidths" on page 57)
Offset	Offset of the channel to the TX channel (Configured channel spacing, see "Channel Bandwidths" on page 57)
Power (Lower/Upper)	The measured power values for the TX and lower and upper adjacent channels. The powers of the transmission channels are output in dBm or dBm/Hz, or in dBc, relative to the specified reference TX channel.

Retrieving Results via Remote Control

All or specific channel power measurement results can be retrieved using the `CALC:MARK:FUNC:POW:RES?` command from a remote computer (see `CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514). Alternatively, the results can be output as channel power density, i.e. in reference to the measurement bandwidth.

Furthermore, the measured power values of the displayed trace can be retrieved as usual using the `TRAC:DATA?` commands (see `TRACe<n>[:DATA]` on page 702). In this case, the measured power value for each sweep point (by default 1001) is returned.

4.2.3 Channel Power Basics

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

4.2.3.1 Measurement Methods

The channel power is defined as the integration of the power across the channel bandwidth.

The **A**djacent **C**hannel **L**eakage Power **R**atio (ACLR), also known as the **A**djacent **C**hannel **P**ower **R**atio (ACPR), is defined as the ratio between the total power of the adjacent channel to the carrier channel's power. An ACLR measurement with several carrier channels (also known as transmission or TX channels) is also possible and is referred to as a "multi-carrier ACLR measurement".

There are two possible methods for measuring channel and adjacent channel power with a signal analyzer:

- IBW method (**I**ntegration **B**andwidth **M**ethod)
- **Fast ACLR**(Zero-span method), i.e. using a channel filter

IBW method

When measuring the channel power, the R&S FSW integrates the linear power which corresponds to the levels of the measurement points within the selected channel. The signal analyzer uses a resolution bandwidth which is far smaller than the channel bandwidth. When sweeping over the channel, the channel filter is formed by the passband characteristics of the resolution bandwidth.

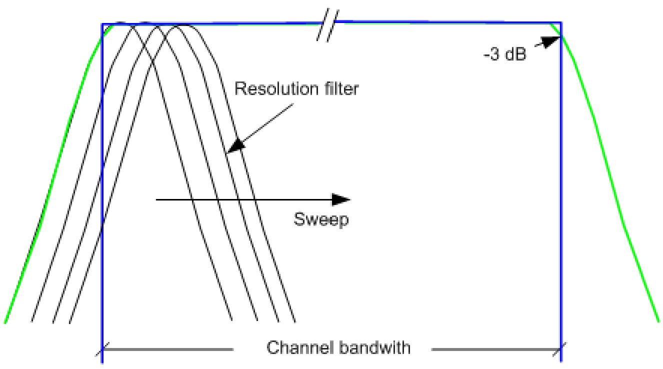


Fig. 4-1: Approximating the channel filter by sweeping with a small resolution bandwidth

The following steps are performed:

1. The linear power of all the trace points within the channel is calculated.

$P_i = 10^{(Li/10)}$

where P_i = power of the trace pixel i

L_i = displayed level of trace point i

2. The powers of all trace points within the channel are summed up and the sum is divided by the number of trace points in the channel.
3. The result is multiplied by the quotient of the selected channel bandwidth and the noise bandwidth of the resolution filter (RBW).

Since the power calculation is performed by integrating the trace within the channel bandwidth, this method is called the IBW method (**I**ntegration **B**and**w**idth method).

Fast ACLR

The integrated bandwidth method (IBW) calculates channel power and ACLR from the trace data obtained during a continuous sweep over the selected span. Most parts of this sweep are neither part of the channel itself nor the defined adjacent channels. Therefore, most of the samples taken during the sweep time cannot be used for channel power or ACLR calculation.

To decrease the measurement times, the R&S FSW offers a "Fast ACLR" mode. In Fast ACLR mode, the power of the frequency range between the channels of interest is not measured, because it is not required for channel power or ACLR calculation. The measurement time per channel is set with the sweep time. It is equal to the selected measurement time divided by the selected number of channels.

In the "Fast ACLR" mode, the R&S FSW measures the power of each channel in the time domain, with the defined channel bandwidth, at the center frequency of the channel in question. The digital implementation of the resolution bandwidths makes it possible to select filter characteristics that are precisely tailored to the signal. In case of CDMA2000, for example, the power in the useful channel is measured with a bandwidth of 1.23 MHz and that of the adjacent channels with a bandwidth of 30 kHz. Therefore the R&S FSW changes from one channel to the other and measures the power at a bandwidth of 1.23 MHz or 30 kHz using the RMS detector.

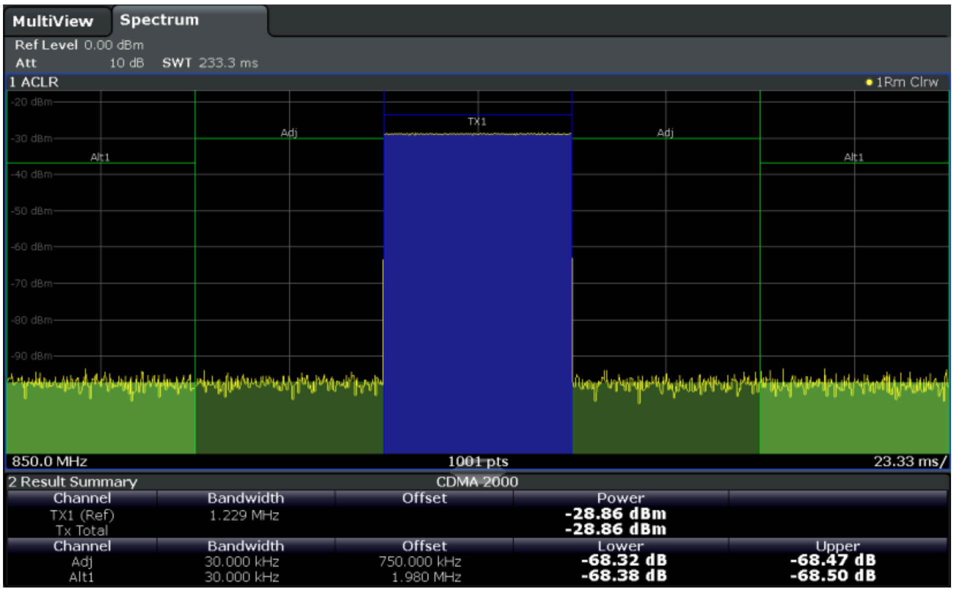


Fig. 4-2: Measuring the channel power and adjacent channel power ratio for CDMA2000 signals with zero span (Fast ACLR)

4.2.3.2 Measurement Repeatability

The repeatability of the results, especially in the narrow adjacent channels, strongly depends on the measurement time for a given resolution bandwidth. A longer sweep time may increase the probability that the measured value converges to the true value of the adjacent channel power, but obviously increases measurement time.

Assuming a measurement with five channels (1 channel plus 2 lower and 2 upper adjacent channels) and a sweep time of 100 ms, a measurement time per channel of 20 ms is required. The number of effective samples taken into account for power calculation in one channel is the product of sweep time in channel times the selected resolution bandwidth.

Assuming a sweep time of 100 ms, there are (30 kHz / 4.19 MHz) * 100 ms * 10 kHz ≈ 7 samples. Whereas in Fast ACLR mode, there are (100 ms / 5) * 30 kHz ≈ 600 samples. Comparing these numbers explains the increase of repeatability with a 95% confidence level (2δ) from ± 2.8 dB to ± 0.34 dB for a sweep time of 100 ms.

For the same repeatability, the sweep time would have to be set to 8.5 s with the integration method. The figure 4-3 shows the standard deviation of the results as a function of the sweep time.

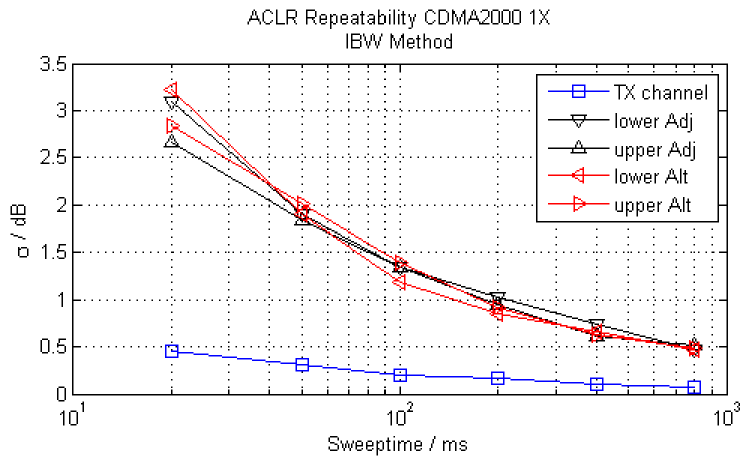


Fig. 4-3: Repeatability of adjacent channel power measurement on CDMA2000 standard signals if the integration bandwidth method is used

The figure 4-4 shows the repeatability of power measurements in the transmit channel and of relative power measurements in the adjacent channels as a function of sweep time. The standard deviation of measurement results is calculated from 100 consecutive measurements. Take scaling into account if comparing power values.

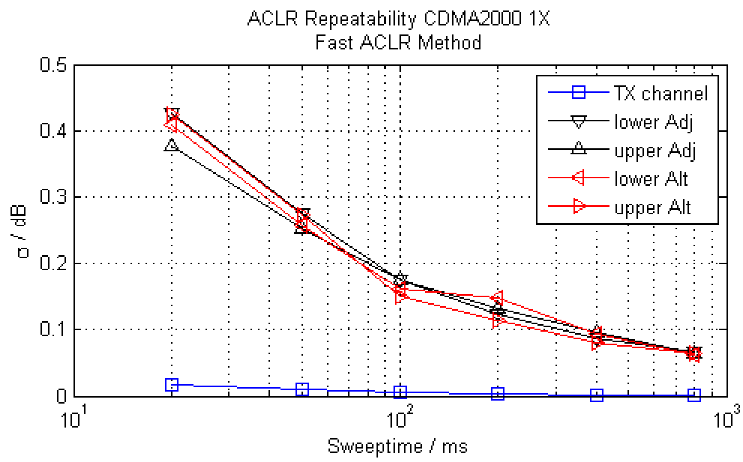


Fig. 4-4: Repeatability of adjacent channel power measurements on CDMA2000 signals in the fast ACLR mode

4.2.3.3 Recommended Common Measurement Parameters

The following sections provide recommendations on the most important measurement parameters for channel power measurements.

All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically using the "Adjust Settings" function (see "Optimized Settings (Adjust Settings)" on page 55).

The easiest way to configure a measurement is using the configuration "Overview", see chapter 5.1, "Configuration Overview", on page 181.

Sweep Time

The sweep time is selected depending on the desired reproducibility of results. Reproducibility increases with sweep time since power measurement is then performed over a longer time period. As a general approach, it can be assumed that approx. 500 non-correlated measured values are required for a reproducibility of 0.5 dB (99 % of the measurements are within 0.5 dB of the true measured value). This holds true for white noise. The measured values are considered as non-correlated if their time interval corresponds to the reciprocal of the measured bandwidth.

With IS 136 the measurement bandwidth is approx. 25 kHz, i.e. measured values at an interval of 40 µs are considered as non-correlated. A measurement time of 40 ms is thus required per channel for 1000 measured values. This is the default sweep time which the R&S FSW sets in coupled mode. Approx. 5000 measured values are required for a reproducibility of 0.1 dB (99 %), i.e. the measurement time is to be increased to 200 ms.

The number of A/D converter values, N, used to calculate the power, is defined by the sweep time. The time per trace pixel for power measurements is directly proportional to the selected sweep time.

If the sample detector is used, it is best to select the smallest sweep time possible for a given span and resolution bandwidth. The minimum time is obtained if the setting is coupled. This means that the time per measurement is minimal. Extending the measurement time does not have any advantages as the number of samples for calculating the power is defined by the number of trace points in the channel.

If the RMS detector is used, the repeatability of the measurement results can be influenced by the selection of sweep times. Repeatability is increased at longer sweep times.

If the RMS detector is used, the number of samples can be estimated as follows:

Since only uncorrelated samples contribute to the RMS value, the number of samples can be calculated from the sweep time and the resolution bandwidth.

Samples can be assumed to be uncorrelated if sampling is performed at intervals of 1/RBW. The number of uncorrelated samples is calculated as follows:

$N_{decorr} = SWT * RBW$

(N_{decorr} means uncorrelated samples)

The number of uncorrelated samples per trace pixel is obtained by dividing N_{decorr} by 1001 (= pixels per trace).

The "Sweep Time" can be defined using the softkey in the "Ch Power" menu or in the "Sweep" configuration dialog box (see "Sweep Time" on page 56).

Frequency Span

The frequency span must cover at least the channels to be measured plus a measurement margin of approximately 10 %.

If the frequency span is large in comparison to the channel bandwidth (or the adjacent-channel bandwidths) being analyzed, only a few points on the trace are available per channel. This reduces the accuracy of the waveform calculation for the channel filter used, which has a negative effect on the measurement accuracy. It is therefore strongly recommended that the formulas mentioned be taken into consideration when selecting the frequency span.

The frequency span for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 55). You can set the frequency span manually in the "Frequency" configuration dialog box, see chapter 5.3.3, "How To Define the Frequency Range", on page 227.

For channel power measurements the "Adjust Settings" function sets the frequency span as follows:

"(No. of transmission channels – 1) x transmission channel spacing + 2 x transmission channel bandwidth + measurement margin"

For adjacent-channel power measurements, the "Adjust Settings" function sets the frequency span as a function of the number of transmission channels, the transmission channel spacing, the adjacent-channel spacing, and the bandwidth of one of adjacent-channels ADJ, ALT1 or ALT2, whichever is furthest away from the transmission channels:

"(No. of transmission channels – 1) x transmission channel spacing + 2 x (adjacent-channel spacing + adjacent-channel bandwidth) + measurement margin"

The measurement margin is approx. 10 % of the value obtained by adding the channel spacing and the channel bandwidth.

Resolution Bandwidth (RBW)

To ensure both acceptable measurement speed and the required selection (to suppress spectral components outside the channel to be measured, especially of the adjacent channels), the resolution bandwidth must not be selected too small or too large. As a general approach, the resolution bandwidth is to be set to values between 1% and 4% of the channel bandwidth.

A larger resolution bandwidth can be selected if the spectrum within the channel to be measured and around it has a flat characteristic. In the standard setting, e.g. for standard IS95A REV at an adjacent channel bandwidth of 30 kHz, a resolution bandwidth of 30 kHz is used. This yields correct results since the spectrum in the neighborhood of the adjacent channels normally has a constant level.

The resolution bandwidth for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 55). You can set the RBW manually in the "Bandwidth" configuration dialog box, see "RBW" on page 245.

With the exception of the IS95 CDMA standards, the "Adjust Settings" function sets the resolution bandwidth (RBW) as a function of the channel bandwidth:

"RBW ≤ 1/40 of channel bandwidth"

The maximum possible resolution bandwidth (with respect to the requirement RBW ≤ 1/40) resulting from the available RBW steps (1, 3) is selected.

Video Bandwidth (VBW)

For a correct power measurement, the video signal must not be limited in bandwidth. A restricted bandwidth of the logarithmic video signal would cause signal averaging and thus result in a too low indication of the power (-2.51 dB at very low video bandwidths). The video bandwidth should therefore be selected at least three times the resolution bandwidth:

"VBW ≥ 3 x RBW"

The video bandwidth for the defined channel settings can be optimized using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 55). You can set the VBW manually in the "Bandwidth" configuration dialog box, see "VBW" on page 245.

The video bandwidth (VBW) is set as a function of the channel bandwidth (see formula above) and the smallest possible VBW with regard to the available step size is selected.

Detector

The RMS detector correctly indicates the power irrespective of the characteristics of the signal to be measured. The whole IF envelope is used to calculate the power for each measurement point. The IF envelope is digitized using a sampling frequency which is at least five times the resolution bandwidth which has been selected. Based on the sample values, the power is calculated for each measurement point using the following formula:

$$P_{RMS} = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^{N} s_i^2}$$

where:

s_i = linear digitized video voltage at the output of the A/D converter

N = number of A/D converter values per measurement point

P_{RMS} = power represented by a measurement point

When the power has been calculated, the power units are converted into decibels and the value is displayed as a measurement point.

In principle, the sample detector would be possible as well. Due to the limited number of measurement points used to calculate the power in the channel, the sample detector would yield less stable results.

The RMS detector can be set for the defined channel settings automatically using the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimized Settings (Adjust Settings)" on page 55). You can set the detector manually in the "Traces" configuration dialog box, see "Detector" on page 295.

Trace Averaging

Averaging, which is often performed to stabilize the measurement results, leads to a level indication that is too low and should therefore be avoided. The reduction in the displayed power depends on the number of averages and the signal characteristics in the channel to be measured.

The "Adjust Settings" function switches off trace averaging. You can deactivate the trace averaging manually in the "Traces" configuration dialog box, see "Average Mode" on page 295.

Reference Level

To achieve an optimum dynamic range, the reference level has to be set such that the signal is as close to the reference level as possible without forcing an overload message or limiting the dynamic range by an S/N ratio that is too small. Since the measurement bandwidth for channel power measurements is significantly smaller than the signal bandwidth, the signal path may be overloaded although the trace is still significantly below the reference level.

The reference level is not influenced by the selection of a predefined standard or by the automatic setting adjustment. The reference level can be set automatically using the "Auto Level" function in the AUTO SET menu, or manually in the "Amplitude" menu.

4.2.3.4 Measurement on Multi-Standard Radio (MSR) Signals

Modern base stations may contain multiple signals for different communication standards. A new measurement standard is provided for the R&S FSW ACLR measurement that allows you to measure such MSR signals, including non-contiguous setups. Multiple (also non-)contiguous transmit channels can be specified at absolute frequencies, independant from the common center frequency selected for display.

Signal structure

Up to 18 transmit channels can be grouped in a maximum of 5 *subblocks*. Between two subblocks, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn contains 2 channels. The channels in the upper gap are identical to those in the lower gap, but inverted. To either side of the outermost transmit channels, lower and upper adjacent channels can be defined as in common ACLR measurement setups.

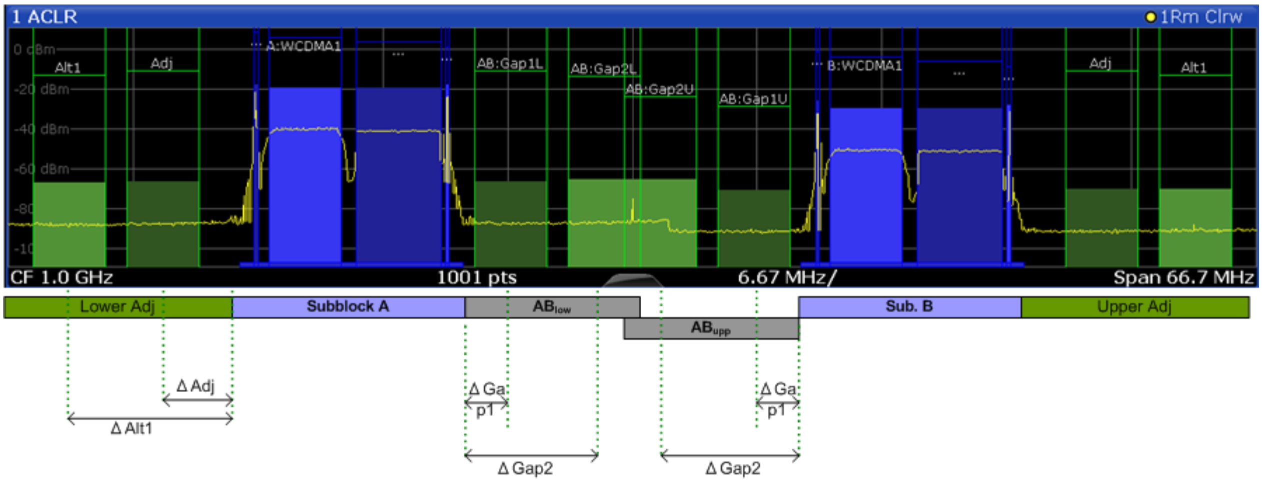


Fig. 4-5: MSR signal structure

Subblock and channel definition

The subblocks are defined by a specified center frequency, RF bandwidth, and number of transmit channels.

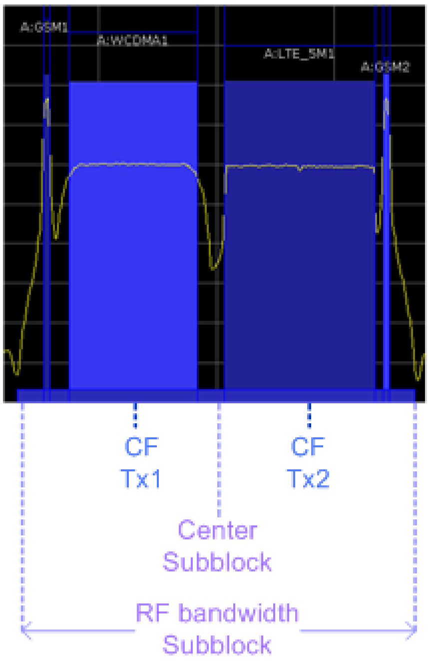


Fig. 4-6: Subblock definition

As opposed to common ACLR channel definitions, the TX channels are defined at absolute frequencies, rather than by a spacing relative to the (common) center frequency. Each transmit channel can be assigned a different technology, used to predefine the required bandwidth.

CACLR channels

If two or more subblocks are defined, the power in the gaps between the subblocks must also be measured (referred to as the ***C****umulative* ***A****djacent* ***C****hannel* ***L****eakage* ***R****atio (CACLR) power*). According to the MSR standard, the CACLR is measured in the two channels for the upper and lower gap (thus referred to as *CACLR channels*). The power in the CACLR channels is then set in relation to the power of the two closest transmission channels to either side of the gap.

CACLR channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding subblocks. Since the upper and lower CACLR channels are identical, only two channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)

Adjacent channels

Adjacent channels are defined as in common ACLR measurements, using bandwidths and spacings, however, relative to the start and stop frequency of the total block of transmit channels:

- The spacing of the lower adjacent channels refers to the CF of the first Tx channel in the first subblock.
- The spacing of the upper adjacent channels refers to the CF of the last Tx channel in the last subblock.

Channel display for MSR signals

As in common ACLR measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel is indicated above the bar. Subblocks are named A,B,C,D,E and are also indicated by a slim blue bar along the frequency axis.

Note that TX channel names correspond to the specified technology (for LTE including the bandwidth), followed by a consecutive number. (If the channel is too narrow to display the channel name, it is replaced by "..." on the screen.) Channel names cannot be defined manually. The assigned subblock is indicated with the channel name, e.g. "B:LTE_5M1" for the first Tx channel in subblock B that uses the LTE 5 MHz bandwidth technology.

Gap channels (CACLR) are indicated by the names of the surrounding subblocks (e.g. "AB" for the gap between subblocks A and B), followed by the channel name ("Gap1" or "Gap2") and an "L" (for lower) or a "U" (for upper). Both the lower and upper gap channels are displayed. However, if the gap between two subblocks is too narrow, the second gap channel may not be displayed. If the gap is even narrower, no gap channels are displayed.

Adjacent and alternate channels are displayed as in common ACLR measurements.

Channel power results

The Result Summary for MRS signal measurements is similar to to the table for common signals (see chapter 4.2.2, "Channel Power Results", on page 37). However, the Tx channel results are grouped by subblocks, and subblock totals are provided instead of a total TX channel power. Instead of the individual channel frequency offsets, the absolute center frequencies are indicated for the transmit channels. The CACLR results for each gap channel are appended at the end of the table. The CACLR results are calculated as the power in the CACLR channel divided by the power sum of the two closest transmission channels to either side of it.

2 Result Summary		Multi-Standard Radio		
Channel	Bandwidth	Frequency	Power	
A:GSM1	200.000 kHz	979.900 MHz	-81.06 dBm	
A:WCDMA1	3.840 MHz	982.500 MHz	-77.68 dBm	
A:LTE_5M1 (Ref)	4.515 MHz	987.500 MHz	-29.07 dBm	
A:GSM2	200.000 kHz	990.100 MHz	-42.85 dBm	
Sub Block A Total			-28.89 dBm	
Channel	Bandwidth	Frequency	Power	
B:GSM1	200.000 kHz	1.010 GHz	-43.85 dBm	
B:WCDMA1	3.840 MHz	1.012 GHz	-29.30 dBm	
B:LTE_5M1	4.515 MHz	1.018 GHz	-73.91 dBm	
B:GSM2	200.000 kHz	1.020 GHz	-80.44 dBm	
Sub Block B Total			-29.15 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	3.840 MHz	5.000 MHz	-33.27 dB	-32.63 dB
Alt1	3.840 MHz	10.000 MHz	-49.76 dB	-50.37 dB
Channel	Bandwidth	Offset	Lower	Upper
AB:Gap1	3.840 MHz	2.500 MHz	-14.08 dB	-14.35 dB
AB:Gap2	3.840 MHz	7.500 MHz	32.12 dB	32.53 dB

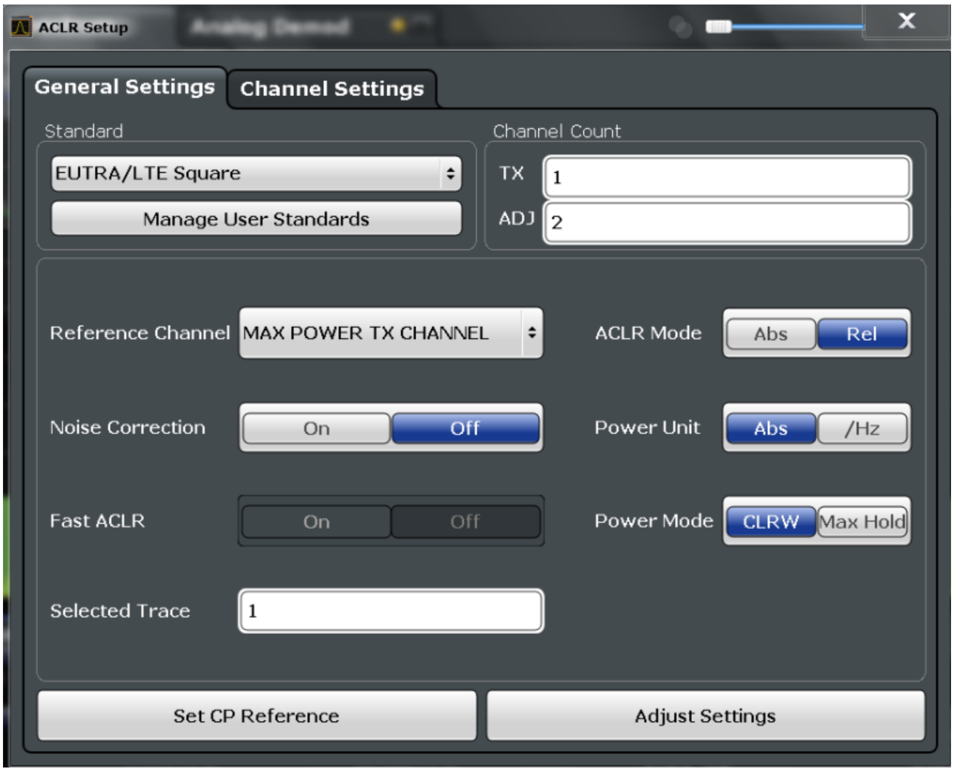
Restrictions and dependencies

As the signal structure in multi-standard radio signals may vary considerably, the channels can be defined very flexibly for the ACLR measurement with the R&S FSW. No checks or limitations are implemented concerning the channel definitions, apart from the maximum number of channels to be defined. Thus, you will not be notified if transmit channels for a specific subblock lie outside the subblock's defined frequency range, or if transmit and CACLR channels overlap.

4.2.4 Channel Power Configuration

Channel Power (CP) and Adjacent-Channel Power (ACLR) measurements are selected via the "Channel Power ACLR" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "ACLR Setup" dialog box, which is displayed when you select the "CP/ACLR Config" softkey from the "CH Power" menu.

If the "Multi-Standard Radio" standard is selected (see "Standard" on page 51), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box. See chapter 4.2.5, "MSR ACLR Configuration", on page 60 for a description of these settings.



The easiest way to configure a measurement is using the configuration "Overview", see chapter 5.1, "Configuration Overview", on page 181.

The remote commands required to perform these tasks are described in chapter 10.3.3, "Measuring the Channel Power and ACLR", on page 518.

4.2.4.1 General CP/ACLR Measurement Settings

General measurement settings are defined in the "ACLR Setup" dialog, in the "General Settings" tab.

Standard

The main measurement settings can be stored as a standard file. When such a standard is loaded, the required channel and general measurement settings are automatically set on the R&S FSW. However, the settings can be changed. Predefined standards are available for standard measurements, but standard files with user-defined configurations can also be created.

Note: If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see chapter 4.2.5, "MSR ACLR Configuration", on page 60).
If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see chapter 4.2.4, "Channel Power Configuration", on page 49).

Note that changes in the configuration are not stored when the dialog boxes are exchanged.

Predefined Standards ← Standard

Predefined standards contain the main measurement settings for standard measurements. When such a standard is loaded, the required channel settings are automatically set on the R&S FSW. However, the settings can be changed.

The predefined standards contain the following settings:

- Channel bandwidths
- Channel spacings
- Detector
- Trace Average setting
- Resolution Bandwidth (RBW)
- Weighting Filter

Predefined standards can be selected via the "CP/ACLR Standard" softkey in the "CH Power" menu or in the "General Settings" tab of the "CP/ACLR Setup" dialog box.

For details on the available standards see chapter 4.2.8, "Reference: Predefined CP/ACLR Standards", on page 84.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518

User-Defined Standards ← Standard

In addition to the predefined standards you can save your own standards with your specific measurement settings in an xml file so you can use them again at a later time. User-defined standards are stored on the instrument in the `C:\R_S\instr\acp_std` directory.

A sample file is provided for an MSR ACLR measurement (MSR_ACLRExample.xml). It sets up the measurement for the MSR signal generator waveform described in the file `C:\R_S\instr\user\waveform\MSRA_GSM_WCDMA_LET_GSM.wv`.

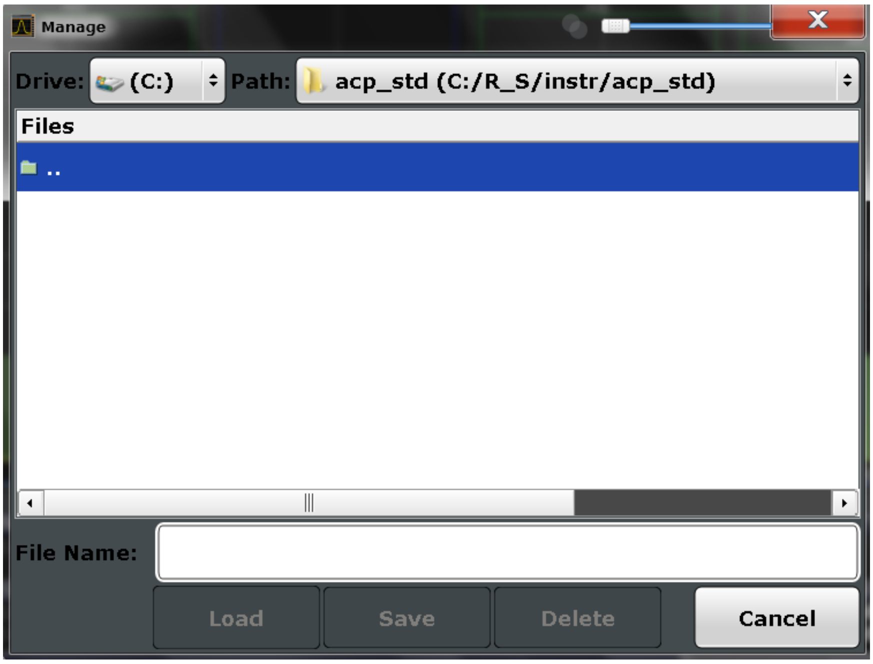
Note that ACLR user standards are not supported for Fast ACLR and Multi-Carrier ACLR measurements.

Note: User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSW. User standards created on an R&S FSW, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

The following parameter definitions are saved in a user-defined standard:

- Number of adjacent channels
- Channel bandwidth of transmission (Tx), adjacent (Adj) and alternate (Alt) channels
- Channel spacings
- Weighting filters
- Resolution bandwidth
- Video bandwidth
- Detector
- ACLR limits and their state
- Sweep time and sweep time coupling
- Trace and power mode
- (MSR only: subblock and gap channel definition)

User-defined standards are managed in the "Manage" dialog box which is displayed when you select the "Manage User Standards" button in the "General Settings" tab of the "CP/ACLR Setup" dialog box.



In the "Manage" dialog box you can save the current measurement settings as a user-defined standard, or load a stored measurement configuration. Furthermore, you can delete an existing configuration file.

For details see chapter 4.2.6.4, "How to Manage User-Defined Configurations", on page 76.

SCPI command:
To query all available standards:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?` on page 519
To load a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518
To save a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE` on page 519
To delete a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete` on page 519

Number of Channels (TX, ADJ)
Up to 18 carrier channels and up to 12 adjacent channels can be defined.

Results are provided for the TX channel and the number of defined adjacent channels *above and below* the TX channel. If more than one TX channel is defined, the carrier channel to which the relative adjacent-channel power values should be referenced must be defined (see "Reference Channel" on page 53).

Note: If several carriers (TX channels) are activated for the measurement, the number of sweep points is increased to ensure that adjacent-channel powers are measured with adequate accuracy.

For more information on how the number of channels affects the measured powers, see chapter 4.2.2, "Channel Power Results", on page 37.

SCPI command:
Number of TX channels:
`[SENSe:]POWer:ACHannel:TXCHannel:COUNt` on page 523
Number of Adjacent channels:
`[SENSe:]POWer:ACHannel:ACPairs` on page 520

Reference Channel
The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one TX channel is defined, you must select which one is to be used as a reference channel.

TX Channel 1	Transmission channel 1 is used. (Not available for MSR ACLR)
Min Power TX Channel	The transmission channel with the lowest power is used as a reference channel.
Max Power TX Channel	The transmission channel with the highest power is used as a reference channel (Default).
Lowest & Highest Channel	The outer left-hand transmission channel is the reference channel for the lower adjacent channels, the outer right-hand transmission channel that for the upper adjacent channels.

SCPI command:
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual` on page 525
`[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 525

Noise cancellation

The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors (see "Detector" on page 295):

- RMS
- Average
- Sample
- Positive Peak

SCPI command:

`[SENSe:]POWer:NCORrection` on page 640

Fast ACLR

If activated, instead of using the IBW method, the R&S FSW sets the center frequency to the different channel center frequencies consecutively and measures the power with the selected measurement time (= sweep time/number of channels).

SCPI command:

`[SENSe:]POWer:HSPeed` on page 531

Selected Trace

The CP/ACLR measurement can be performed on any active trace.

SCPI command:

`[SENSe:]POWer:TRACe` on page 517

Absolute and Relative Values (ACLR Mode)

The powers of the adjacent channels are output in dBm or dBm/Hz (absolute values), or in dBc, relative to the specified reference TX channel.

"Abs" The absolute power in the adjacent channels is displayed in the unit of the y-axis, e.g. in dBm, dBµV.

"Rel" The level of the adjacent channels is displayed relative to the level of the transmission channel in dBc.

SCPI command:

`[SENSe:]POWer:ACHannel:MODE` on page 540

Channel Power Levels and Density (Power Unit)

By default, the channel power is displayed in absolute values. If "/Hz" is activated, the channel power density is displayed instead. Thus, the absolute unit of the channel power is switched from dBm to dBm/Hz.

Note: The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:
"channel power density = channel power – $\log_{10}$(channel bandwidth)"

Thus you can measure the signal/noise power density, for example, or use the additional functions Absolute and Relative Values (ACLR Mode) and Reference Channel to obtain the signal to noise ratio.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 540

Power Mode

The measured power values can be displayed directly for each trace ("Clear/Write"), or only the maximum values over a series of measurements can be displayed ("Max Hold"). In the latter case, the power values are calculated from the current trace and compared with the previous power value using a maximum algorithm. The higher value is retained. If "Max Hold" mode is activated, "Pwr Max" is indicated in the table header. Note that the *trace* mode remains unaffected by this setting.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 514

Setting a Fixed Reference for Channel Power Measurements (Set CP Reference)

For pure channel power measurements (no adjacent channels defined) with only one TX channel, the currently measured channel power can be used as a fixed reference value for subsequent channel power measurements.

When you select this button, the channel power currently measured on the TX channel is stored as a fixed reference power. In the following channel power measurements, the power is indicated relative to the fixed reference power. The reference value is displayed in the "Reference" field (in relative ACLR mode); the default value is 0 dBm.

Note: In adjacent-channel power measurement, the power is always referenced to a transmission channel (see "Reference Channel" on page 53), thus, this function is not available.

SCPI command:
`[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE` on page 525

Optimized Settings (Adjust Settings)

All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically.

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

The following settings are optimized by "Adjust Settings":

- "Frequency Span" on page 44
- "Resolution Bandwidth (RBW)" on page 44
- "Video Bandwidth (VBW)" on page 45

- "Detector" on page 45
- "Trace Averaging" on page 46

Note: The reference level is not affected by this function. To adjust the reference level automatically, use the Setting the Reference Level Automatically (Auto Level) function in the AUTO SET menu.

SCPI command:

`[SENSe:]POWer:ACHannel:PRESet` on page 517

Sweep Time

With the RMS detector, a longer sweep time increases the stability of the measurement results. For recommendations on setting this parameter, see "Sweep Time" on page 43.

The sweep time can be set via the softkey in the "Ch Power" menu and is identical to the general setting in the "Sweep" configuration dialog box.

SCPI command:

`[SENSe:]SWEep:TIME` on page 636

4.2.4.2 Channel Setup

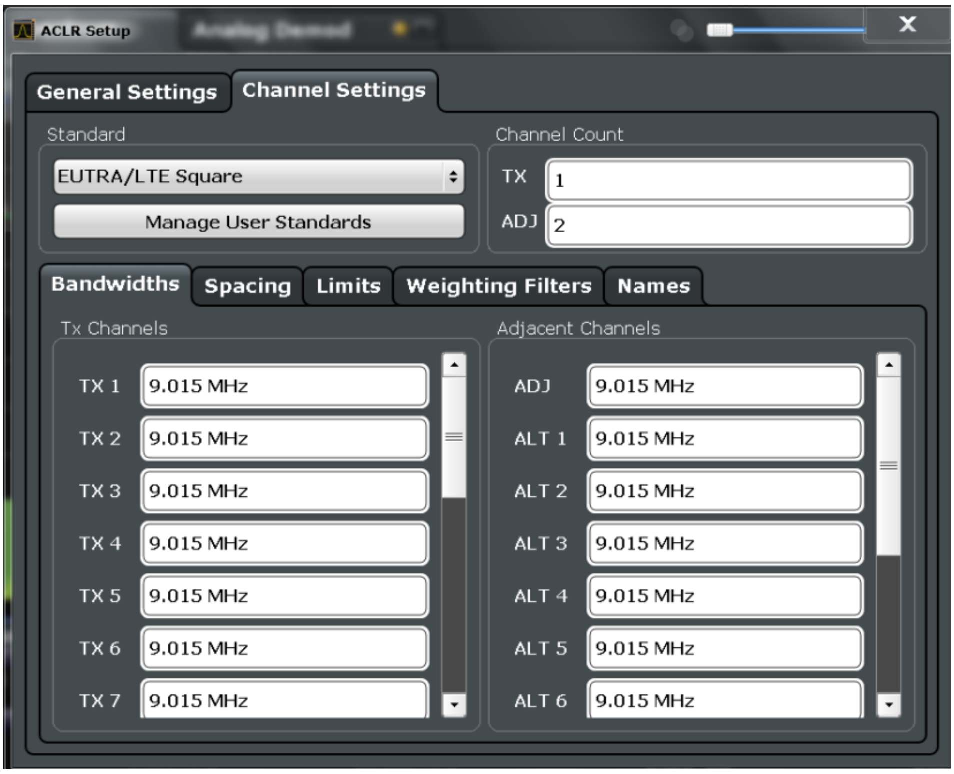
The "Channel Settings" tab in the "ACLR Setup" dialog box provides all the channel settings to configure the channel power or ACLR measurement. You can define the channel settings for all channels, independant of the defined number of *used* TX or adjacent channels (see "Number of Channels (TX, ADJ)" on page 53).

For details on setting up channels, see chapter 4.2.6.2, "How to Set up the Channels", on page 74.

In addition to the specific channel settings, the general settings "Standard" on page 51 and "Number of Channels (TX, ADJ)" on page 53 are also available in this tab.

The following settings are available in individual subtabs of the "Channel Settings" tab.

Channel Bandwidths



The Tx channel bandwidth is normally defined by the transmission standard. The correct bandwidth is set automatically for the selected standard. The bandwidth for each channel is indicated by a colored bar in the display.

For measurements that require channel bandwidths which deviate from those defined in the selected standard, use the IBW method ("Fast ACLR Off"). With the IBW method, the channel bandwidth borders are right and left of the channel center frequency. Thus, you can visually check whether the entire power of the signal under test is within the selected channel bandwidth.

The value entered for any TX channel is automatically also defined for all subsequent TX channels. Thus, only one value needs to be entered if all TX channels have the same bandwidth.

The value entered for any ADJ or ALT channel is automatically also defined for all alternate (ALT) channels. Thus, only one value needs to be entered if all adjacent channels have the same bandwidth.

SCPI command:

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] on page 521
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel on page 520
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch> on page 520

Channel Spacings

Channel spacings are normally defined by the selected standard but can be changed.

If the spacings are not equal, the channel distribution in relation to the center frequency is as follows:

Odd number of TX channels	The middle TX channel is centered to center frequency.
Even number of TX channels	The two TX channels in the middle are used to calculate the frequency between those two channels. This frequency is aligned to the center frequency.

The spacings between all TX channels can be defined individually. When you change the spacing for one channel, the value is automatically also defined for all subsequent TX channels in order to set up a system with equal TX channel spacing quickly. For different spacings, a setup from top to bottom is necessary.

TX1-2	spacing between the first and the second carrier
TX2-3	spacing between the second and the third carrier
...	...

If you change the adjacent-channel spacing (ADJ), all higher adjacent channel spacings (ALT1, ALT2, ...) are multiplied by the same factor (new spacing value/old spacing value). Again, only one value needs to be entered for equal channel spacing. For different spacing, configure the spacings from top to bottom.

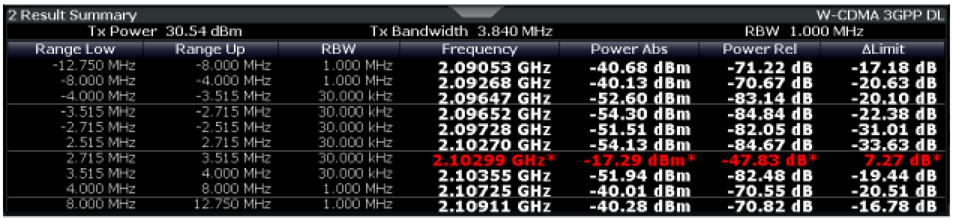
For details see chapter 4.2.6.2, "How to Set up the Channels", on page 74

SCPI command:

`[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>` on page 522
`[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` on page 521
`[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` on page 522

Limit Checking

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.



2 Result Summary — W-CDMA 3GPP DL

Tx Power 30.54 dBm — Tx Bandwidth 3.840 MHz — RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The results of the power limit checks are also indicated in the STAT:QUES:ACPL status registry (see "STATus:QUEStionable:ACPLimit Register" on page 453).

SCPI command:
CALCulate<n>:LIMit<k>:ACPower[:STATe] on page 530
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe on page 527
CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute on page 526
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe on page 528
CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] on page 527
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe on page 529
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute on page 528
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe on page 530
CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] on page 529
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? on page 527

Weighting Filters

Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Weighting filters are not available for all supported standards and cannot always be defined manually where they are available.

SCPI command:
Activating/Deactivating:
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> on page 525
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel on page 524
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> on page 524
Alpha value:
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> on page 524
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel on page 523
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> on page 523

Channel Names

In the R&S FSW's display, carrier channels are labelled "TX" by default; the first neighboring channel is labelled "Adj" (adjacent) channel; all others are labelled "Alt" (alternate) channels. You can define user-specific channel names for each channel which are displayed in the result diagram and result table.

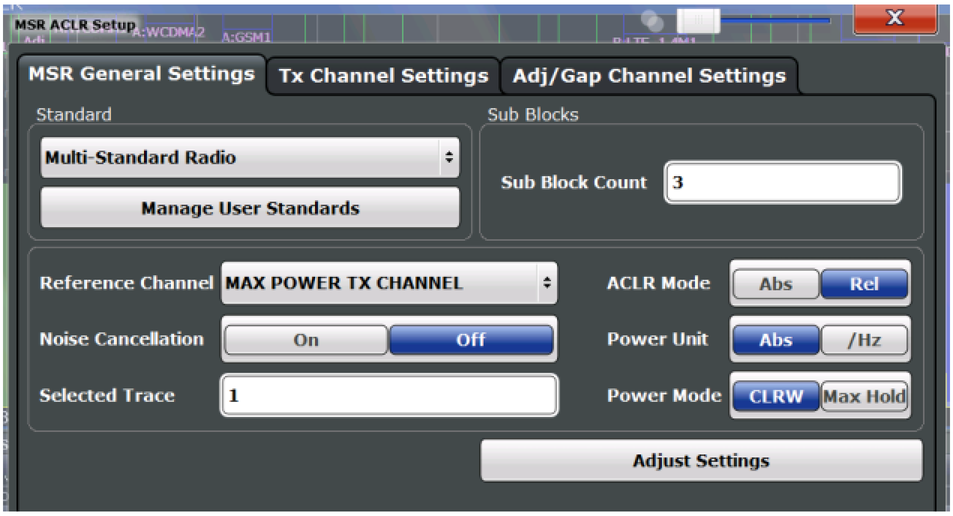
SCPI command:
[SENSe:]POWer:ACHannel:NAME:ACHannel on page 521
[SENSe:]POWer:ACHannel:NAME:ALTernate<ch> on page 521
[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> on page 521

4.2.5 MSR ACLR Configuration

ACLR measurements can also be performed on input containing multiple signals for different communication standards. A new measurement standard is provided that allows you to define multiple discontiguous transmit channels at specified frequencies, independant from the selected center frequency. If the "Multi-Standard Radio" standard is selected (see "Standard" on page 51), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box.

To display the "MSR ACLR Setup" dialog box dialog box, do one of the following:

- Select the "CP/ACLR Standard" softkey from the "CH Power" menu and select the "Multi-Standard Radio" standard. Then select the "CP/ACLR Config" softkey.
- Select the "CP/ACLR Config" softkey from the "CH Power" menu. Then select the "Multi-Standard Radio" standard from the "Standard" selection list.



For more information see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.

The remote commands required to perform these tasks are described in chapter 10.3.3, "Measuring the Channel Power and ACLR", on page 518.

4.2.5.1 General MSR ACLR Measurement Settings

General MSR ACLR measurement settings are defined in the "MSR ACLR Setup" dialog, in the "MSR General Settings" tab.

Standard
The main measurement settings can be stored as a standard file. When such a standard is loaded, the required channel and general measurement settings are automatically set on the R&S FSW. However, the settings can be changed. Predefined standards are available for standard measurements, but standard files with user-defined configurations can also be created.

Note: If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see chapter 4.2.5, "MSR ACLR Configuration", on page 60).
If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see chapter 4.2.4, "Channel Power Configuration", on page 49).

Note that changes in the configuration are not stored when the dialog boxes are exchanged.

Predefined Standards ← Standard
Predefined standards contain the main measurement settings for standard measurements. When such a standard is loaded, the required channel settings are automatically set on the R&S FSW. However, the settings can be changed.

The predefined standards contain the following settings:

- Channel bandwidths
- Channel spacings
- Detector
- Trace Average setting
- Resolution Bandwidth (RBW)
- Weighting Filter

Predefined standards can be selected via the "CP/ACLR Standard" softkey in the "CH Power" menu or in the "General Settings" tab of the "CP/ACLR Setup" dialog box.

For details on the available standards see chapter 4.2.8, "Reference: Predefined CP/ACLR Standards", on page 84.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518

User-Defined Standards ← Standard
In addition to the predefined standards you can save your own standards with your specific measurement settings in an xml file so you can use them again at a later time. User-defined standards are stored on the instrument in the `C:\R_S\instr\acp_std` directory.

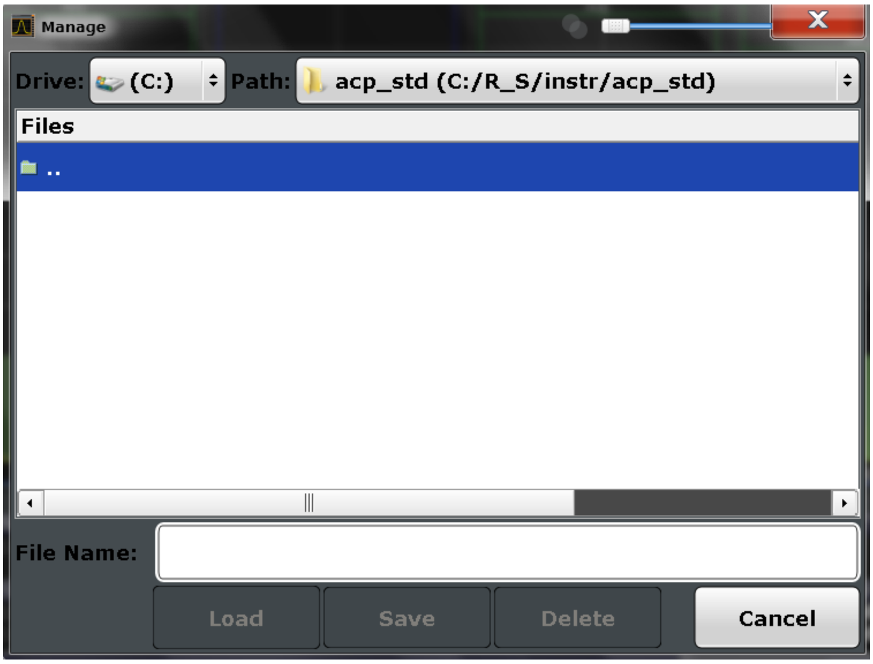
A sample file is provided for an MSR ACLR measurement (MSR_ACLRExample.xml). It sets up the measurement for the MSR signal generator waveform described in the file `C:\R_S\instr\user\waveform\MSRA_GSM_WCDMA_LET_GSM.wv`.

Note that ACLR user standards are not supported for Fast ACLR and Multi-Carrier ACLR measurements.

Note: User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSW. User standards created on an R&S FSW, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

The following parameter definitions are saved in a user-defined standard:
- Number of adjacent channels
- Channel bandwidth of transmission (Tx), adjacent (Adj) and alternate (Alt) channels
- Channel spacings
- Weighting filters
- Resolution bandwidth
- Video bandwidth
- Detector
- ACLR limits and their state
- Sweep time and sweep time coupling
- Trace and power mode
- (MSR only: subblock and gap channel definition)

User-defined standards are managed in the "Manage" dialog box which is displayed when you select the "Manage User Standards" button in the "General Settings" tab of the "CP/ACLR Setup" dialog box.



In the "Manage" dialog box you can save the current measurement settings as a user-defined standard, or load a stored measurement configuration. Furthermore, you can delete an existing configuration file.

For details see chapter 4.2.6.4, "How to Manage User-Defined Configurations", on page 76.

SCPI command:
To query all available standards:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog? on page 519
To load a standard:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet on page 518
To save a standard:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE on page 519
To delete a standard:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete on page 519

Number of Subblocks
Defines the number of subblocks, i.e. groups of transmission channels in an MSR signal.

For more information see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.

SCPI command:
[SENSe:]POWer:ACHannel:SBCount on page 536

Reference Channel
The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one TX channel is defined, you must select which one is to be used as a reference channel.

TX Channel 1	Transmission channel 1 is used. (Not available for MSR ACLR)
Min Power TX Channel	The transmission channel with the lowest power is used as a reference channel.
Max Power TX Channel	The transmission channel with the highest power is used as a reference channel (Default).
Lowest & Highest Channel	The outer left-hand transmission channel is the reference channel for the lower adjacent channels, the outer right-hand transmission channel that for the upper adjacent channels.

SCPI command:
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual on page 525
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO on page 525

Noise cancellation
The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors (see "Detector" on page 295):

- RMS
- Average
- Sample
- Positive Peak

SCPI command:
`[SENSe:]POWer:NCORrection` on page 640

Selected Trace
The CP/ACLR measurement can be performed on any active trace.

SCPI command:
`[SENSe:]POWer:TRACe` on page 517

Absolute and Relative Values (ACLR Mode)
The powers of the adjacent channels are output in dBm or dBm/Hz (absolute values), or in dBc, relative to the specified reference TX channel.

"Abs"	The absolute power in the adjacent channels is displayed in the unit of the y-axis, e.g. in dBm, dBµV.
"Rel"	The level of the adjacent channels is displayed relative to the level of the transmission channel in dBc.

SCPI command:
`[SENSe:]POWer:ACHannel:MODE` on page 540

Channel Power Levels and Density (Power Unit)
By default, the channel power is displayed in absolute values. If "/Hz" is activated, the channel power density is displayed instead. Thus, the absolute unit of the channel power is switched from dBm to dBm/Hz.

Note: The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:
"channel power density = channel power – $\log_{10}$(channel bandwidth)"

Thus you can measure the signal/noise power density, for example, or use the additional functions Absolute and Relative Values (ACLR Mode) and Reference Channel to obtain the signal to noise ratio.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 540

Power Mode

The measured power values can be displayed directly for each trace ("Clear/Write"), or only the maximum values over a series of measurements can be displayed ("Max Hold"). In the latter case, the power values are calculated from the current trace and compared with the previous power value using a maximum algorithm. The higher value is retained. If "Max Hold" mode is activated, "Pwr Max" is indicated in the table header. Note that the *trace* mode remains unaffected by this setting.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 514

Optimized Settings (Adjust Settings)

All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically.

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

The following settings are optimized by "Adjust Settings":

- "Frequency Span" on page 44
- "Resolution Bandwidth (RBW)" on page 44
- "Video Bandwidth (VBW)" on page 45
- "Detector" on page 45
- "Trace Averaging" on page 46

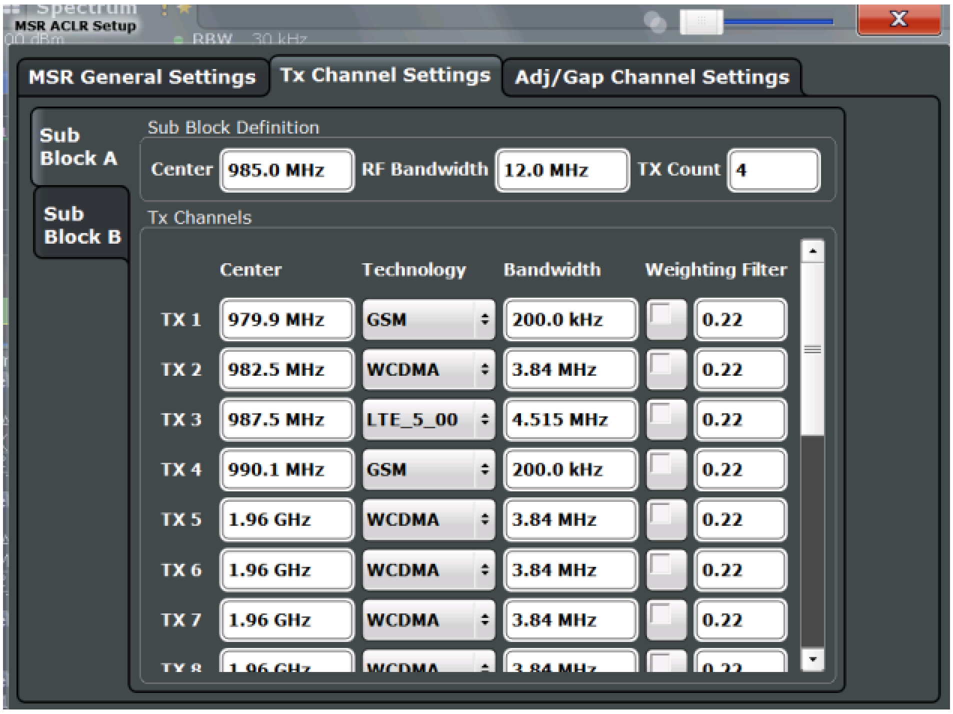
Note: The reference level is not affected by this function. To adjust the reference level automatically, use the Setting the Reference Level Automatically (Auto Level) function in the AUTO SET menu.

SCPI command:

`[SENSe:]POWer:ACHannel:PRESet` on page 517

4.2.5.2 MSR Subblock and Tx Channel Definition

The "Tx Channel Settings" tab in the "MSR ACLR Setup" dialog box provides all the channel settings to configure subblocks and Tx channels in MSR ACLR measurements.



For details on MSR signals see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.

For details on setting up channels, see chapter 4.2.6.3, "How to Configure an MSR ACLR Measurement", on page 75.

The Tx channel settings for the individual subblocks are configured in individual subtabs of the "Tx Channel Settings" tab.

Subblock Definition

Subblocks are groups of transmit channels in an MSR signal. Up to 5 subblocks can be defined. They are defined as an RF bandwidth around a center frequency with a specific number of transmit channels (max. 18).

Subblocks are named A,B,C,D,E and are indicated by a slim blue bar along the frequency axis.

Subblock Center Frequency ← Subblock Definition
Defines the center of an MSR subblock. Note that the position of the subblock also affects the position of the adjacent gap channels (CACLR).

SCPI command:
[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer on page 537

RF Bandwidth ← Subblock Definition
Defines the bandwidth of the individual MSR subblock. Note that subblock ranges also affect the position of the adjacent gap channels (CACLR).

SCPI command:
[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth on page 538

Number of Tx Channels (Tx Count) ← Subblock Definition
Defines the number of transmit channels the specific subblock contains. The maximum is 18 Tx channels.

SCPI command:
[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt on page 539

Tx Channel Definition
As opposed to common ACLR channel definitions, the TX channels are defined at absolute frequencies, rather than by a spacing relative to the (common) center frequency. Each transmit channel can be assigned a different technology, used to predefine the required bandwidth.

The Tx channel settings for the individual subblocks are configured in individual subtabs of the "Tx Channel Settings" tab.

For details on configuring MSR Tx channels see chapter 4.2.6.3, "How to Configure an MSR ACLR Measurement", on page 75.

Note: Channel names. In MSR ACLR measurements, TX channel names correspond to the specified technology (for LTE including the bandwidth), followed by a consecutive number. (If the channel is too narrow to display the channel name, it is replaced by "..." on the screen.) Channel names cannot be defined manually. The assigned subblock (A,B,C,D,E) is indicated with the channel name (e.g. B:LTE_5M1).

SCPI command:
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]? on page 537

Tx Center Frequency ← Tx Channel Definition
Defines the (absolute) center frequency of an MSR Tx channel. Each Tx channel is defined independantly of the others; automatic spacing as in common ACLR measurements is not performed.

Note that the position of the first Tx channel in the first subblock and the last Tx channel in the last subblock also affect the position of the adjacent channels.

SCPI command:
[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] on page 536

Technology Used for Transmission ← Tx Channel Definition

The technology used for transmission by the individual channel can be defined for each channel. The required channel bandwidth and use of a weighting filter are preconfigured automatically according to the selected technology standard.

"GSM"	Transmission according to GSM standard
"WCDMA"	Transmission according to WCDMA standard
"LTE_1_40""LTE_3_00""LTE_5_00""LTE_10_00""LTE_15_00""LTE_20_00"	Transmission according to LTE standard for different channel band-widths
"USER"	User-defined transmission; no automatic preconfiguration possible

SCPI command:

[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>] on page 538

Tx Channel Bandwidth ← Tx Channel Definition

The Tx channel bandwidth is normally defined by the transmission technology standard. The correct bandwidth is predefined automatically for the selected technology. Each Tx channel is defined independantly of the others; automatic bandwidth configuration for subsequent channels as in common ACLR measurements is not performed.

The bandwidth for each channel is indicated by a colored bar in the display.

SCPI command:

[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>] on page 536

Weighting Filters ← Tx Channel Definition

Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

SCPI command:

Activating/Deactivating:

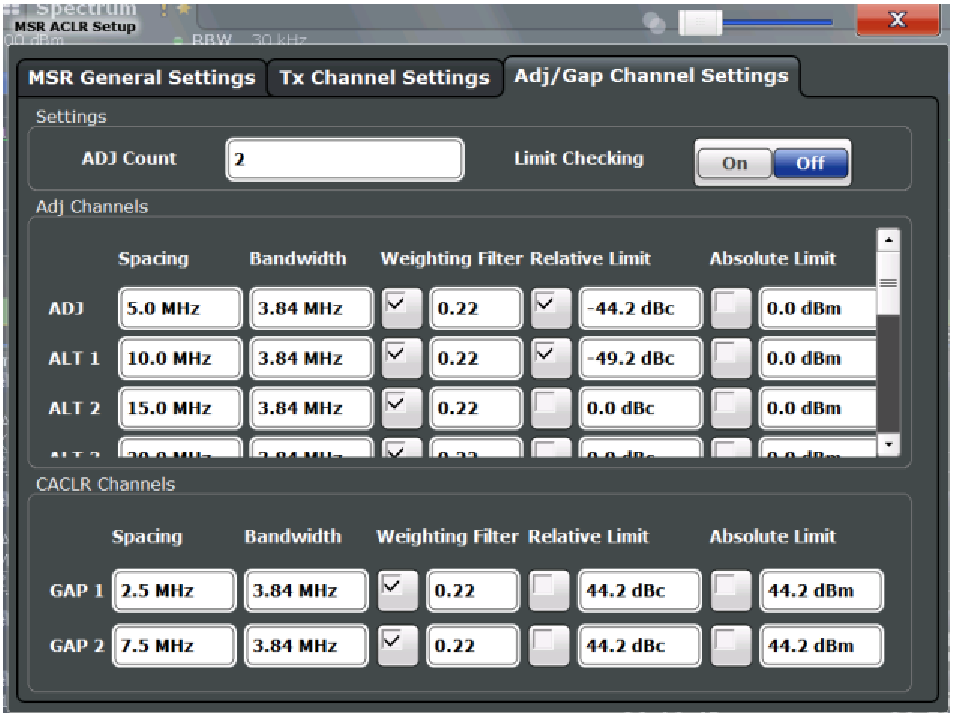
[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch> on page 536

Alpha value:

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch> on page 535

4.2.5.3 MSR Adjacent and Gap Channel Setup

The "Adj/Gap Channel Settings" tab in the "MSR ACLR Setup" dialog box provides all the channel settings to configure adjacent and gap (CACLR) channels in MSR ACLR measurements.



For details on MSR signals see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.

For details on setting up channels see chapter 4.2.6.3, "How to Configure an MSR ACLR Measurement", on page 75.

Number of Adjacent Channels (ADJ Count)

Defines the number of adjacent channels *above and below* the Tx channel block in an MSR signal. The carrier channel to which the relative adjacent-channel power values should be referenced must be defined (see "Reference Channel" on page 53).

SCPI command:

`[SENSe:]POWer:ACHannel:ACPairs` on page 520

Limit Checking

Activates or deactivates limit checks globally for all adjacent and gap (CACLR) channels. In addition, limits must be defined and activated individually for each channel.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit Register" on page 453).

SCPI command:

`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 530

Adjacent Channel Definition

Defines the channels adjacent to the transmission channel block in MSR signals. A maximum of 12 adjacent channels can be defined.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

The lower adjacent channels are defined in relation to the CF of the first Tx channel in the first subblock.

The upper adjacent channels are defined in relation to the CF of the last Tx channel in the last subblock.

Adjacent channels are named "Adj" and "Alt1" to "Alt11"; the names cannot be changed manually.

In all other respects, channel definition is identical to common ACLR measurements.

Adjacent Channel Spacings ← Adjacent Channel Definition

Channel spacings are normally predefined by the selected technology but can be changed.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

The spacing of the lower adjacent channels refers to the CF of the first Tx channel in the first subblock.

The spacing of the upper adjacent channels refers to the CF of the last Tx channel in the last subblock.

If you change the adjacent-channel spacing (ADJ), all higher adjacent channel spacings (ALT1, ALT2, ...) are multiplied by the same factor (new spacing value/old spacing value). Again, only one value needs to be entered for equal channel spacing. For different spacing, configure the spacings from top to bottom.

For details see chapter 4.2.6.3, "How to Configure an MSR ACLR Measurement", on page 75

SCPI command:

`[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` on page 521

`[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` on page 522

Adjacent Channel Bandwidths ← Adjacent Channel Definition

The adjacent channel bandwidth is normally predefined by the transmission technology standard. The correct bandwidth is set automatically for the selected technology. The bandwidth for each channel is indicated by a colored bar in the display.

The value entered for any ADJ or ALT channel is automatically also defined for all subsequent alternate (ALT) channels. Thus, only one value needs to be entered if all adjacent channels have the same bandwidth.

SCPI command:

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel` on page 520

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch>` on page 520

Weighting Filters ← Adjacent Channel Definition

Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

SCPI command:

Activating/Deactivating:

`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` on page 524

`[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>` on page 524

Alpha value:

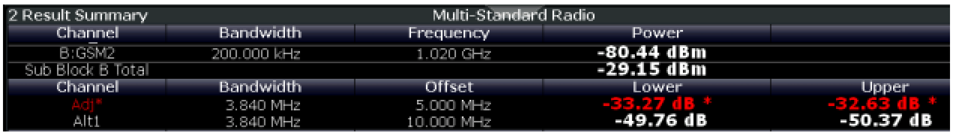
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel` on page 523

`[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>` on page 523

Limit Checking ← Adjacent Channel Definition

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both, for each individual adjacent channel. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.

Note that in addition to activating limit checking for individual channels, limit checking must also be activated globally for the MSR ACLR measurement (see "Limit Checking" on page 69).



2 Result Summary		Multi-Standard Radio		
Channel	Bandwidth	Frequency	Power	
B:GSM2	200.000 kHz	1.020 GHz	-80.44 dBm	
Sub Block B Total			-29.15 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj*	3.840 MHz	5.000 MHz	-33.27 dB *	-32.63 dB *
Alt1	3.840 MHz	10.000 MHz	-49.76 dB	-50.37 dB

SCPI command:

`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 530

`CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe` on page 527

`CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute` on page 526

`CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe` on page 528

`CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]` on page 527

`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe` on page 529

`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute` on page 528

`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe` on page 530

`CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]` on page 529

`CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?` on page 527

Gap (CACLR) Channel Definition

Between two subblocks in an MSR signal, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn contains 2 channels, the *CACLR channels*. The channels in the upper gap are identical to those in the lower gap, but inverted. Thus, in the R&S FSW MSR ACLR measurement, only 2 gap channels are configured.

Gap channels (CACLR) are indicated by the names of the surrounding subblocks (e.g. "AB" for the gap between subblocks A and B), followed by the channel name ("Gap1" or "Gap2") and an "L" (for lower) or a "U" (for upper). Both the lower and upper gap channels are displayed. However, if the gap between two subblocks is too narrow, the second gap channel may not be displayed. If the gap is even narrower, no gap channels are displayed.

Gap (CACLR) Channel Spacings ← Gap (CACLR) Channel Definition

CACLR channel spacings are normally predefined by the MSR standard but can be changed.

CACLR channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding subblocks. Since the upper and lower CACLR channels are identical, only two channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)

Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)

(See also figure 4-5 and figure 4-6.)

For details see chapter 4.2.6.3, "How to Configure an MSR ACLR Measurement", on page 75.

SCPI command:

`[SENSe:]POWer:ACHannel:SPACing:GAP<gap>` on page 539

Gap (CACLR) Channel Bandwidths ← Gap (CACLR) Channel Definition

The gap channel bandwidth is normally predefined by the transmission technology standard. The correct bandwidth is set automatically for the selected technology. The bandwidth for each channel is indicated by a colored bar in the display (if the gap is not too narrow, see "Channel display for MSR signals" on page 48).

SCPI command:

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap>` on page 534

Weighting Filters ← Gap (CACLR) Channel Definition

Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel you can activate or deactivate the use of the weighting filter and define an individual weighting factor ("Alpha" value).

SCPI command:

`[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap>` on page 535

`[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>` on page 535

Limit Checking ← Gap (CACLR) Channel Definition

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both, for each individual gap channel. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.

Note that in addition to activating limit checking for individual channels, limit checking must also be activated globally for the MSR ACLR measurement (see "Limit Checking" on page 69).

SCPI command:

`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 530

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe` on page 532

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute` on page 532

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RELative:STATe` on page 533

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RELative` on page 533

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?` on page 534

4.2.6 How to Perform Channel Power Measurements

The following step-by-step instructions demonstrate the most common tasks when performing channel power measurements.

4.2.6.1 How to Perform a Standard Channel Power Measurement

Performing a channel power or ACLR measurement according to common standards is a very easy and straightforward task with the R&S FSW.

1. Press the MEAS key or tap "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
   The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select a standard from the list.
   The measurement is restarted with the predefined settings for the selected standard.
4. If necessary, edit the settings for your specific measurement as described in chapter 4.2.6.2, "How to Set up the Channels", on page 74, or load a user-defined configuration (see "To load a user-defined configuration" on page 77).

4.2.6.2 How to Set up the Channels

Channel definition is the basis for measuring power levels in certain frequency ranges. Usually, the power levels in one or more carrier (TX) channels and possibly the adjacent channels are of interest. Up to 18 carrier channels and up to 12 adjacent channels can be defined.

When a measurement standard is selected in the "Ch Power" menu or the "ACLR Setup" dialog box, all settings including the channel bandwidths and channel spacings are set according to the selected standard and can be adjusted afterwards.

Channel setup consists of the following settings:

- The number of transmission (TX) and adjacent channels
- The bandwidth of each channel
- For multi-carrier ACLR measurements: which TX channel is used as a reference
- The spacing between the individual channels
- Optionally: the names of the channels displayed in the diagram and result table
- Optionally: the influence of individual channels on the total measurement result ("Weighting Filter")
- Optionally: limits for a limit check on the measured power levels

Changes to an existing standard can be stored as a user-defined standard, see chapter 4.2.6.4, "How to Manage User-Defined Configurations", on page 76.

► In the "Ch Power" menu, select the "CP / ACLR Config" softkey, then select the "Channel Settings" tab to configure the channels in the "ACLR Setup" dialog box.

In the "Channel Setup" dialog box you can define the channel settings for all channels, independant of the defined number of *used* TX or adjacent channels.

To define channel spacings

Channel spacings are normally defined by the selected standard but can be changed.

► In the "Channel Settings" tab of the "ACLR Setup" dialog box, select the "Spacing" subtab.
The value entered for any TX channel is automatically also defined for all subsequent TX channels. Thus, only one value needs to be entered if all TX channels have the same spacing.
If the channel spacing for the adjacent or an alternate channel is changed, all higher alternate channel spacings are multiplied by the same factor (new spacing value/old spacing value). The lower adjacent-channel spacings remain unchanged. Only one value needs to be entered for equal channel spacing.

Example: Defining channel spacing

In the default setting, the adjacent channels have the following spacing: 20 kHz ("ADJ"), 40 kHz ("ALT1"), 60 kHz ("ALT2"), 80 kHz ("ALT3"), 100 kHz ("ALT4"), ...

If the spacing of the first adjacent channel ("ADJ") is set to 40 kHz, the spacing of all other adjacent channels is multiplied by factor 2 to result in 80 kHz ("ALT1"), 120 kHz ("ALT2"), 160 kHz ("ALT3"), ...

If, starting from the default setting, the spacing of the 5th adjacent channel ("ALT4") is set to 150 kHz, the spacing of all higher adjacent channels is multiplied by factor 1.5 to result in 180 kHz ("ALT5"), 210 kHz ("ALT6"), 240 kHz ("ALT7"), ...

4.2.6.3 How to Configure an MSR ACLR Measurement

Performing an ACLR measurement on MSR signals is supported by a special configuration with the R&S FSW.

1. Press the MEAS key or tap "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
   The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select the "Multi-Standard Radio" standard from the list.
4. Select the "CP / ACLR Config" softkey to configure general MSR settings, including the number of subblocks (up to 5).
5. Select the "Tx Channel Settings" tab to configure the subblocks and transmission channels.
   For each subblock:
   a) Define the (center frequency) position and bandwidth of the subblock, as well as the number of transmission channels it contains.
   b) For each transmission channel in the subblock, define the center frequency and select the technology used for transmission. If necessary, edit the bandwidth and define the use of a weighting filter for the channel.

6. Select the "Adj/Gap Channel Settings" tab to configure the adjacent and gap (CACLR) channels.
7. Define the number of adjacent channels and the settings for each channel:
   - The spacing, defined as the distance from the center frequency of the first transmission channel in the first subblock. If the distance between each adjacent channel and the next is identical, you only need to define the spacing for the first adjacent channel, the others are adapted automatically.
   - The bandwidth; if it is identical for all adjacent channels, you only need to define the bandwidth for the first channel, the others are adapted automatically.
   - If necessary, a weighting filter
   - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
8. Define the settings for the two (upper or lower) gap (CACLR) channels; since the upper and lower channels are identical, it is only necessary to configure two channels.
   - The spacing, defined as the distance from the outer edge of the subblock to the left or right of the gap. The required spacing can be determined as follows: Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)
   - The bandwidth
   - If necessary, a weighting filter
   - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
9. If power limits are defined and activated, activate global limit checking for the measurement on the "Adj/Gap Channel Settings" tab.
10. Optionally, store the settings for the MSR ACLR measurement as a user-defined standard as described in "To store a user-defined configuration" on page 77. Otherwise the configuration will be lost when you select a different measurement standard!

4.2.6.4 How to Manage User-Defined Configurations

You can define measurement configurations independently of a predefinded standard and save the current ACLR configuration as a "user standard" in an xml file. You can then load the file and thus the settings again at a later time.

User-defined standards are not supported for "Fast ACLR" and Multi-Carrier ACLR measurements.

Compatibility to R&S FSP

User standards created on an analyzer of the R&S FSP family are compatible to the R&S FSW. User standards created on an R&S FSW, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

To store a user-defined configuration

1. In the "Ch Power" menu, select the "CP / ACLR Config" softkey to display the "ACLR Setup" dialog box.
2. Configure the measurement as required (see also chapter 4.2.6.2, "How to Set up the Channels", on page 74).
3. In the "General Settings" tab, select the "Manage User Standards" button to display the "Manage" dialog box.
4. Define a file name for the user standard and select its storage location.
   By default, the xml file is stored in `C:\R_S\Instr\acp_std\`. However, you can define any other storage location.
5. Select "Save".

To load a user-defined configuration

1. In the "General Settings" tab of the "ACLR Setup" dialog box, select the "Manage User Standards" button to display the "Manage" dialog box.
2. Select the user standard file.
3. Select "Load".

   The stored settings are automatically set on the R&S FSW and the measurement is restarted with the new parameters.

4.2.6.5 How to Compare the TX Channel Power in Successive Measurements

For pure channel power measurements, where no adjacent channels and only one TX channel is defined, you can define a fixed reference power and compare subsequent measurement results to the stored reference power.

1. Configure a measurement with only one TX channel and no adjacent channels (see also chapter 4.2.6.2, "How to Set up the Channels", on page 74).
2. Select the "Set CP Reference" softkey in the "Ch Power" menu, or the "Set CP Reference" button in the "ACLR Setup" dialog box.

   The channel power currently measured on the TX channel is stored as a fixed reference power. The reference value is displayed in the "Reference" field of the result table (in relative ACLR mode).
3. Start a new measurement.

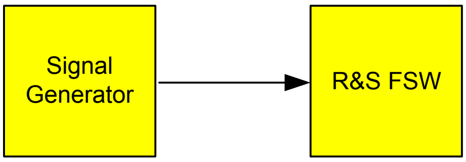
   The resulting power is indicated relative to the fixed reference power.
4. Repeat this for any number of measurements.
5. To start a new measurement without the fixed reference, temporarily define a second channel or preset the instrument.

4.2.7 Measurement Examples

The R&S FSW has test routines for simple channel and adjacent channel power measurements. These routines give quick results without any complex or tedious setting procedures.

4.2.7.1 Measurement Example 1 – ACPR Measurement on an CDMA2000 Signal

Test setup:



Signal generator settings (e.g. R&S SMU):

Frequency:	850 MHz
Level:	0 dBm
Modulation:	CDMA2000

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *850 MHz*.
3. Set the span to *4 MHz*.
4. Set the reference level to *+10 dBm*.
5. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
6. Set the "CDMA2000 1X" standard for adjacent channel power measurement in the "ACLR Setup" dialog box.

   The R&S FSW sets the channel configuration according to the 2000 standard with 2 adjacent channels above and 2 below the transmit channel. The spectrum is displayed in the upper part of the screen, the numeric values of the results and the channel configuration in the lower part of the screen. The various channels are represented by vertical lines on the graph.

The frequency span, resolution bandwidth, video bandwidth and detector are selected automatically to give correct results. To obtain stable results – especially in the adjacent channels (30 kHz bandwidth) which are narrow in comparison with the transmission channel bandwidth (1.23 MHz) – the RMS detector is used.

7. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function in the AUTO SET menu.

8. Activate "Fast ACLR" mode in the "ACLR Setup" dialog box to increase the repeatability of results.

   The R&S FSW sets the optimal RF attenuation and the reference level based on the transmission channel power to obtain the maximum dynamic range. The figure 4-7 shows the result of the measurement.

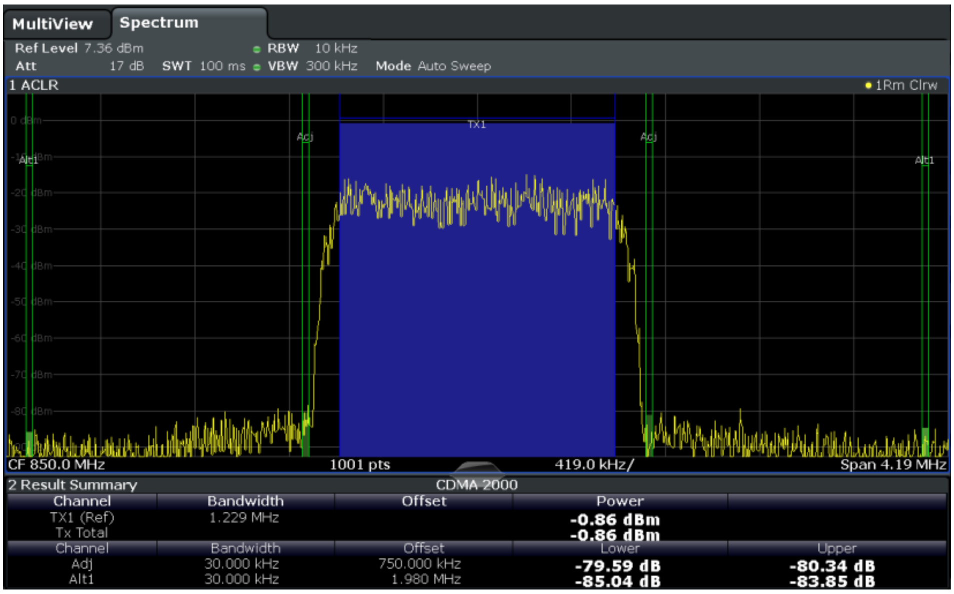
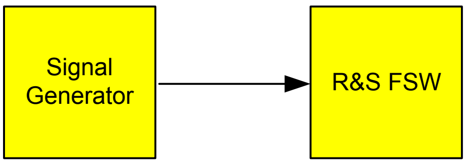


Fig. 4-7: Adjacent channel power measurement on a CDMA2000 1x signal

4.2.7.2 Measurement Example 2 – Measuring Adjacent Channel Power of a W-CDMA Uplink Signal

Test setup:



Signal generator settings (e.g. R&S FSW SMU):

Frequency:	1950 MHz
Level:	4 dBm
Modulation:	3 GPP W-CDMA Reverse Link

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *1950 MHz*.
3. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
4. Set the "W-CDMA 3GPP REV" standard for adjacent channel power measurement in the "ACLR Setup" dialog box.

   The R&S FSW sets the channel configuration to the 3GPP W-CDMA standard for mobiles with two adjacent channels above and below the transmit channel. The frequency span, the resolution and video bandwidth and the detector are automatically set to the correct values. The spectrum is displayed in the upper window and the channel power, the level ratios of the adjacent channel powers and the channel configuration in the lower window. The individual channels are displayed as bars in the graph.
5. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function.

   The R&S FSW sets the optimum RF attenuation and the reference level for the power in the transmission channel to obtain the maximum dynamic range. The following figure shows the result of the measurement.

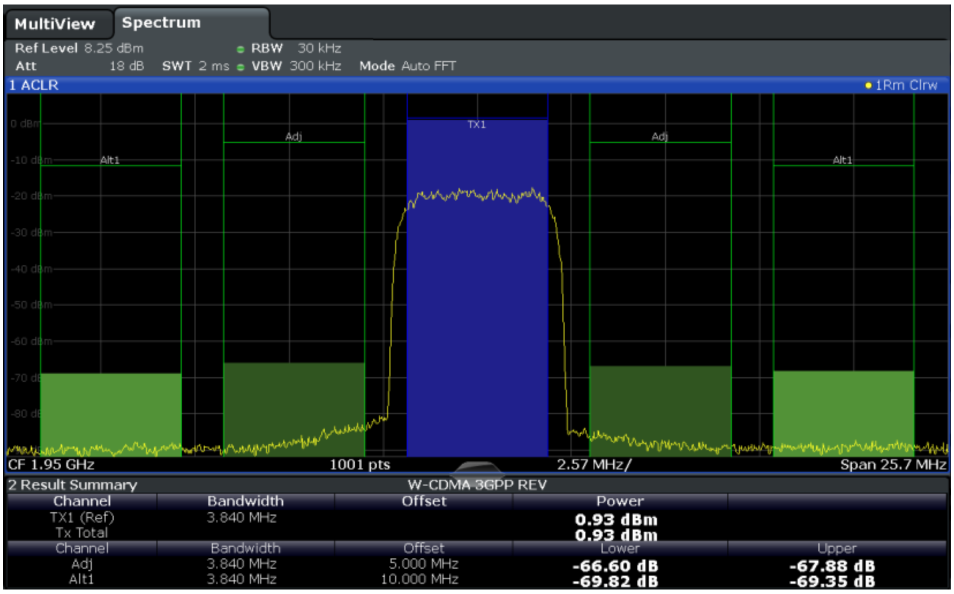


Fig. 4-8: Measuring the relative adjacent channel power on a W-CDMA uplink signal

The R&S FSW measures the power of the individual channels with zero span. A root raised cosine filter with the parameters α = 0.22 and chip rate 3.84 Mcps (= receive filter for 3GPP W-CDMA) is used as channel filter.

Optimum Level Setting for ACLR Measurements on W-CDMA Signals

The dynamic range for ACLR measurements is limited by the thermal noise floor, the phase noise and the intermodulation (spectral regrowth) of the signal analyzer. The power values produced by the R&S FSW due to these factors accumulate linearly. They depend on the applied level at the input mixer. The three factors are shown in the figure below for the adjacent channel (5 MHz carrier offset).

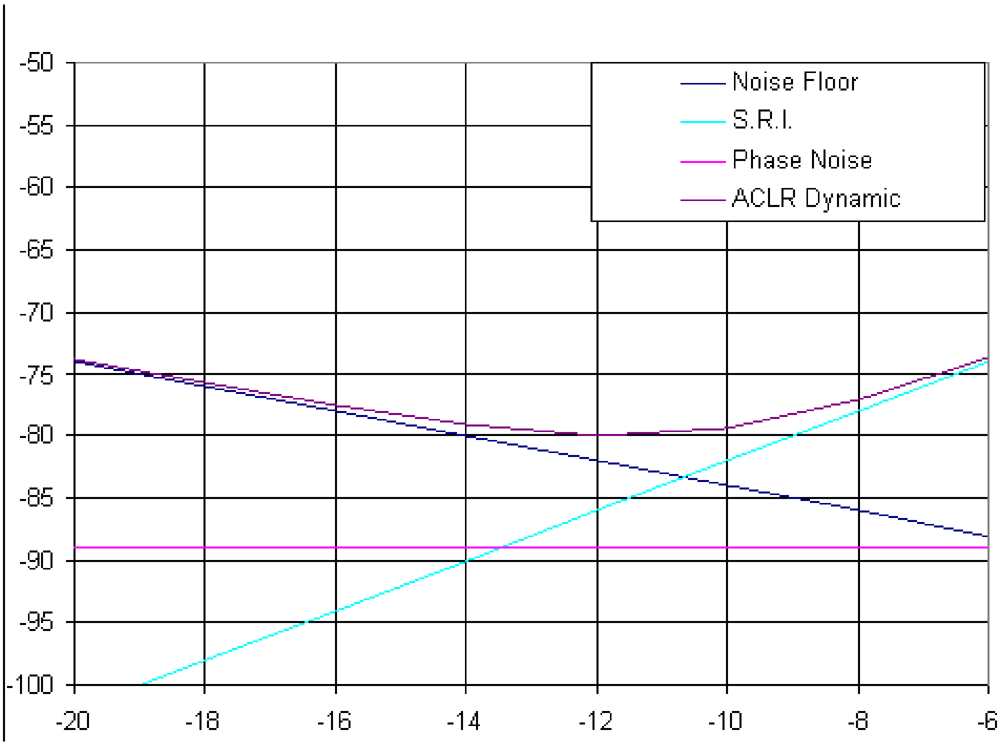


Fig. 4-9: Dynamic range for ACLR measurements on W-CDMA uplink signals as a function of the mixer level

The level of the W-CDMA signal at the input mixer is shown on the horizontal axis, i.e. the measured signal level minus the selected RF attenuation. The individual components which contribute to the power in the adjacent channel and the resulting relative level (total ACPR) in the adjacent channel are displayed on the vertical axis. The optimum mixer level is -12 dBm. The relative adjacent channel power (ACPR) at an optimum mixer level is -77 dBc. Since, at a given signal level, the mixer level is set in 1 dB steps with the 1 dB RF attenuator, the optimum range spreads from -10 dBm to -14 dBm.

To set the attenuation parameter manually, the following method is recommended:

► Set the RF attenuation so that the mixer level (= measured channel power – RF attenuation) is between -10 dBm and -14 dBm.

This method is automated with the "Auto Level" function. Especially in remote control mode, e.g. in production environments, it is best to correctly set the attenuation parameters prior to the measurement, as the time required for automatic setting can be saved.

To measure the R&S FSW's intrinsic dynamic range for W-CDMA adjacent channel power measurements, a filter which suppresses the adjacent channel power is required at the output of the transmitter. A SAW filter with a bandwidth of 4 MHz, for example, can be used.

4.2.7.3 Measurement Example 3 – Measuring the Intrinsic Noise of the R&S FSW with the Channel Power Function

Noise in any bandwidth can be measured with the channel power measurement functions. Thus the noise power in a communication channel can be determined, for example. If the noise spectrum within the channel bandwidth is flat, the noise marker can be used to determine the noise power in the channel by considering the channel bandwidth. If, however, phase noise and noise that normally increases towards the carrier is dominant in the channel to be measured, or if there are discrete spurious signals in the channel, the channel power measurement method must be used to obtain correct measurement results.

Test setup:

► Leave the RF input of the R&S FSW open-circuited or terminate it with 50 Ω.

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *1 GHz* and the span to *1 MHz*.
3. To obtain maximum sensitivity, set RF attenuation to *0 dB* and the reference level to *-40 dBm*.
4. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
5. In the "ACLR Setup" dialog box, set up a single TX channel with the channel bandwidth *1.23 MHz*.
6. Select the "Adjust Settings" softkey.
   The settings for the frequency span, the bandwidth (RBW and VBW) and the detector are automatically set to the optimum values required for the measurement.
7. Stabilize the measurement result by increasing the sweep time.
   Set the sweep time to *1 s*.

   The trace becomes much smoother because of the RMS detector and the channel power measurement display is much more stable.

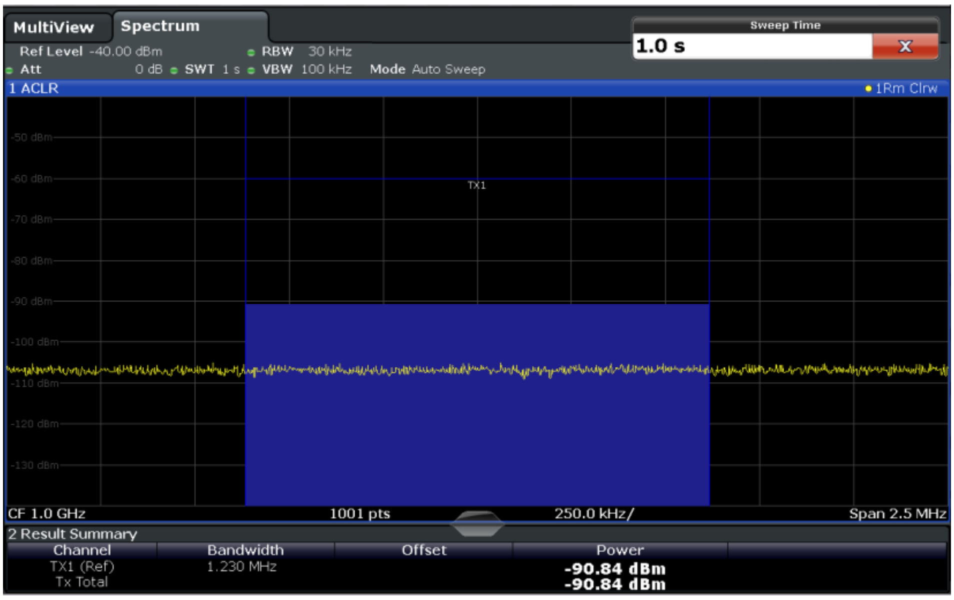


Fig. 4-10: Measurement of the R&S FSW's intrinsic noise power in a 1.23 MHz channel bandwidth.

4.2.8 Reference: Predefined CP/ACLR Standards

When using predefined standards for ACLR measurement, the test parameters for the channel and adjacent-channel measurements are configured automatically.

You can select a predefined standard via the "CP / ACLR Standard" softkey in the "Ch Power" menu or the selection list in the "General Settings" tab of the "ACLR Setup" dialog box (see "Standard" on page 51).

Table 4-2: Predefined CP / ACLR standards with remote command parameters

Standard	Remote parameter
None	NONE
Multi-Standard Radio	MSR
EUTRA/LTE Square	EUTRa
EUTRA/LTE Square/RRC	REUTra
W-CDMA 3GPP FWD	FW3Gppcdma
W-CDMA 3GPP REV	RW3Gppcdma
CDMA IS95A FWD	F8CDma
CDMA IS95A REV	R8CDma
CDMA IS95C Class 0 FWD	FIS95c0
CDMA IS95C Class 0 REV	RIS95c0
CDMA J-STD008 FWD	F19Cdma
CDMA J-STD008 REV	R19Cdma

Standard	Remote parameter
CDMA IS95C Class 1 FWD	FIS95c1
CDMA IS95C Class 1 REV	RIS95c1
CDMA2000	S2CDma
TD-SCDMA FWD	FTCDma
TD-SCDMA REV	TRCDma
WLAN 802.11A	AWLAN
WLAN 802.11B	BWLAN
WIMAX	WIMax
WIBRO	WIBRo
GSM	GSM
RFID 14443	RFID14443
TETRA	TETRa
PDC	PDC
PHS	PHS
CDPD	CDPD
APCO-25 P2	PAPCo25
User Standard	USER
Customized Standard	<string>

For the R&S FSW, the channel spacing is defined as the distance between the center frequency of the adjacent channel and the center frequency of the transmission channel. The definition of the adjacent-channel spacing in standards IS95C and CDMA 2000 is different. These standards define the adjacent-channel spacing from the center of the transmission channel to the closest border of the adjacent channel. This definition is also used by the R&S FSW for the standards marked with an asterisk ***)**.

4.3 Carrier-to-Noise Measurements

The R&S FSW can easily determine the carrier-to-noise ratio, also normalized to a 1 Hz bandwidth.

4.3.1 About the Measurement

The largest signal in the frequency span is the carrier. It is searched when the C/N or C/NO function is activated and is marked using a fixed reference marker ("FXD").

To determine the noise power, a channel with a defined bandwidth at the defined center frequency is analyzed. The power within this channel is integrated to obtain the noise power level. (If the carrier is within this channel, an extra step is required to determine the correct noise power level, see below.)

The noise power of the channel is subtracted from the maximum carrier signal level, and in the case of a C/N_O measurement, it is referred to a 1 Hz bandwidth.

For this measurement, the RMS detector is activated.

The carrier-to-noise measurements are only available in the frequency domain (span >0).

Measurement process

Depending on whether the carrier is inside or outside the analyzed channel, the measurement process for the carrier-to-noise ratio varies:

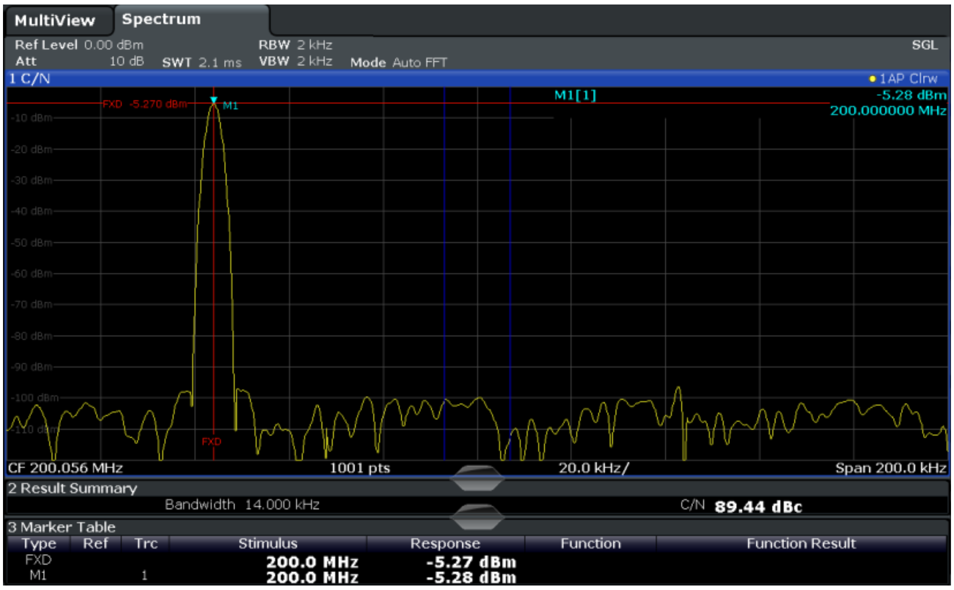
- The carrier is outside the analyzed channel: In this case, it is sufficient to switch on the desired measurement function and to set the channel bandwidth. The carrier/noise ratio is displayed on the screen.
- The carrier is inside the analyzed channel: In this case, the measurement must be performed in two steps:
  - First, perform the reference measurement by switching on either the C/N or the C/NO measurement and waiting for the end of the next measurement run. The fixed reference marker is set to the maximum of the measured carrier signal.
  - Then, switch off the carrier so that only the noise of the test setup is active in the channel. The carrier-to-noise ratio is displayed after the subsequent measurement has been completed.

Frequency Span

The frequency span should be set to approximately 4 times the channel bandwidth in order to measure the carrier-to-noise ratio correctly. This setting is defined automatically by the "Adjust Settings" function.

4.3.2 Carrier-to-Noise Results

As a result of the carrier-to-noise measurement the evaluated bandwidth and the calculated C/N ratio are displayed in the result window. The fixed reference marker is indicated in the diagram.

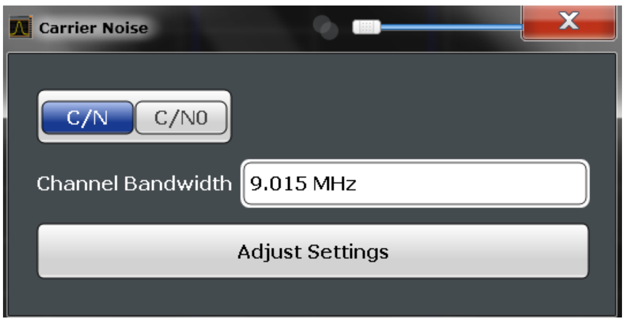


SCPI command:

You can also query the determined carrier-to-noise ratio via the remote command `CALC:MARK:FUNC:POW:RES? CN` or `CALC:MARK:FUNC:POW:RES? CN0`, see `CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514.

4.3.3 Carrier-to-Noise Configuration

The Carrier-to-noise ratio (C/N) and the Carrier-to-noise ratio in relation to the bandwidth (C/N$_0$) measurements are selected via the corresponding button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Carrier Noise" configuration dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Carrier Noise Config" softkey from the "Carrier Noise" menu.



Carrier-to-noise measurements are not available in zero span mode.

The easiest way to configure a measurement is using the configuration "Overview", see chapter 5.1, "Configuration Overview", on page 181.

The remote commands required to perform these tasks are described in chapter 10.3.4, "Measuring the Carrier-to-Noise Ratio", on page 545.

C/N

Switches the measurement of the carrier/noise ratio on or off. If no marker is active, marker 1 is activated.

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see "Assigning the Marker to a Trace" on page 324).

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 516
`CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514
`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 516

C/No

Switches the measurement of the carrier/noise ratio with reference to a 1 Hz bandwidth on or off. If no marker is active, marker 1 is activated.

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see "Assigning the Marker to a Trace" on page 324).

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 516
`CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514
`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 516

Channel Bandwidth

Defines the measurement channel bandwidth.

The default setting is 14 kHz.

SCPI command:

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` on page 521

Adjust Settings

Enables the RMS detector and adjusts the span to the selected channel bandwidth according to:

"4 x channel bandwidth + measurement margin"

The adjustment is performed once; if necessary, the setting can be changed later on.

SCPI command:

`[SENSe:]POWer:ACHannel:PRESet` on page 517

4.3.4 How to Determine the Carrier-to-Noise Ratio

1. Press the "C/N, C/NO" softkey to configure the carrier-to-noise ratio measurement.
2. To change the channel bandwidth to be analyzed, press the "Channel Bandwidth" softkey.
3. To optimize the settings for the selected channel configuration, press the "Adjust Settings" softkey.
4. To activate the measurements without reference to the bandwidth, press the "C/N" softkey.
   To activate the measurements with reference to the bandwidth, press the "C/NO" softkey .
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel and perform a second measurement.

   The carrier-to-noise ratio is displayed after the measurement has been completed.

4.4 Occupied Bandwidth Measurement (OBW)

An important characteristic of a modulated signal is its occupied bandwidth. In a radio communications system, for instance, the occupied bandwidth must be limited to enable distortion-free transmission in adjacent channels.

4.4.1 About the Measurement

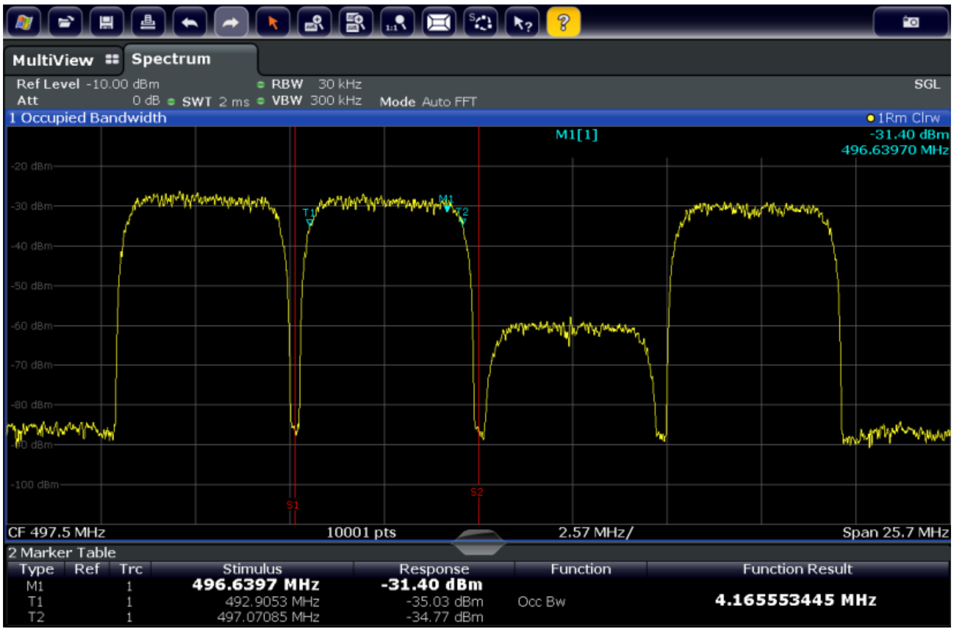
The occupied bandwidth is defined as the bandwidth containing a defined percentage of the total transmitted power. A percentage between 10 % and 99.9 % can be set.

Measurement principle

The bandwidth containing 99% of the signal power is to be determined, for example. The algorithm first calculates the total power of all displayed points of the trace. In the next step, the points from the right edge of the trace are summed up until 0.5 % of the total power is reached. Auxiliary marker 1 is positioned at the corresponding frequency. Then the points from the left edge of the trace are summed up until 0.5 % of the power is reached. Auxiliary marker 2 is positioned at this point. 99 % of the power is now between the two markers. The distance between the two frequency markers is the occupied bandwidth which is displayed in the marker field.

New: OBW now also possible within defined search limits - multi-carrier OBW measurement in one sweep

As of R&S FSW firmware version 1.30, the occupied bandwidth of the signal can be determined within defined search limits instead of for the entire signal. Thus, only a single sweep is required to determine the OBW for a multi-carrier signal. To do so, search limits are defined for an individual carrier and the OBW measurement is restricted to the frequency range contained within those limits. Then the search limits are adapted for the next carrier and the OBW is automatically re-calculated for the new range.



For step-by-step instructions see "How to determine the OBW for a multi-carrier signal using search limits" on page 94.

Prerequisites

To ensure correct power measurement, especially for noise signals, and to obtain the correct occupied bandwidth, the following prerequisites and settings are necessary:

- Only the signal to be measured is displayed in the window, or search limits are defined to include only one (carrier) signal. An additional signal would falsify the measurement.
- RBW << occupied bandwidth (approx. 1/20 of occupied bandwidth, for voice communication type: 300 Hz or 1 kHz)
- VBW ≥ 3 x RBW
- RMS detector
- Span ≥ 2 to 3 x occupied bandwidth

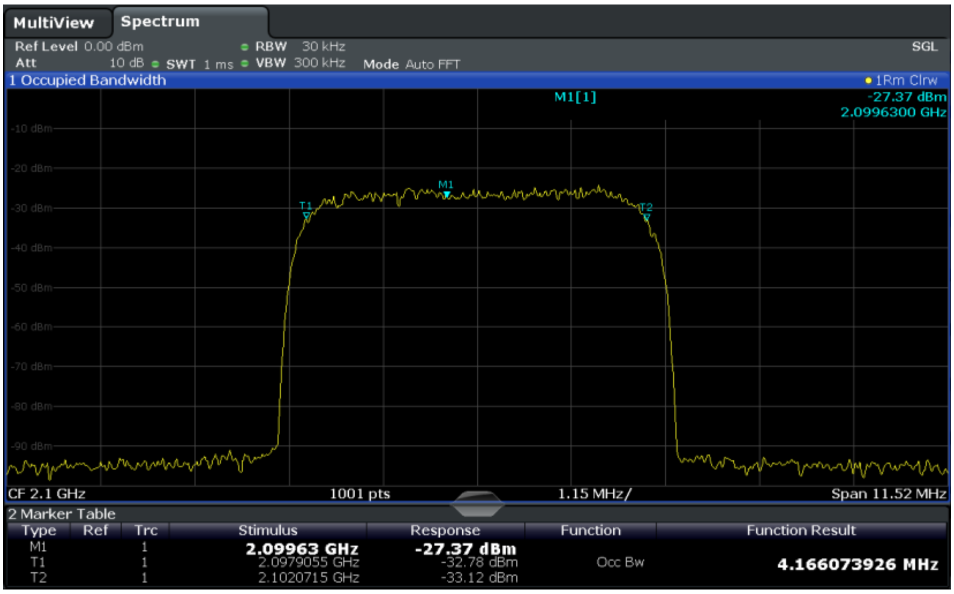
Some of the measurement specifications (e.g. PDC, RCR STD-27B) require measurement of the occupied bandwidth using a peak detector. The detector setting of the R&S FSW has to be changed accordingly then.

4.4.2 OBW Results

As a result of the OBW measurement the occupied bandwidth ("Occ BW") is indicated in the marker results. Furthermore, the marker at the center frequency and the temporary markers are indicated.

The measurement is performed on the trace with marker 1. In order to evaluate another trace, marker 1 must be placed on another trace (see Assigning the Marker to a Trace).

The OBW calculation is repeated if the Search Limits are changed, without performing a new sweep. Thus, the OBW for a multi-carrier signal can be determined using only one sweep.



SCPI command:

The determined occupied bandwidth can also be queried using the remote command `CALC:MARK:FUNC:POW:RES? OBW` or `CALC:MARK:FUNC:POW:RES? AOBW`. While the `OBW` parameter returns only the occupied bandwidth, the `AOBW` parameter also returns the position and level of the temporary markers T1 and T2 used to calculate the occupied bandwidth.

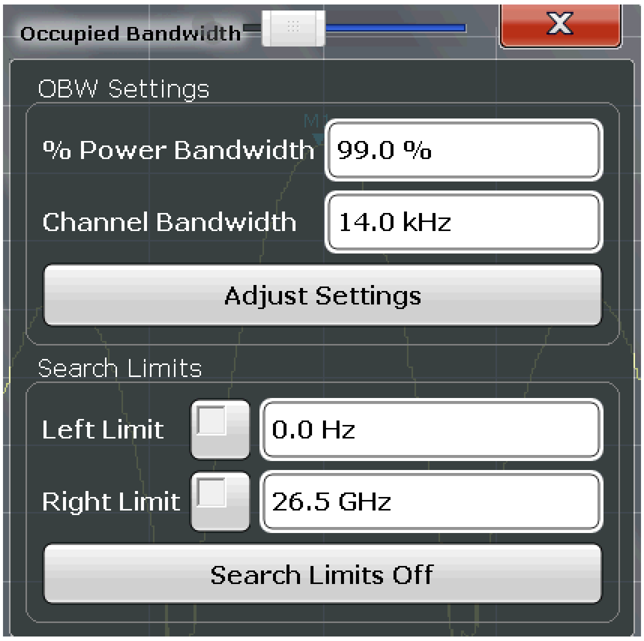
`CALC:MARK:FUNC:POW:SEL OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect` on page 516

`CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]` on page 516

`CALC:MARK:FUNC:POW:RES? OBW`, see `CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514

4.4.3 OBW Configuration

OBW measurements are selected via the "OBW" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Occupied Bandwidth" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "OBW Config" softkey from the "OBW" menu.



This measurement is not available in zero span.

Configuring search limits for OBW measurement

The OBW measurement uses the same search limits as defined for marker search (see "Search Limits" on page 328). However, only the left and right limits are considered.

The remote commands required to perform these tasks are described in chapter 10.3.5, "Measuring the Occupied Bandwidth", on page 546.

% Power Bandwidth

Defines the percentage of total power in the displayed frequency range which defines the occupied bandwidth. Values from 10% to 99.9% are allowed.

SCPI command:

`[SENSe:]POWer:BANDwidth|BWIDth` on page 547

Channel Bandwidth
Defines the channel bandwidth for the transmission channel in single-carrier measurements. This bandwidth is used to optimize the test parameters (for details see "Adjust Settings" on page 93). The default setting is 14 kHz.

For measurements according to a specific transmission standard, define the bandwidth specified by the standard for the transmission channel.

For multi-carrier measurements this setting is irrelevant.

SCPI command:
[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] on page 521

Adjust Settings
Optimizes the instrument settings for the measurement of the occupied bandwidth according to the specified channel bandwidth.

This function is only useful for single carrier measurements.

All instrument settings relevant for power measurement within a specific frequency range are optimized:

- Frequency span: 3 × channel bandwidth
- RBW ≤ 1/40 of channel bandwidth
- VBW ≥ 3 × RBW
- Detector: RMS

The reference level is not affected by "Adjust Settings". For an optimum dynamic range it should be selected such that the signal maximum is close to the reference level (see "Setting the Reference Level Automatically (Auto Level)" on page 233).

The adjustment is carried out only once. If necessary, the instrument settings can be changed later.

SCPI command:
[SENSe:]POWer:ACHannel:PRESet on page 517

Search Limits (Left / Right)
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 315.

SCPI command:
CALCulate:MARKer:X:SLIMits[:STATe] on page 712
CALCulate:MARKer:X:SLIMits:LEFT on page 712
CALCulate:MARKer:X:SLIMits:RIGHT on page 713

Deactivating All Search Limits
Deactivates the search range limits.

SCPI command:
CALCulate:MARKer:X:SLIMits[:STATe] on page 712
CALCulate:THReshold:STATe on page 714

4.4.4 How to Determine the Occupied Bandwidth

How to determine the OBW for a single signal

1. Select the "OBW" measurement function from the "Select Measurement" dialog box.
2. Select the "OBW Config" softkey to display the "Occupied Bandwidth" configuration dialog box.
3. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
4. If necessary, change the channel bandwidth for the transmission channel.
5. To optimize the settings for the selected channel configuration, select "Adjust Settings".
6. Start a sweep.

   The result is displayed as OBW in the marker results.

How to determine the OBW for a multi-carrier signal using search limits

1. Select the "OBW" measurement function from the "Select Measurement" dialog box.
2. Select the "OBW Config" softkey to display the "Occupied Bandwidth" configuration dialog box.
3. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
4. Define search limits so the search area contains only the first carrier signal:
   a) Enter values for the left or right limits, or both.
   b) Enable the use of the required limits.
5. Start a sweep.

   The result for the first carrier is displayed as OBW in the marker results.
6. Change the search limits so the search area contains the next carrier signal as described in step step 4.

   The OBW is re-calculated and the result for the next carrier is displayed. A new sweep is not necessary!
7. Continue in this way until all carriers have been measured.

4.4.5 Measurement Example

In the following example, the bandwidth that occupies 99% of the total power of a PDC signal at 800 MHz, level 0 dBm is measured.

1. Preset the R&S FSW.

2. Set the center frequency to *800 MHz*.
3. Set the reference level to *-10 dBm*.
4. Select the "OBW" measurement function from the "Select Measurement" dialog box.
5. Set the percentage of power to *99%*.
6. Set the channel bandwidth to *21 kHz* as specified by the PDC standard.
7. Optimize the settings for the selected channel configuration by selecting "Adjust Settings".
8. Adjust the reference level to the measured total power by selecting the "Auto Level" softkey in the AUTO SET menu.
9. The PDC standard requires the peak detector for OBW measurement. In the "Traces" configuration dialog, set the trace detector to "Positive Peak".
10. Start a sweep.

    The result is displayed as OBW in the marker results.

4.5 Spectrum Emission Mask (SEM) Measurement

The R&S FSW supports Spectrum Emission Mask (SEM) measurements.

4.5.1 About the Measurement

The Spectrum Emission Mask (SEM) measurement defines a measurement that monitors compliance with a spectral mask. The mask is defined with reference to the input signal power. The R&S FSW allows for a flexible definition of all parameters in the SEM measurement. The analyzer performs measurements in predefined frequency ranges with settings that can be specified individually for each of these ranges.

SEM measurement configurations can be saved to an xml file which can then be exported to another application or loaded on the R&S FSW again at a later time. Some predefined XML files are provided that contain ranges and parameters according to the selected standard.

In order to improve the performance of the R&S FSW for spectrum emission mask measurements, a "Fast SEM" mode is available.

Monitoring compliance of the spectrum is supported by a special limit check for SEM measurements.

4.5.2 Typical Applications

Spectrum Emission Mask measurements are typically performed to ensure that modulated signals remain within the valid signal level ranges defined by a particular transmission standard, both in the transmission channel and neighboring channels. Any violations of the mask may interfere with other transmissions.

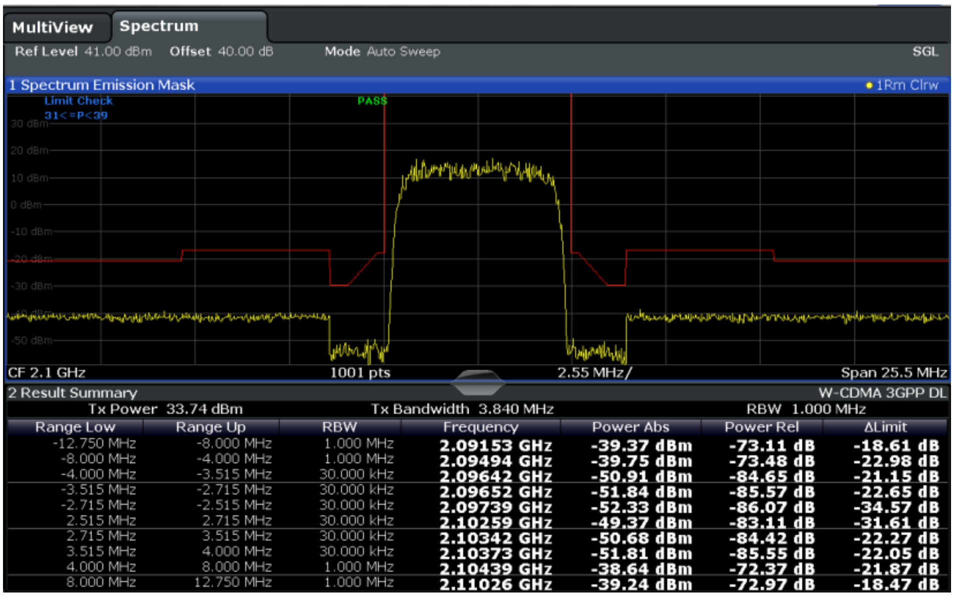
The 3GPP TS 34.122 standard, for example, defines a mask for emissions outside the transmission channel. This mask is defined relative to the input signal power. Three frequency ranges to each side of the transmission channel are defined.

4.5.3 SEM Results

As a result of the Spectrum Emission Mask measurement, the measured signal levels, the result of the limit check (mask monitoring) and the defined limit lines are displayed in a diagram (see also chapter 4.5.4.2, "Limit Lines in SEM Measurements", on page 100). Furthermore, the TX channel power "P" is indicated with the used power class.

Example:

For example, "P<31" is indicated if the lowest power class is defined from infinity to 31 and the power is currently 17 dBm.



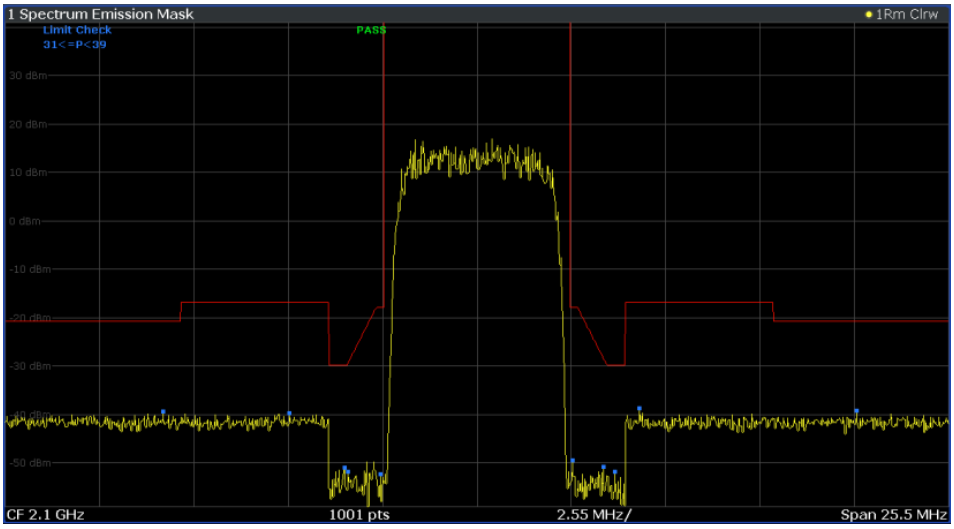
In addition to the graphical results of the SEM measurement displayed in the diagram, a result table is displayed to evaluate the limit check results (see also chapter 4.5.4.2, "Limit Lines in SEM Measurements", on page 100).

The following information is provided in the result table:

Label	Description
General Information	
Standard	Loaded standard settings
Tx Power	Power of the reference range
Tx Bandwidth	Tx bandwidth used by the reference range
RBW	RBW used by the reference range
Range results	
Range Low	Frequency range start for the range the peak value belongs to
Range Up	Frequency range end for the range the peak value belongs to
RBW	RBW of the range
Frequency	Frequency
Power Abs	Absolute power level
Power Rel	Power level relative to the TX channel power
ΔLimit	Deviation of the power level from the defined limit

In which detail the data is displayed in the result table can be defined in the "List Evaluation" settings (see chapter 4.5.5.6, "List Evaluation", on page 115). By default, one peak per range is displayed. However, you can change the settings to display only peaks that exceed a threshold ("Margin").

In addition to listing the peaks in the list evaluation, detected peaks can be indicated by blue squares in the diagram ("Show Peaks").



Furthermore, you can save the evaluation list to a file which can be exported to another application for further analysis.

Retrieving Results via Remote Control

The measurement results of the spectrum emission mask test can be retrieved using the `CALC:LIM:FAIL?` command from a remote computer (see `CALCulate<n>:LIMit<k>:FAIL` on page 754 for a detailed description).

The power result for the reference range can be queried using `CALC:MARK:FUNC:POW:RES? CPOW`, the peak power for the reference range using `CALC:MARK:FUNC:POW:RES? PPOW`, see `CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514.

The measured power trace can be queried using `TRAC:DATA?` and `TRAC:DATA:X?`, see `TRACe<n>[:DATA]` on page 702 and `TRACe<n>[:DATA]:X?` on page 704:

The measured peak power list can be queried using `TRAC:DATA? LIST``TRACe<n>[:DATA]` on page 702.

4.5.4 SEM Basics

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

4.5.4.1 Ranges and Range Settings

In the Spectrum Emission Mask measurements, a range defines a segment for which you can define the following parameters separately:

- Start and stop frequency
- RBW
- VBW
- Sweep time
- Sweep points
- Reference level
- Attenuator settings
- Preamplifier settings
- Transducer settings
- Limit values

Via the sweep list, you define the ranges and their settings. For details on settings refer to chapter 4.5.5.1, "Sweep List", on page 104.

For details on defining the limits (masks) see chapter 4.5.4.2, "Limit Lines in SEM Measurements", on page 100.

For details on defining the limits (masks) see the base unit description "Working with Lines in SEM".

Range definition

After a preset, the sweep list contains a set of default ranges and parameters. For each range, you can change the parameters listed above. You can insert or delete ranges.

The changes of the sweep list are only kept until you load another parameter set (by pressing PRESET or by loading an XML file). If you want a parameter set to be available permanently, create an XML file for this configuration (for details refer to "How to save a user-defined SEM settings file" on page 118).

If you load one of the provided XML files, the sweep list contains ranges and parameters according to the selected standard.

Reference range

The range centered around the center frequency is defined as the reference range for all other ranges in the sweep list. All range limits are defined in relation to the reference range. Power levels in the result table are also calculated in relation to the reference range. You can define whether the power used for reference is the peak power level or the integrated power of the reference range. In the "Sweep List", the reference range is highlighted in blue and cannot be deleted.

Rules

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but may have gaps).
- The maximum number of ranges is 30 (in frimware versions < 1.60: 20 ranges).
- The minimum number of three ranges is 3.
- The reference range cannot be deleted.
- The reference range has to be centered on the center frequency.
- The minimum span of the reference range is given by the current TX Bandwidth.
- Frequency values for each range have to be defined relative to the center frequency.

In order to change the start frequency of the first range or the stop frequency of the last range, select the appropriate span with the SPAN key. If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Symmetrical ranges

You can easily define a sweep list with symmetrical range settings, i.e. the ranges to the left and right of the reference range are defined symmectrically. When symmetrical setup is activated, the current sweep list configuration is changed to define a symmetrical setup regarding the reference range. The number of ranges to the left of the reference range is reflected to the right, i.e. any missing ranges on the right are inserted, while superfluous ranges are removed. The values in the ranges to the right of the reference range are adapted symmetrically to those in the left ranges.

Symmetrical ranges fulfull the conditions required for "Fast SEM" mode (see chapter 4.5.4.3, "Fast SEM Measurements", on page 102).

Power classes

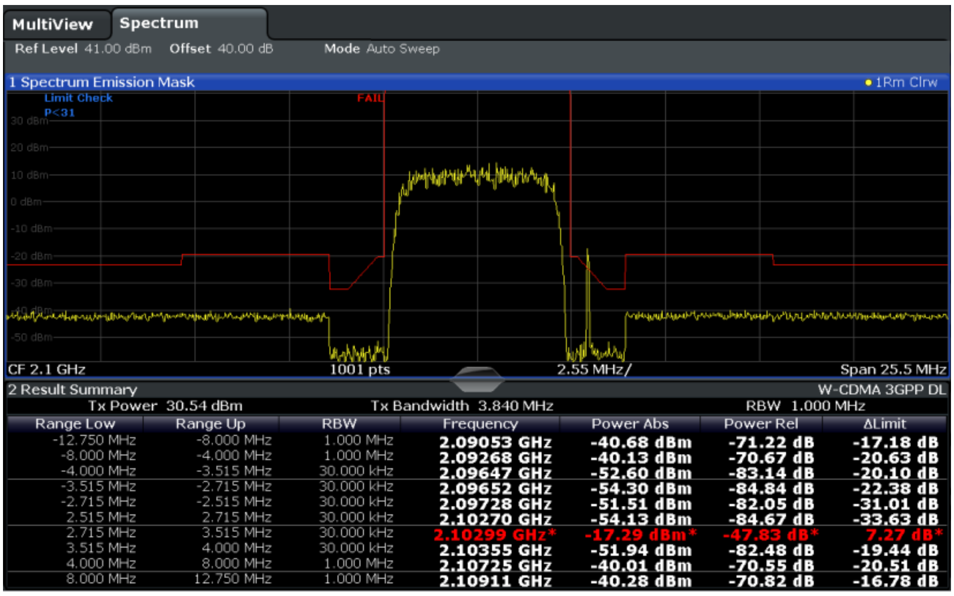
If the signal power level to be monitored may vary and the limits will vary accordingly, you can define power classes, which can then be assigned to the frequency ranges. Thus, the limits for the signal levels can be defined differently for varying input levels. For instance, for higher input levels a transmission standard may allow for higher power levels in adjacent channels, whereas for lower input levels the allowed deviation may be stricter. Up to four different power classes can be defined.

4.5.4.2 Limit Lines in SEM Measurements

On the R&S FSW, the spectrum emission mask is defined using limit lines. Limit lines allow you to check the measured data against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the LINES key. For SEM measurements, however, special limit lines are available via the "Sweep List", and it is strongly recommended that you use only these limit line definitions.

In the "Sweep List" you can define a limit line for each power class that varies its level according to the specified frequency ranges. Distinguished limit lines ("_SEM_LINE_ABS<0...3>"/ "_SEM_LINE_REL<0...3>") are automatically defined for each power class according to the current "Sweep List" settings every time the settings change.

The limit line defined for the currently used power class is indicated by a red line in the display, and the result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a "margin" function as for general limit lines is not available.



The indicated limit line depends on the settings in the "Sweep List". Several types of limit checks are possible:

Table 4-3: Limit check types

Limit check type	Pass/fail criteria	Limit line definition
Absolute	Absolute power levels may not exceed limit line	Defined by the "Abs Limit Start"/ "Abs Limit Stop" values for each range
Relative	Power deviations relative to the TX channel power may not exceed limit line	Defined by the "Rel Limit Start"/ "Rel Limit Stop" values (relative to the TX channel power), fixed for each range.
Relative with function f(x)	If the power exceeds **both** the absolute **and** the relative limits, the check fails.	Defined by the maximum of the absolute or relative (relative to the TX channel power) "Rel Limit Start"/ "Rel Limit Stop" values for each range. Thus, the start or stop point of the limit range, or both, are variable (since the maximum may vary).
Abs and Rel	If the power exceeds **both** the absolute **and** the relative limits, the check fails.	The less strict (higher) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: the power must exceed the absolute limit, as well as the absolute and relative function values.
Abs or Rel	If the power exceeds **either** the absolute **or** the relative limits, the check fails.	The stricter (lower) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: if the power exceeds the absolute limit, or the higher of the absolute and relative function values, the check fails.

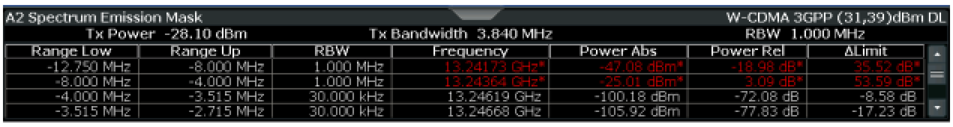
Relative limit line functions

A new function allows you to define limit lines whose start or end points (or both) are variable, depending on the carrier power. Thus, the resulting limit line may change its slope within the range, depending on the carrier power. Common relative limit lines are calculated once for the defined start and end points and maintain a constant slope.

If the relative limit value function is used in combination with the "Abs and Rel" or "Abs or Rel" limit check types, an additional condition is considered for the limit check (see table 4-3).

Limit check results in the evaluation list

The largest deviations of the power from the limit line for each range are displayed in the evaluation list. Furthermore, the absolute powers for those values, as well as the relative deviation from the TX channel power are displayed. Values that exceed the limit are indicated in red and by an asterisk (*).



Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list can be defined in the list evaluation settings. For details see chapter 4.5.5.6, "List Evaluation", on page 115.

4.5.4.3 Fast SEM Measurements

In order to improve the performance of the R&S FSW for spectrum emission mask measurements, a "Fast SEM" mode is available. If this mode is activated, several consecutive ranges with identical sweep settings are combined to one sweep internally, which makes the measurement considerably more efficient. The displayed results remain unchanged and still consist of several ranges. Thus, measurement settings that apply only to the results, such as limits or transducer factors, can nevertheless be defined individually for each range.

Prerequisites

"Fast SEM" mode is available if the following criteria apply:

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see chapter 4.5.5.1, "Sweep List", on page 104):
  - Filter Type
  - RBW
  - VBW
  - Sweep Time Mode
  - Reference Level
  - Rf Attenuation Mode
  - RF Attenuation
  - Preamplificiation

Activating Fast SEM mode

"Fast SEM" mode is activated in the sweep list (see chapter 4.5.5.1, "Sweep List", on page 104) or using a remote command. Activating the mode for one range automatically activates it for all ranges in the sweep list.

SCPI command:

`[SENSe:]ESPectrum:HighSPeed` on page 551

Consequences

When the "Fast SEM" mode is activated, the ranges for which these criteria apply are displayed as one single range. The sweep time is defined as the sum of the individual sweep times, initially, but can be changed.

If "Symmetrical Setup" mode is active when "Fast SEM" mode is activated, not all sweep list settings can be configured symmetrically automatically (see also "Symmetric Setup" on page 108).

Any other changes to the sweep settings of the combined range are applied to each included range and remain changed even after deactivating "Fast SEM" mode.

Example

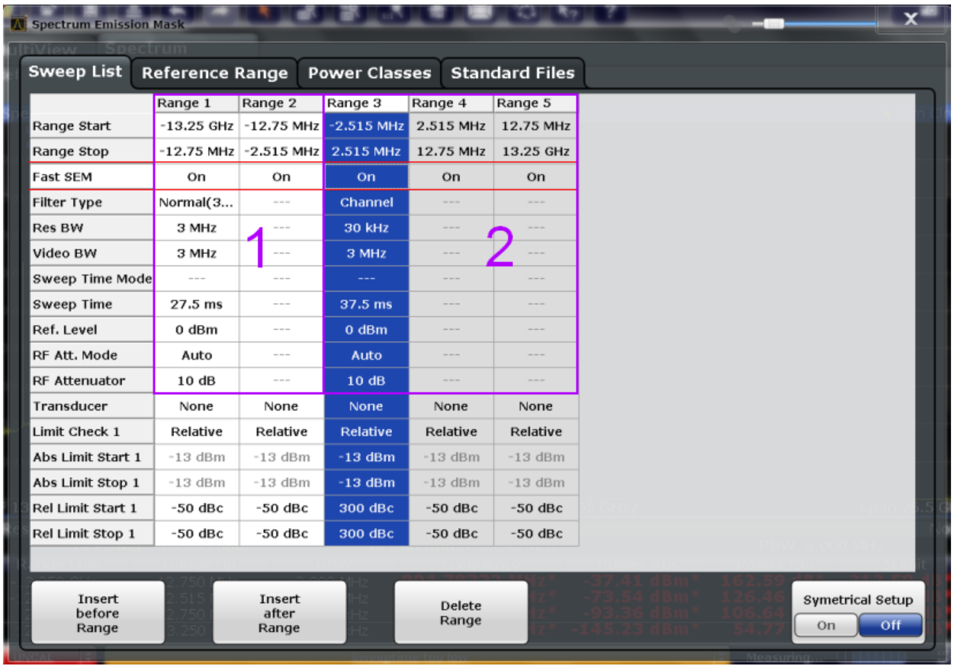


Fig. 4-11: Sweep list using Fast SEM mode

In figure 4-11, a sweep list is shown for which Fast SEM is activated. The formerly 5 separately defined ranges are combined to 2 sweep ranges internally.

4.5.4.4 Multi-Standard Radio (MSR) SEM Measurements

Multi-standard radio (MSR) measurements allow you to perform SEM tests on signals with multiple carriers using different digital standards. MSR measurements are described in the specification 3GPP TS 37.141. Various typical combinations of standards for base station tests are described, e.g. LTE FDD and WCDMA carriers. By performing an MSR SEM measurement you can determine if or how the different carriers affect each other, i.e. if unwanted emissions occur. On the R&S FSW, the MSR SEM measurement is a standard measurement as for single carriers. The MSR settings merely provide a convenient way of configuring the sweep list for all required ranges according to the specification very quickly.

4.5.5 SEM Configuration

SEM measurements are selected via the "Spectrum Emission Mask" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Spectrum Emission Mask" configuration dialog box, which is displayed when you select the "SEM Setup" button in the "Overview" or one of the softkeys from the "SEMask" menu.

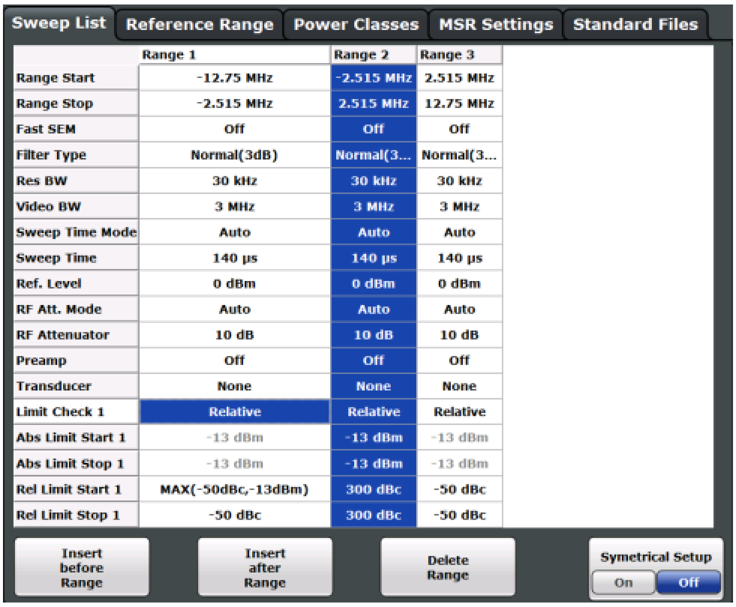
The remote commands required to perform these tasks are described in chapter 10.3.6, "Measuring the Spectrum Emission Mask", on page 548.

The following settings are available in individual tabs of the "Spectrum Emission Mask" configuration dialog box.

4.5.5.1 Sweep List

For SEM measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply. In the "Sweep List" tab of the "Spectrum Emission Mask" dialog box you configure the individual frequency ranges and mask limits.

If you edit the sweep list, always follow the rules and consider the limitations described in chapter 4.5.4.1, "Ranges and Range Settings", on page 98.



Sweep List | Reference Range | Power Classes | MSR Settings | Standard Files

	Range 1	Range 2	Range 3
Range Start	-12.75 MHz	-2.515 MHz	2.515 MHz
Range Stop	-2.515 MHz	2.515 MHz	12.75 MHz
Fast SEM	Off	Off	Off
Filter Type	Normal(3dB)	Normal(3...	Normal(3...
Res BW	30 kHz	30 kHz	30 kHz
Video BW	3 MHz	3 MHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto
Sweep Time	140 µs	140 µs	140 µs
Ref. Level	0 dBm	0 dBm	0 dBm
RF Att. Mode	Auto	Auto	Auto
RF Attenuator	10 dB	10 dB	10 dB
Preamp	Off	Off	Off
Transducer	None	None	None
Limit Check 1	Relative	Relative	Relative
Abs Limit Start 1	-13 dBm	-13 dBm	-13 dBm
Abs Limit Stop 1	-13 dBm	-13 dBm	-13 dBm
Rel Limit Start 1	MAX(-50dBc,-13dBm)	300 dBc	-50 dBc
Rel Limit Stop 1	-50 dBc	300 dBc	-50 dBc

Insert before Range | Insert after Range | Delete Range | Symetrical Setup On Off

Range Start / Range Stop

Sets the start frequency/stop frequency of the selected range.

In order to change the start/stop frequency of the first or last range, respectively, select the appropriate span with the SPAN key. If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Frequency values for each range have to be defined relative to the center frequency. The reference range has to be centered on the center frequency. The minimum span of the reference range is given by the current Channel Power Settings.

SCPI command:

`[SENSe:]ESPectrum:RANGe<range>[:FREQuency]:STARt` on page 552
`[SENSe:]ESPectrum:RANGe<range>[:FREQuency]:STOP` on page 553

Fast SEM

Activates "Fast SEM" mode for all ranges in the sweep list. For details see chapter 4.5.4.3, "Fast SEM Measurements", on page 102.

Note: If "Fast SEM" mode is deactivated while "Symmetrical Setup" mode is on, "Symmetrical Setup" mode is automatically also deactivated.
If "Fast SEM" mode is activated while "Symmetrical Setup" mode is on, not all range settings can be set automatically.

SCPI command:

`[SENSe:]ESPectrum:HighSPeed` on page 551

Filter Type

Sets the filter type for this range.

For details on filter types see chapter 5.5.1.6, "Which Data May Pass: Filter Types", on page 241.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:FILTer:TYPE on page 552

RBW

Sets the RBW value for this range.

For details on the RBW see chapter 5.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 238.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:BANDwidth[:RESolution] on page 551

VBW

Sets the VBW value for this range.

For details on the VBW see chapter 5.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 239.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:BANDwidth:VIDeo on page 551

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode see chapter 5.5.1.7, "How Long the Data is Measured: Sweep Time", on page 242

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:SWEep:TIME:AUTO on page 561

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time see chapter 5.5.1.7, "How Long the Data is Measured: Sweep Time", on page 242

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:SWEep:TIME on page 561

Ref. Level

Sets the reference level for the range.

For details on the reference level see chapter 5.4.1.1, "Reference Level", on page 229.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:RLEVel on page 561

RF Att. Mode

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation see chapter 5.4.1.2, "RF Attenuation", on page 230.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:INPut:ATTenuation:AUTO on page 554

RF Attenuator

Sets the attenuation value for that range.

For details on attenuation see chapter 5.4.1.2, "RF Attenuation", on page 230.

SCPI command:

`[SENSe:]ESPectrum:RANGe<range>:INPut:ATTenuation` on page 553

Preamp

Switches the preamplifier on or off.

For details on the preamplifier see "Preamplifier (option B24)" on page 234.

SCPI command:

`[SENSe:]ESPectrum:RANGe<range>:INPut:GAIN:STATe` on page 555

Transd. Factor

Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers see chapter 8.2, "Basics on Transducer Factors", on page 388.

SCPI command:

`[SENSe:]ESPectrum:RANGe<range>:TRANsducer` on page 562

Limit Check 1-4

Sets the type of limit check for all ranges.

For details on limit checks see chapter 4.5.4.2, "Limit Lines in SEM Measurements", on page 100.

The limit state affects the availability of all limit settings.

Depending on the number of active power classes (see chapter 4.5.5.3, "Power Classes", on page 110), the number of limits that can be set varies. Up to four limits are possible. The sweep list is extended accordingly.

SCPI command:

`[SENSe:]ESPectrum:RANGe:LIMit<PClass>:STATe` on page 560

`CALCulate<n>:LIMit<k>:FAIL` on page 754

Abs Limit Start/Stop

Sets an absolute limit value at the start or stop frequency of the range [dBm].

SCPI command:

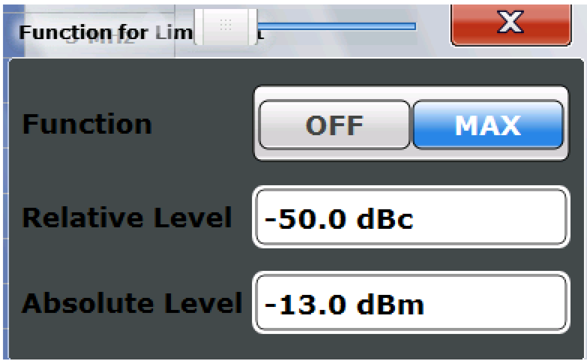
`[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:ABSolute:STARt` on page 555

`[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:ABSolute:STOP` on page 556

Rel Limit Start/Stop

Sets a relative limit value at the start or stop frequency of the range [dBc].

By default, this value is a fixed relative level, i.e. no function is defined. To define a function for the relative limit, tap the input field for "Rel Limit Start" or "Rel Limit Stop" and select the "f(x)" icon that appears.



If the function is set to "MAX", you can define a relative *and* an absolute level. In this case, the maximum of the two values is used as the limit level.

For more information see "Relative limit line functions" on page 101.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt on page 556

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP on page 558

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion on page 558

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion on page 559

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS on page 557

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute on page 559

Insert before/after Range

Inserts a new range to the left of the currently focused range (before) or to the right (after). The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:INSert on page 555

Delete Range

Deletes the currently focused range, if possible (The reference range cannot be deleted. A minimum of 3 ranges is required.) The range numbers are updated accordingly.

SCPI command:

[SENSe:]ESPectrum:RANGe<range>:DELete on page 552

Symmetric Setup

Any changes to the range settings in active "Symmetric Setup" mode lead to symmetrical changes in the other ranges (where possible). In particular, this means:

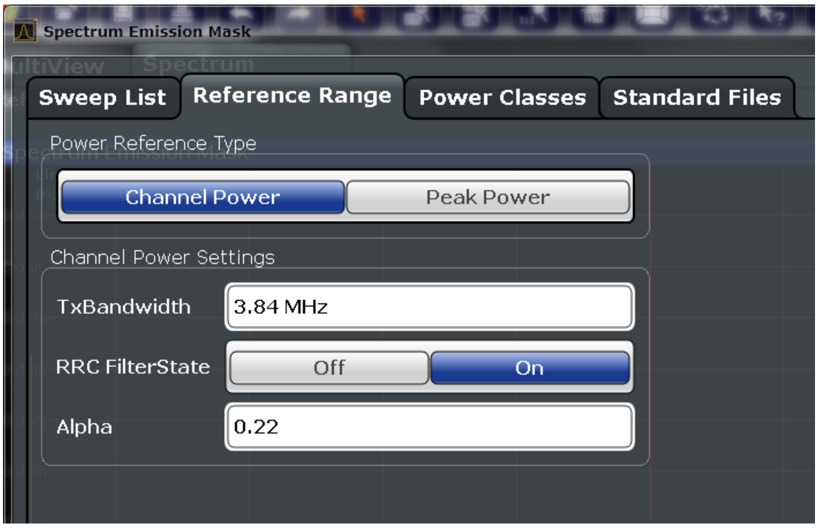
- Inserting ranges: a symmetrical range is inserted on the other side of the reference range
- Deleting ranges: the symmetrical range on the other side of the reference range is also deleted
- Editing range settings: the settings in the symmetrical range are adapted accordingly

Note: If "Fast SEM" mode is deactivated while "Symmetric Setup" mode is on, "Sym Setup" mode is automatically also deactivated.
If "Fast SEM" mode is activated while "Symmetric Setup" mode is on, not all range settings can be set automatically.

4.5.5.2 Reference Range

The range centered around the center frequency is defined as the reference range for all other ranges in the sweep list.

In the "Reference Range" tab of the "Spectrum Emission Mask" dialog box you define the general settings for the reference range.



Power Reference Type

Defines how the reference power is calculated.

"Channel Power" Measures the channel power within the reference range using the integral bandwidth method (see also "IBW method" on page 39). Additional settings can be configured for this method.

"Peak Power" Determines the peak power within the reference range.

SCPI command:

`[SENSe:]ESPectrum:RTYPe` on page 563

Channel Power Settings
If the Power Reference Type "Channel Power" was selected, additional parameters can be configured.

Tx Bandwidth ← Channel Power Settings
Defines the bandwidth used for measuring the channel power, with:

minimum span ≤ Tx Bandwidth ≤ span of reference range

SCPI command:
`[SENSe:]ESPectrum:BWID` on page 562

RRC Filter State ← Channel Power Settings
Activates or deactivates the use of an RRC filter.

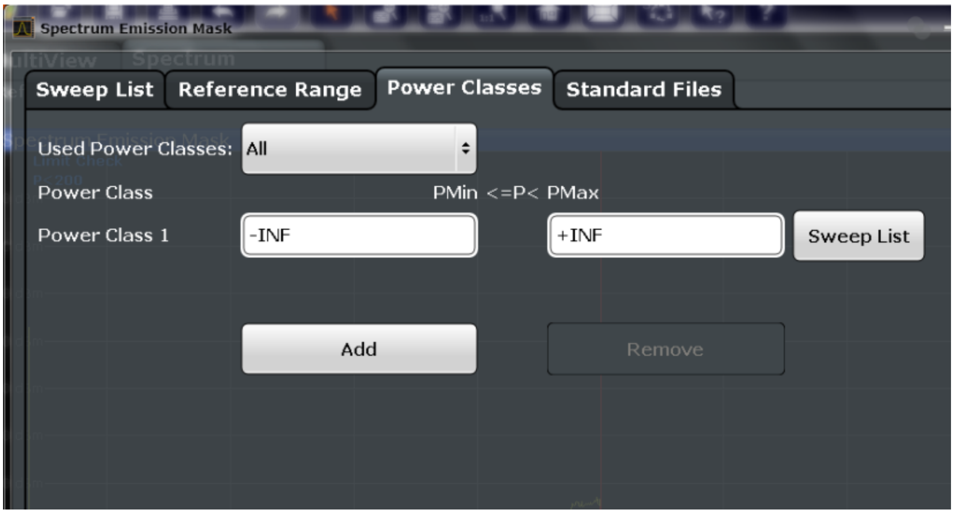
SCPI command:
`[SENSe:]ESPectrum:FILTer[:RRC][:STATe]` on page 563

Alpha ← Channel Power Settings
Sets the alpha value of the RRC filter (if activated).

SCPI command:
`[SENSe:]ESPectrum:FILTer[:RRC]:ALPHa` on page 562

4.5.5.3 Power Classes

In the "Power Classes" tab of the "Spectrum Emission Mask" dialog box you configure power classes which can then be assigned to the sweep list ranges. For details see "Power classes" on page 100.



Used Power Classes
Defines which power classes are considered for the SEM measurement. Limits can be defined only for used power classes. It is only possible to select either one specific power class or all of the defined power classes.

If "All" is selected, the power class that corresponds to the currently measured power in the reference range is used for monitoring. The limits assigned to that power class are applied (see "Limit Check 1-4" on page 107).

SCPI command:
`CALCulate:LIMit:ESPectrum:PCLass<class>[:EXCLusive]` on page 566
To define all limits in one step:
`CALCulate:LIMit:ESPectrum:PCLass<class>:LIMit[:STATe]` on page 566

PMin/PMax
Defines the level limits for each power class. The range always starts at -200 dBm (-INF) and always stops at 200 dBm (+INF). These fields cannot be modified. If more than one power class is defined, the value of "PMin" must be equal to the value of "PMax" of the previous power class and vice versa.

Note that the power level may be equal to the lower limit, but must be lower than the upper limit:

$P_{min} \leqq P < P_{max}$

SCPI command:
`CALCulate:LIMit:ESPectrum:PCLass<class>:MINimum` on page 567
`CALCulate:LIMit:ESPectrum:PCLass<class>:MAXimum` on page 567

Sweep List
Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog box and focuses the "Limit Check" setting for the corresponding power class (1-4) in the reference range (see "Limit Check 1-4" on page 107).

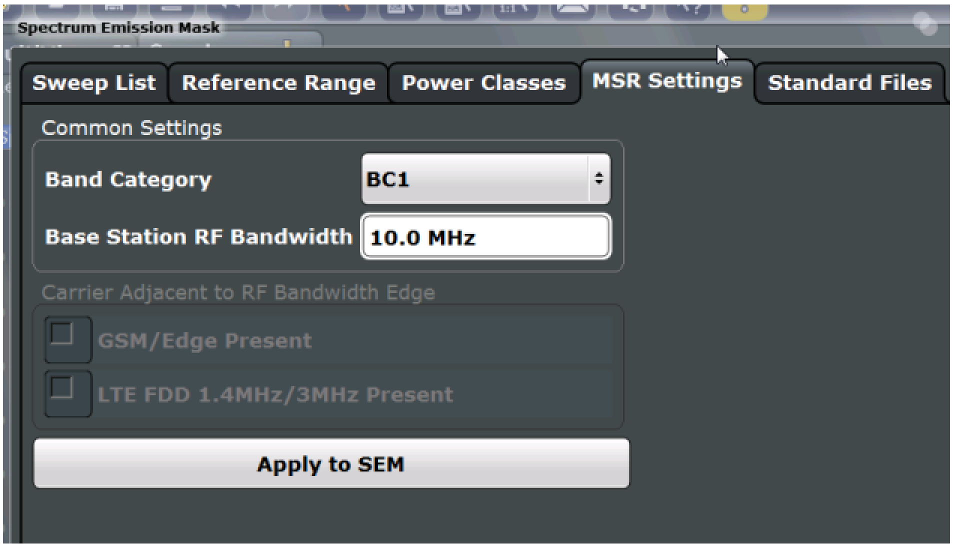
Adding or Removing a Power Class
Adds a new power class at the end of the list or removes the last power class. After adding or removing, the last power class is adapted to end at "+INF".

SCPI command:
`CALCulate:LIMit:ESPectrum:PCLass<class>[:EXCLusive]` on page 566

4.5.5.4 MSR Settings

In the "MSR Settings" tab of the "Spectrum Emission Mask" dialog box you configure multi-standard radio (MSR) measurements, which allow you to perform SEM tests on multiple carriers using different digital standards.

For details see chapter 4.5.4.4, "Multi-Standard Radio (MSR) SEM Measurements", on page 103.



Band Category

Defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

"BC1" LTE FDD and WCDMA

"BC2" LTE FDD, WCDMA and GSM/EDGE

"BC3" LTE TDD and TD-SCDMA

SCPI command:

`[SENSe:]ESPectrum:MSR:BCATegory` on page 568

Base Station RF Bandwidth

Defines the relevant RF bandwidth (span) required to measure all available carriers in MSR SEM measurements.

SCPI command:

`[SENSe:]ESPectrum:MSR:RFBWidth` on page 569

Carrier Adjacent to RF Bandwidth Edge

For particular measurement setups the specification demands specific limits for the SEM ranges.

These settings are only available for Band Category 2.

"GSM/ Edge present" A GSM/EDGE carrier is located at the edge of the RF bandwidth.

"LTE FDD 1.4 MHz / 3 MHz present"	An LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the RF bandwidth.

SCPI command:

`[SENSe:]ESPectrum:MSR:GSM:CPResent` on page 568

`[SENSe:]ESPectrum:MSR:LTE:CPResent` on page 569

Apply to SEM

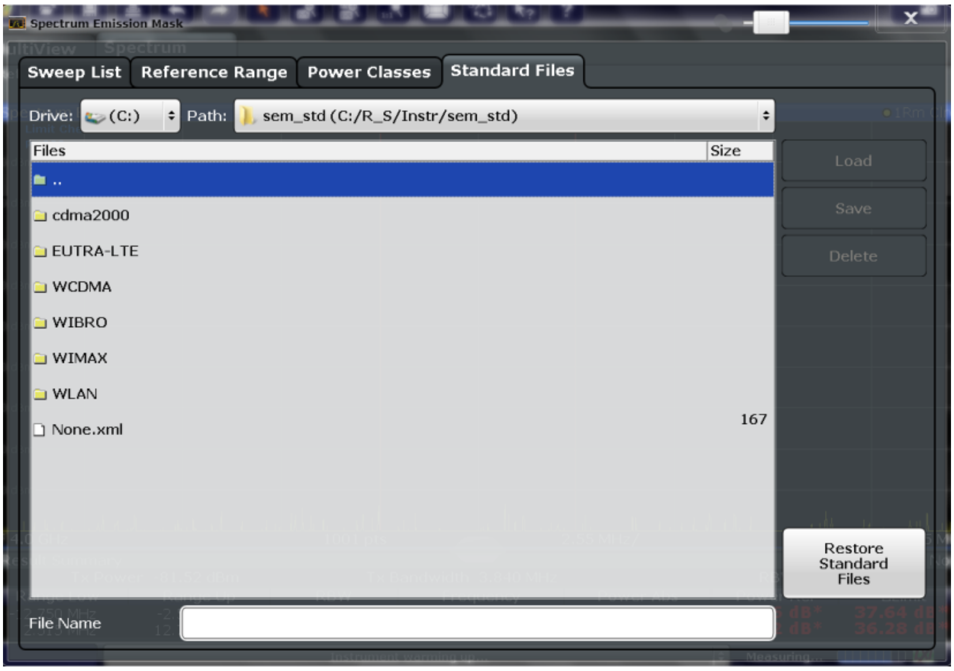
Configures the SEM sweep list according to the specified MSR settings.

SCPI command:

`[SENSe:]ESPectrum:MSR:APPLy` on page 568

4.5.5.5 Standard Files

In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box you can save the current measurement settings as a user-defined standard, or load stored measurement settings. Furthermore, you can delete an existing settings file.



For details see chapter 4.5.6.1, "How to Manage SEM Settings Files", on page 118.

Selecting the Storage Location - Drive/ Path/ Files

Select the storage location of the settings file on the instrument or an external drive.

The "Drive" indicates the internal (C:) or any connected external drives (e.g. a USB storage device).

The "Path" contains the drive and the complete file path to the currently selected folder.

The "Files" list contains all subfolders and files of the currently selected path.

The default storage location for the SEM settings files is: `C:\R_S\instr\sem_std`.

SCPI command:
`MMEMory:CATalog?` on page 756

File Name
Contain the name of the data file without the path or extension.

By default, the name of a settings file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. `limit_lines_005`.

For details on the file name and location see chapter 7.2.2.2, "Storage Location and File Name", on page 369.

Load Standard
Loads the selected measurement settings file.

Save Standard
Saves the current measurement settings for a specific standard as a file with the defined name.

Delete Standard
Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standards" softkey.
(See "Restore Standard Files" on page 114).

Restore Standard Files
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

The XML files from the `C:\R_S\instr\sem_backup` folder are copied to the `C:\R_S\instr\sem_std` folder.

Note that this function will overwrite customized standards that have the same name as predefined standards.

SCPI command:
`[SENSe:]ESPectrum:PRESet:RESTore` on page 549

Restore Standard Files
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

The XML files from the `C:\R_S\instr\sem_backup` folder are copied to the `C:\R_S\instr\sem_std` folder.

Note that this function will overwrite customized standards that have the same name as predefined standards.

SCPI command:
`[SENSe:]ESPectrum:PRESet:RESTore` on page 549

4.5.5.6 List Evaluation

In the "List Evaluation" dialog box, which is displayed when you select the "Evaluations" button in the "Overview" or the "List Evaluation" softkey in the "SEMAsk" menu, you configure the contents and display of the result list.

List Evaluation State

Activates or deactivates the list evaluation.

SCPI command:

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:AUTO on page 569

TRACe<n>[:DATA] on page 702

Show Peaks

If activated, all peaks that have been detected during an active list evaluation are marked with blue squares in the diagram.

SCPI command:

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:PSHow on page 570

Margin

Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list (and diagram, if activated) can be defined. Only peaks that exceed the margin value are displayed.

SCPI command:

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:MARGin on page 570

Saving the Evaluation List

Exports the evaluation list of the SEM measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details see chapter 4.5.7.2, "ASCII File Export Format (Spectrum Emission Mask)", on page 125.

SCPI command:

`MMEMory:STORe:LIST` on page 775

`FORMat:DEXPort:DSEParator` on page 756

4.5.6 How to Perform a Spectrum Emission Mask Measurement

SEM measurements can be performed according to a specific standard or freely configured. Configuration for signals with a very regular channel definition can be configured very quickly and easily. Selecting the SEM measurement is a prerequisite for all other tasks. For multi-standard radio SEM measurements, configuration for specified scenarios can be done automatically.

The following tasks are described:

- "To select an SEM measurement" on page 116
- "To perform an SEM measurement according to a standard" on page 116
- "To configure a user-defined SEM measurement" on page 116
- "To perform an MSR SEM measurement" on page 118

To select an SEM measurement

► Press the MEAS key, then select the "Spectrum Emission Mask" measurement.

To perform an SEM measurement according to a standard

► Load the settings file as described in "How to load an SEM settings file" on page 118 and start a measurement.

To configure a user-defined SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition may be, for example:
   - The signal power level
   - The required resolution bandwidth or sweep time
   - Transducer factors
   - Permitted deviation from the defined signal level, i.e. the required limit values for monitoring

   If the signal consists of a transmission channel and adjacent channels, the channel ranges can usually be used for the range definition.

3. If the signal power level to be monitored may vary and the limits will vary accordingly, define power classes. For each range of levels that can be monitored in the same way, define a power class.
   a) Select the "Overview" softkey, then select the "SEM Setup" button and swtich to the "Power Classes" tab.
   b) Add a power class by selecting the "Add" button.
   c) Enter the start and stop power levels to define the class.
   d) Select the power classes to be used for the current measurement: either a specific class, or all classes, to have the required class selected automatically according to the input level measured in the reference range.
4. Select the "Sweep List" tab of the "Spectrum Emission Mask" dialog box.
5. Insert the required ranges using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range (the reference range by default). If the signal trace is symmetric to the center frequency, activate the "Sym Setup" option to make setup easier and quicker.
6. Define the measurement parameters for each range as required. If symmetrical setup is activated, you only have to configure the ranges to one side of the center range. In particular, define the limits for each range of the signal, i.e. the area in which the signal level may deviate without failing the limit check. If several power classes were defined (see step 3), define limits for each power class.
   a) Define the type of limit check, i.e. whether absolute values or relative values are to be checked, or both. The type of limit check is identical for all power classes.
   b) Define the limit start and stop values.
7. If the sweep list settings - other than the limit and transducer values - are identical for several adjacent ranges, activate "Fast SEM" mode to speed up the measurement. You only have to activate the mode for one range, the others are adapted automatically.
8. If necessary, change the settings for the reference power to which all SEM results refer in the "Reference Range" tab.
9. To indicate the determined peaks in the display during an SEM measurement, select the "Evaluations" button in the "Overview" and activate the "Show Peaks" option.
10. To save the current SEM measurement settings to a file to re-use them later, save a settings file as described in "How to save a user-defined SEM settings file" on page 118.
11. Start a sweep.

    The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
12. To save the evaluation list, export the results to a file as described in chapter 4.5.6.2, "How to Save SEM Result Files", on page 119.

To perform an MSR SEM measurement

1. Select the "MSR Config" softkey.
2. Select the band category that determines the digital standards used in the measurement setup (see "Band Category" on page 112).
3. Define the bandwidth that contains all relevent carrier signals to be measured.
4. For measurements with GSM/EDGE, LTE FDD and WCDMA carriers (BC2), define whether a GSM/EDGE or an LTE FDD carrier, or both, are located at the edge of the bandwidth.
5. Select the "Apply to SEM" button.

   The Sweep list is configured according to the MSR specification, with the required number of ranges and defined limits.
6. Start a sweep.

   The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
7. To save the evaluation list, export the results to a file as described in chapter 4.5.6.2, "How to Save SEM Result Files", on page 119.

4.5.6.1 How to Manage SEM Settings Files

SEM measurement settings can be saved to an xml file which can then be exported to another application or loaded on the R&S FSW again at a later time. Some predefined XML files are provided that contain ranges and parameters according to the selected standard. All XML files are stored under `C:\r_s\instr\sem_std`.

For details on the file format of the SEM settings file, see chapter 4.5.7.1, "Format Description of SEM XML Files", on page 120.

SEM settings or standard files are managed in the "Standards" tab of the "Spectrum Emission Mask" dialog box. To display this dialog box, select the "Overview" softkey and then the "SEM Setup" button.

How to load an SEM settings file

1. From the file selection dialog box, select the settings file (with an ".xml" extension).
2. Select the "Load" button.

   The settings from the selected file are restored to the R&S FSW and you can repeat the SEM measurement with the stored settings.

How to save a user-defined SEM settings file

1. Configure the SEM measurement as required (see chapter 4.5.6, "How to Perform a Spectrum Emission Mask Measurement", on page 116).

2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, define a file name and storage location for the settings file.
3. Select the "Save" button.

   The settings are stored to a file with the extension ".xml" as specified.

How to delete an SEM settings file

1. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the file you want to delete.
2. Select the "Delete" button.
3. Confirm the message.

   The settings file is removed from the R&S FSW.

How to restore default SEM settings files

The R&S FSW is delivered with predefined settings files which can be edited and overwritten. However, you can restore the original files.

► In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the "Restore Standard Files" button.

  The original predefined settings files are available for selection on the R&S FSW.

4.5.6.2 How to Save SEM Result Files

The evaluation list from an SEM measurement can be saved to a file, which can be exported to another application for further analysis, for example.

For details on the file format of the SEM export file, see chapter 4.5.7.2, "ASCII File Export Format (Spectrum Emission Mask)", on page 125.

1. Configure and perform an SEM measurement as described in chapter 4.5.6, "How to Perform a Spectrum Emission Mask Measurement", on page 116.
2. In the "Overview", select the "Evaluation" button.
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

   The file with the specified name and the extension `.dat` is stored in the defined storage location.

4.5.7 Reference: SEM File Descriptions

This reference provides details on the format of the SEM settings and result files.

4.5.7.1 Format Description of SEM XML Files

The SEM XML files offer a quick way to change the measurement settings. A set of ready-made XML files for different standards is already provided. You can also create and use your own XML files. Alternatively, edit the settings directly in the "Spectrum Emission Mask" dialog box and save the XML file afterwards. This way, no modifications have to be done in the XML file itself.

In addition to saving the current settings to a file, settings files can also be created independantly of the R&S FSW, in an exernal application. When creating your own XML files, be sure to comply with the following conventions because the R&S FSW can only interpret XML files of a known structure. For sample files look in the `C:\r_s\instr\sem_std` directory of the R&S FSW.

To load a settings file, use the "Load" function in the "Standard Files" tab of the "Spectrum Emission Mask" dialog box (see "How to load an SEM settings file" on page 118). All XML files are stored under `C:\r_s\instr\sem_std`.

The files for importing range settings obey the rules of the XML standard. The child nodes, attributes, and structure defined for the data import are described here.

Be sure to follow the structure exactly as shown below or else the R&S FSW is not able to interpret the XML file and error messages are shown on the screen. It is recommended that you make a copy of an existing file and edit the copy of the file.

Basically, the file consists of three elements that can be defined:

- The "BaseFormat" element
- The "PowerClass" element
- The "Range" element

The "BaseFormat" element

It carries information about basic settings. In this element only the "ReferencePower" child node has any effects on the measurement itself. The other attributes and child nodes are used to display information about the Spectrum Emission Mask Standard on the measurement screen. The child nodes and attributes of this element are shown in table 4-4.

Example:

In the sample file `PowerClass_39_43.xml` under `C:\r_s\instr\sem_std\WCDMA\3GPP`, these attributes are defined as follows:

- Standard="W-CDMA 3GPP"
- LinkDirection="DL"
- PowerClass="(39,43)dBm"

The "PowerClass" element

It is embedded in the "BaseFormat" element and contains settings information about the power classes. Up to four different power classes can be defined. For details refer to chapter 4.5.5.3, "Power Classes", on page 110. The child nodes and attributes of this element are shown in table 4-5.

The "Range" element

This element is embedded in the "PowerClass" element. It contains the settings information of the range. There have to be at least three defined ranges: one reference range and at least one range to either side of the reference range. The maximum number of ranges is 30. Note that the R&S FSW uses the same ranges in each power class. Therefore, the contents of the ranges of each defined power class have to be identical to the first power class. An exception are the Start and Stop values of the two Limit nodes that are used to determine the power class. Note also, that there are two Limit nodes to be defined: one that gives the limit in absolute values and one in relative values. Make sure units for the Start and Stop nodes are identical for each Limit node.

For details refer to chapter 4.5.5.1, "Sweep List", on page 104. The child nodes and attributes of this element are shown in table 4-6.

The following tables show the child nodes and attributes of each element and show if a child node or attribute is mandatory for the R&S FSW to interpret the file or not. Since the hierarchy of the XML can not be seen in the tables, either view one of the default files already stored on the R&S FSW in the "`C:\r_s\instr\sem_std`" directory or check the structure as shown below.

Below, a basic example of the structure of the file is shown, containing all mandatory attributes and child nodes. Note that the "PowerClass" element and the range element are themselves elements of the "BaseFormat" element and are to be inserted where noted. The separation is done here simply for reasons of a better overview. Also, no example values are given here to allow a quick reference to the tables above. Italic font shows the placeholders for the values.

- The "BaseFormat" element is structured as follows:
  - <RS_SEM_ACP_FileFormat Version=""1.0.0.0"">
    <Name>"Standard"</Name>
    <Instrument>
    <Type>"Instrument Type"</Type>
    <Application>"Application"</Application>
    </Instrument>
    <LinkDirection Name=""Name"">
    <ReferencePower>

<Method>"Method"</Method>
</ReferencePower>
<PowerClass Index=""n"">
<!-- For contents of the PowerClass node see table 4-5 -->
<!-- Define up to four PowerClass nodes -->
</PowerClass>
</LinkDirection>
</RS_SEM_ACP_File>

- The "PowerClass" element is structured as follows:
  – <PowerClass Index=""n"">
  <StartPower Unit=""dBm"" InclusiveFlag=""true"" Value=""StartPowerValue""/>
  <StopPower Unit=""dBm"" InclusiveFlag=""false"" Value=""StopPowerValue""/>
  <DefaultLimitFailMode>"Limit Fail Mode"</DefaultLimitFailMode>
  <Range Index=""n"">
  <!-- For contents of the Range node see table 4-6 -->
  <!-- Define up to twenty Range nodes -->
  </Range>
  …
  </PowerClass>
- The "Range" element is structured as follows:
  – <Range Index=""n"">
  <Name=""Name"">
  <ChannelType>"Channel Type"</Channel Type>
  <WeightingFilter>
  <Type>"FilterType"</Type>
  <RollOffFactor>"Factor"</RollOffFactor>
  <Bandwith>"Bandwidth"</Bandwidth>
  </WeightingFilter>
  <FrequencyRange>
  <Start>"RangeStart"</Start>
  <Stop>"RangeStop"</Stop>
  </FrequencyRange>
  <Limit>
  <Start Unit=""Unit"" Value=""Value""/>
  <Stop Unit=""Unit"" Value=""Value""/>
  </Limit>
  <Limit>
  <Start Unit=""Unit"" Value=""Value""/>
  <Stop Unit=""Unit"" Value=""Value""/>
  </Limit>
  <RBW Bandwidth=""Bandwidth"" Type=""FilterType""/>
  <VBW Bandwidth=""Bandwidth""/>
  <Detector>"Detector"</Detector>
  <Sweep Mode=""SweepMode"" Time=""SweepTime""/>
  <Amplitude>
  <ReferenceLevel Unit=""dBm"" Value=""Value""/>
  <RFAttenuation Mode=""Auto"" Unit=""dB"" Value=""Value""/>
  <Preamplifier State=""State""/>
  </Amplitude>

</Range>

Table 4-4: Attributes and child nodes of the BaseFormat element

Child Node	Attribute	Value	Parameter Description	Mand.
	FileFormatVersion	1.0.0.0		Yes
	Date	YYYY-MM-DD HH:MM:SS	Date in ISO 8601 format	No
Name		<string>	Name of the standard	Yes
Instrument	Type	FSL	Name of the instrument	No
	Application	SA | K72 | K82	Name of the application	No
LinkDirection	Name	Downlink | Uplink | None		Yes
	ShortName	DL | UL		No
Reference-Power				Yes
Method	TX Channel Power | TX Channel Peak Power			Yes
Reference-Channel	<string>			No

Table 4-5: Attributes and child nodes of the PowerClass element

Child Node	Attribute	Value	Parameter Description	Mand.
StartPower	Value	<power in dBm>	The start power must be equal to the stop power of the previous power class. The Start-Power value of the first range is -200	Yes
	Unit	dBm		Yes
	InclusiveFlag	true		Yes
StopPower	Value	<power in dBm>	The stop power must be equal to the start power of the next power class. The StopPower value of the last range is 200	Yes
	Unit	dBm		
	InclusiveFlag	false		Yes
DefaultLimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative		Yes

Table 4-6: Attributes and child nodes of the Range element (normal ranges)

Child Node	Attribute	Value	Parameter Description	Mand.
	Index	0…19	Inde XE s are continuous and have to start with 0	Yes
	Name	<string>	Name of the range	Only if ReferenceChannel contains a name and the range is the reference range
	Short-Name	<string>	Short name of the range	No
ChannelType		TX | Adjacent		Yes
WeightingFilter				Only if ReferencePower method is TX Channel Power and the range is the reference range
Type		RRC | CFilter	Type of the weighting filter	Yes
Roll Off Factor		0…1	Excess bandwidth of the filter	Only if the filter type is RRC
Bandwidth		<bandwidth in Hz>	Filter bandwidth	Only if the filter type is RRC
FrequencyRange				Yes
Start		<frequency in Hz>	Start value of the range	Yes
Stop		<frequency in Hz>	Stop value of the range	Yes
Limit		dBm/Hz | dBm | dBc | dBr | dB	A Range must contain exactly two limit nodes; one of the limit nodes has to have a relative unit (e.g. dBc), the other one must have an absolute unit (e.g. dBm)	Yes
Start	Value	<numeric_value>	Power limit at start frequency	Yes
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the start value	
Stop	Value	<numeric_value>	Power limit at stop frequency	
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the stop value	
LimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative	If used, it has to be identical to DefaultLimitFailMode	No
RBW	Bandwidth	<bandwidth in Hz>	"RBW" on page 106	Yes
	Type	NORM | PULS | CFIL | RRC		No
VBW	Bandwidth	<bandwidth in Hz>	"VBW" on page 106	Yes

Child Node	Attribute	Value	Parameter Description	Mand.
Detector		NEG | POS | SAMP | RMS | AVER | QUAS	If used, it has to be identical in all ranges.	No
Sweep	Mode	Manual | Auto	"Sweep Time Mode" on page 106	Yes
	Time	<time in sec>	"Sweep Time" on page 106	No
Amplitude				No
ReferenceLevel	Value	<power in dBm>	"Ref. Level" on page 106	Yes, if the ReferenceLevel child node is used
	Unit	dBm	Defines dBm as unit	Yes, if the ReferenceLevel node is used
RFAttenuation	Mode	Manual | Auto	"RF Att. Mode" on page 106	Yes, if the ReferenceLevel child node is used
Preamplifier		ON | OFF	"Preamp" on page 107	Yes

4.5.7.2 ASCII File Export Format (Spectrum Emission Mask)

When trace data from an SEM measurement is exported, the data is stored in ASCII format as described below. The first part of the file lists information about the signal analyzer and the general setup.

File contents	Explanation
File header	
Type;FSW-26;	Model
Version;1.00;	Firmware version
Date;31.Mar 11;	Storage date of data set
Mode;ANALYZER;SEM;	Operating mode and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;25500000.000000;Hz	
x-Axis;LIN;	
Start;13237250000.000000;Hz	
Stop;13262750000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	

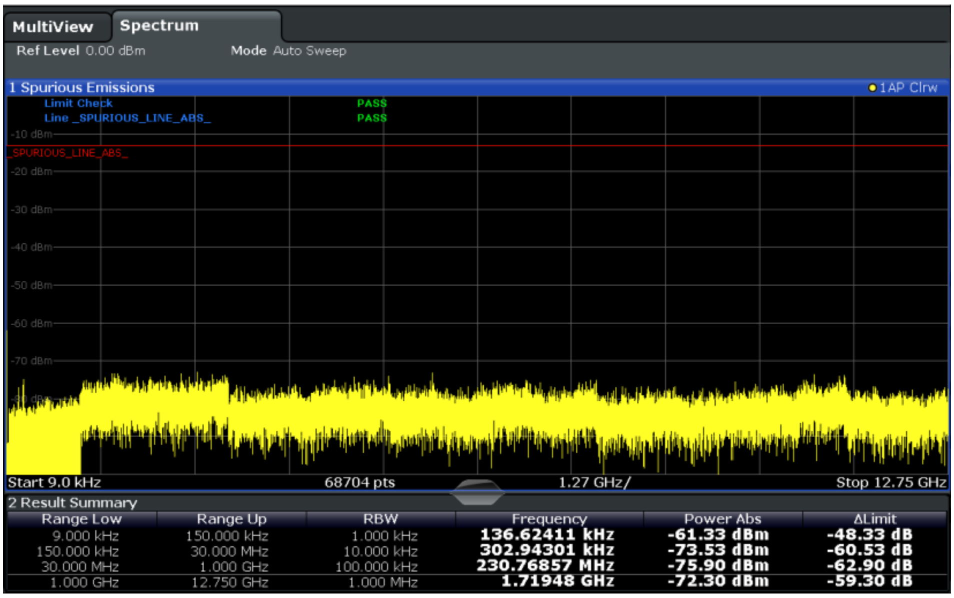
File contents	Explanation
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Detector;RMS;	
Sweep Count;0;	
Trace 1:;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
Margin;200;	Peak List margin
Reference range settings	
RefType; CPOWER;	Reference power type
TxBandwidth;3840000;;Hz	Channel power settings
Filter State; ON;	
Alpha;0.22;	
PeaksPerRange;1;	Max. number of peaks per range to be detected
Values;2;	Number of detected peaks
File data section	
0;-12750000;-2515000;30000;13242367500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <relative power in dBc of peak>; (related to the channel power) <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;
2;2515000;12750000;30000;13257632500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	

4.6 Spurious Emissions Measurement

The R&S FSW supports Spurious Emissions measurements.

4.6.1 About the Measurement

The Spurious Emissions measurement monitors unwanted RF products outside the assigned frequency band generated by an amplifier. The spurious emissions are usually measured across a wide frequency range. The Spurious Emissions measurement allows a flexible definition of all parameters. A result table indicates the largest deviations of the absolute power from the limit line for each range, and the results can be checked against defined limits automatically.



4.6.2 Spurious Emissions Measurement Results

The measured signal, including any spurious emissions, and optionally the detected peaks are displayed in the Spurious Emissions measurement diagram. If defined, the limit lines and the limit check results are also indicated. In addition to the graphical results, a result table can be displayed to evaluate the measured powers and limit check results (see also chapter 4.6.3.2, "Limit Lines in Spurious Measurements", on page 129). The details of the evaluation list can be configured.

2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	136.62411 kHz	-61.33 dBm	-48.33 dB
150.000 kHz	30.000 MHz	10.000 kHz	302.94301 kHz	-73.53 dBm	-60.53 dB
30.000 MHz	1.000 GHz	100.000 kHz	230.76857 MHz	-75.90 dBm	-62.90 dB
1.000 GHz	12.750 GHz	1.000 MHz	1.71948 GHz	-72.30 dBm	-59.30 dB

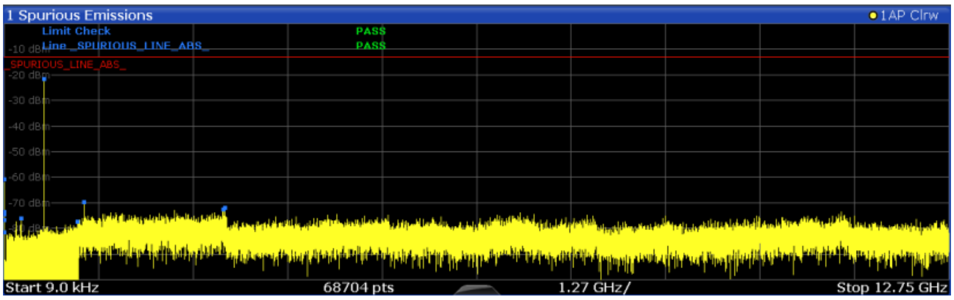
The following information is provided in the evaluation list for each range:

Column	Description
Range Low	Frequency range start for the range the peak value belongs to
Range Up	Frequency range end for the range the peak value belongs to
RBW	RBW of the range
Frequency	Frequency at the peak value
Power Abs	Absolute power level at the peak value
ΔLimit	Deviation of the absolute power level from the defined limit for the peak value

By default, one peak per range is displayed. However, you can change the settings to:

- Display all peaks
- Display a certain number of peaks per range
- Display only peaks that exceed a threshold ("Margin")

In addition to listing the peaks in the list evaluation, detected peaks can be indicated by blue squares in the diagram.



Furthermore, you can save the evaluation list to a file.

Retrieving Results via Remote Control

The measured spurious values of the displayed trace can be retrieved using the `TRAC:DATA? SPUR` command (see `TRACe<n>[:DATA]` on page 702).

4.6.3 Spurious Emissions Basics

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

4.6.3.1 Ranges and Range Settings

Conditions for ranges

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but may have gaps).
- The maximum number of ranges is 30 (in firmware versions < 1.60: 20 ranges).
- The maximum number of sweep points in all ranges is limited to 100001.

If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Defining ranges by remote control

In Spurious Emissions measurements, there are no remote commands to insert new ranges between existing ranges directly. However, you can delete or re-define the existing ranges to create the required order.

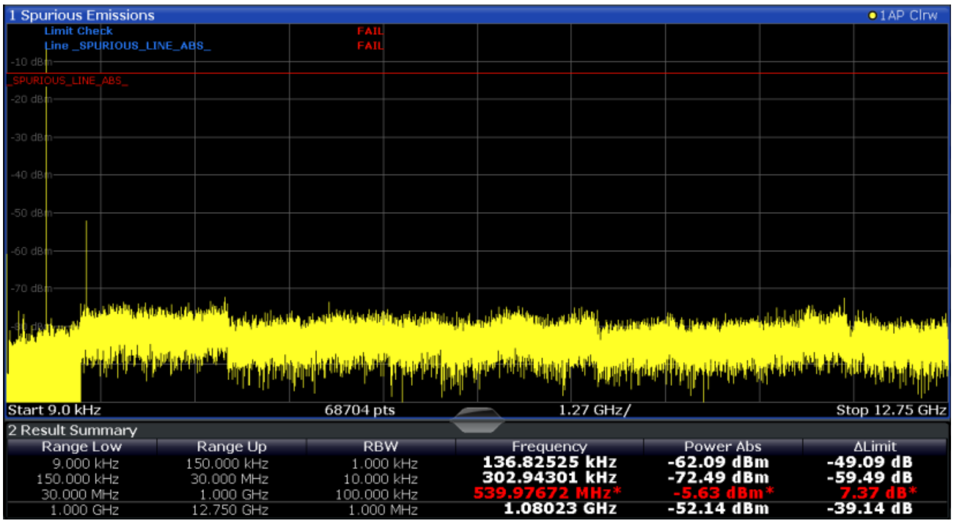
A remote command example for defining parameters and ranges in Spurious Emissions measurements is described in chapter 10.3.7.6, "Programming Example: Spurious Emissions Measurement", on page 584.

4.6.3.2 Limit Lines in Spurious Measurements

Limit lines allow you to check the measured data against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the LINES key. For Spurious measurements, however, a special limit line is available via the "Sweep List", and it is strongly recommended that you use only this limit line definition.

In the "Sweep List" you can define a limit line that varies its level according to the specified frequency ranges. A distinguished limit line ("_SPURIOUS_LINE_ABS") is automatically defined according to the current "Sweep List" settings every time the settings change.

If a limit check is activated in the "Sweep List", the "_SPURIOUS_LINE_ABS" limit line is indicated by a red line in the display, and the result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a "margin" function as for general limit lines is not available. Also, only absolute limits can be checked, not relative ones.



As for general limit lines, the results of each limit line check are displayed (here: "_SPURIOUS_LINE_ABS"), as well as the combined result for all defined limit lines ("Limit Check").

The limit check is considered to be "failed" if any signal level outside the absolute limits is measured.

In addition to the limit line itself, the largest deviations of the absolute power from the limit line for each range are displayed in the evaluation list if the limit check is activated. Values that exceed the limit are indicated in red and by an asterisk (*).

Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list can be defined in the list evaluation settings. Furthermore, you can define how many peaks per range are listed. For details see chapter 4.6.4.3, "List Evaluation", on page 135.

4.6.4 Spurious Emissions Measurement Configuration

Spurious emissions measurements are selected via the "Spurious Emissions" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Spurious Emissions" dialog box, which is displayed when you select the "Spurious Setup" button in the "Overview" or the "Sweep List" softkey from the "Spurious Emissions" menu.

For details on using the configuration "Overview", see chapter 5.1, "Configuration Overview", on page 181.

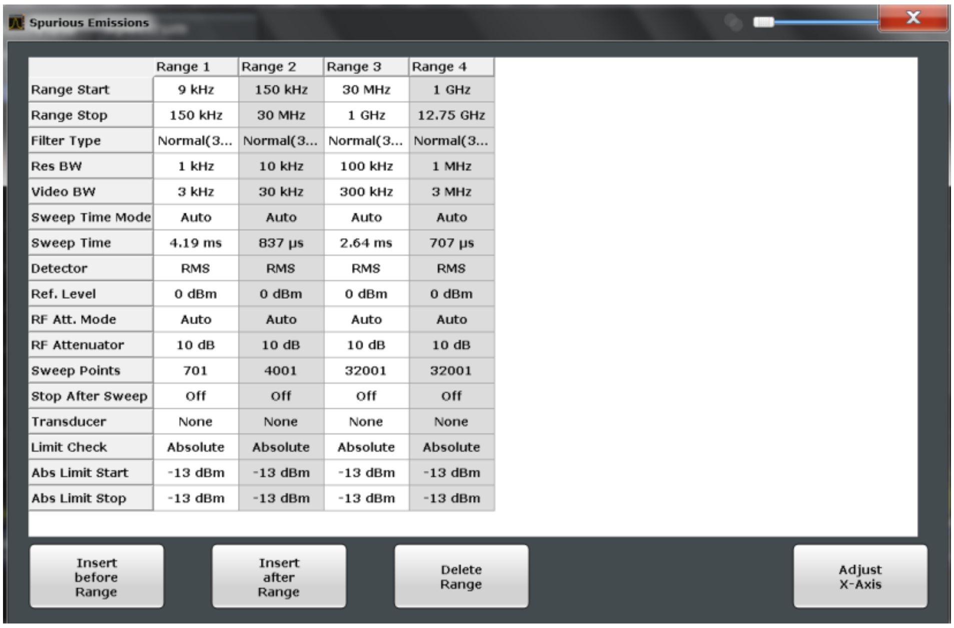
The remote commands required to perform these tasks are described in chapter 10.3.7, "Measuring Spurious Emissions", on page 574.

The following settings are available in individual tabs of the "Spurious Emissions" configuration dialog box, or via softkeys in the "SpurEm" menu.

4.6.4.1 Sweep List

For Spurious Emissions measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply. In the "Sweep List" dialog box you configure the individual frequency ranges and limits.

If you edit the sweep list, always follow the rules and consider the limitations described in chapter 4.6.3.1, "Ranges and Range Settings", on page 129.



	Range 1	Range 2	Range 3	Range 4
Range Start	9 kHz	150 kHz	30 MHz	1 GHz
Range Stop	150 kHz	30 MHz	1 GHz	12.75 GHz
Filter Type	Normal(3...	Normal(3...	Normal(3...	Normal(3...
Res BW	1 kHz	10 kHz	100 kHz	1 MHz
Video BW	3 kHz	30 kHz	300 kHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto	Auto
Sweep Time	4.19 ms	837 µs	2.64 ms	707 µs
Detector	RMS	RMS	RMS	RMS
Ref. Level	0 dBm	0 dBm	0 dBm	0 dBm
RF Att. Mode	Auto	Auto	Auto	Auto
RF Attenuator	10 dB	10 dB	10 dB	10 dB
Sweep Points	701	4001	32001	32001
Stop After Sweep	Off	Off	Off	Off
Transducer	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute
Abs Limit Start	-13 dBm	-13 dBm	-13 dBm	-13 dBm
Abs Limit Stop	-13 dBm	-13 dBm	-13 dBm	-13 dBm

Range Start / Range Stop

Sets the start frequency/stop frequency of the selected range.

If you set a span that is smaller than the overall span of the ranges, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

SCPI command:

`[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt` on page 577

`[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP` on page 578

Filter Type

Sets the filter type for this range.

For details on filter types see chapter 5.5.1.6, "Which Data May Pass: Filter Types", on page 241.

SCPI command:

`[SENSe:]LIST:RANGe<range>:FILTer:TYPE` on page 577

RBW

Sets the RBW value for this range.

For details on the RBW see chapter 5.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 238.

SCPI command:

`[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution]` on page 575

VBW

Sets the VBW value for this range.

For details on the VBW see chapter 5.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 239.

SCPI command:

`[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo` on page 575

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode see chapter 5.5.1.7, "How Long the Data is Measured: Sweep Time", on page 242

SCPI command:

`[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO` on page 582

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time see chapter 5.5.1.7, "How Long the Data is Measured: Sweep Time", on page 242

SCPI command:
`[SENSe:]LIST:RANGe<range>:SWEep:TIME` on page 581

Detector
Sets the detector for the range. For details refer to chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282.

SCPI command:
`[SENSe:]LIST:RANGe<range>:DETector` on page 576

Ref. Level
Sets the reference level for the range.

For details on the reference level see chapter 5.4.1.1, "Reference Level", on page 229.

SCPI command:
`[SENSe:]LIST:RANGe<range>:RLEVel` on page 581

RF Att. Mode
Activates or deactivates the auto mode for RF attenuation.

For details on attenuation see chapter 5.4.1.2, "RF Attenuation", on page 230.

SCPI command:
`[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO` on page 579

RF Attenuator
Sets the attenuation value for that range.

For details on attenuation see chapter 5.4.1.2, "RF Attenuation", on page 230.

SCPI command:
`[SENSe:]LIST:RANGe<range>:INPut:ATTenuation` on page 578

Preamp
Switches the preamplifier on or off.

For details on the preamplifier see "Preamplifier (option B24)" on page 234.

SCPI command:
`[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe` on page 579

Sweep Points
Sets the number of sweep points for the specified range.

For details on sweep points see chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242.

SCPI command:
`[SENSe:]LIST:RANGe<range>:POINts` on page 581

Stop After Sweep
This command configures the sweep behavior.

"ON" The R&S FSW stops after one range is swept and continues only if you confirm (a message box is displayed).

"OFF" The R&S FSW sweeps all ranges in one go.

SCPI command:
`[SENSe:]LIST:RANGe:BREak` on page 575

Transducer
Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers see chapter 8.2, "Basics on Transducer Factors", on page 388.

SCPI command:
`[SENSe:]LIST:RANGe<range>:TRANsducer` on page 582

Limit Check
Activates or deactivates the limit check for all ranges.

For details on limit checks see chapter 4.6.3.2, "Limit Lines in Spurious Measurements", on page 129.

"Absolute" Signal is checked against absolute limit values

"None" No limit check is performed.

SCPI command:
`[SENSe:]LIST:RANGe:LIMit:STATe` on page 580
`CALCulate<n>:LIMit<k>:FAIL` on page 754

Abs Limit Start/Stop
Sets an absolute limit value at the start or stop frequency of the range [dBm].

SCPI command:
`[SENSe:]LIST:RANGe<range>:LIMit:STARt` on page 580
`[SENSe:]LIST:RANGe<range>:LIMit:STOP` on page 580

Insert before/after Range
Inserts a new range to the left of the currently focused range (before) or to the right (after). The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

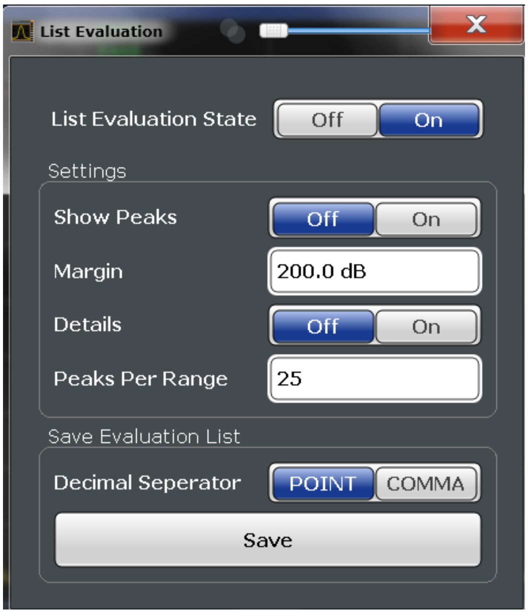
Delete Range
Deletes the currently focused range. The range numbers are updated accordingly.

4.6.4.2 Adjusting the X-Axis to the Range Definitions

The frequency axis of the measurement diagram can be adjusted automatically so that the span of all sweep list ranges corresponds to the displayed span. Thus, the x-axis range is set from the start frequency of the first sweep range to the stop frequency of the last sweep range.

4.6.4.3 List Evaluation

In the "List Evaluation" dialog box, which is displayed when you select the "Evaluations" button in the "Overview" or the "List Evaluation" softkey in the "Spurious Emissions" menu, you configure the contents and display of the result list.



List Evaluation State

Activates or deactivates the list evaluation.

SCPI command:

`CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:AUTO` on page 569

`TRACe<n>[:DATA]` on page 702

Show Peaks

If activated, all peaks that have been detected during an active list evaluation are marked with blue squares in the diagram.

SCPI command:

`CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:PSHow` on page 570

Margin
Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list (and diagram, if activated) can be defined. Only peaks that exceed the margin value are displayed.

SCPI command:
`CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:MARGin` on page 570

Details
Configures how detailed the list is.

On	Includes all detected peaks (up to a maximum defined by "Peaks per Range").
Off	Includes only one peak per range.

Peaks per Range
Defines the maximum number of peaks per range that are stored in the list. Once the selected number of peaks has been reached, the peak search is stopped in the current range and continued in the next range. The maximum value is 50.

SCPI command:
`CALCulate<n>:PSEarch|PEAKsearch:SUBRanges` on page 583

Saving the Evaluation List
Exports the evaluation list of the Spurious Emissions measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details see "How to Save the Spurious Emissions Evaluation List" on page 137.

SCPI command:
`MMEMory:STORe:LIST` on page 775
`FORMat:DEXPort:DSEParator` on page 756

4.6.5 How to Perform a Spurious Emissions Measurement

1. Press the MEAS key, then select the "Spurious Emissions" measurement.
2. Define the span of the signal to be monitored in the general span settings.
3. Select the "Overview" softkey, then select the "Spurious Setup" button.
   The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   Define the required ranges in the "Sweep List" using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range.
5. Define the measurement parameters for each range as required.

6. Optionally, define a limit check.
   a) Activate the limit check by setting "Limit Check" to "Absolute". The limit check is always activated or deactivated for all ranges simultaneously.
   b) Define the limit line's start and stop values for each range of the signal. If a signal level higher than the defined limit is measured, the limit check fails, which may indicate a spurious emission.
7. Configure the peak detection during a Spurious Emissions measurement: select the "Evaluations" button in the "Overview".
   - To indicate the determined peaks in the display, activate the "Show Peaks" option.
   - To restrict peak detection, define a "Margin". Only peaks that exceed this value are detected.
   - To allow for more peaks per range to be detected than the default 1, increase the "Peaks Per Range" value and set "Details" to "On".
8. Start a sweep.

   The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
9. To save the evaluation list, export the results to a file as described in "How to Save the Spurious Emissions Evaluation List" on page 137.

How to Save the Spurious Emissions Evaluation List

The evaluation list from a Spurious Emissions measurement can be saved to a file, which can be exported to another application for further analysis, for example.

1. Configure and perform an Spurious Emissions measurement as described in chapter 4.6.5, "How to Perform a Spurious Emissions Measurement", on page 136.
2. Select the "Evaluations" button in the "Overview".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

   The file with the specified name and the extension `.dat` is stored in the defined storage location.

4.6.6 Reference: ASCII Export File Format (Spurious)

The file has a header containing important parameters for scaling, several data sections containing the sweep settings per range, and a data section containing the peak list.

The header data is made up of three columns, separated by ';', with the syntax:

parameter name; numeric value; basic unit

File contents	Explanation
File header	
Type;FSW-26;	Model
Version;1.00;	Firmware version
Date;31.Mar 11;	Storage date of data set
Mode;ANALYZER; SPURIOUS;	Operating mode and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;26499982000.000000;Hz	
x-Axis;LIN;	
Start;9000.000000;Hz Stop;8000000000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Sweep Count;1;	
TRACE 1:	
Trace Mode;CLR/WRITE;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
Margin;6.000000;s	Peak List margin
PeaksPerRange;25;	Max. number of peaks per range to be detected
Values;3;	Number of detected peaks

File contents	Explanation
File data section	
0;9000;150000;1000;79500;-25.006643295288086;-12.006643295288086;PASS; 0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS; 0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;

4.7 Statistical Measurements (APD, CCDF)

To measure the amplitude distribution, the R&S FSW has simple measurement functions to determine both the Amplitude Probability Distribution (APD) and the Complementary Cumulative Distribution Function (CCDF). Only one of the signal statistic functions can be switched on at a time.

4.7.1 About the Measurements

The probability of amplitude values can be measured with the Amplitude Probability Distribution function (APD). During a selectable measurement time all occurring amplitude values are assigned to an amplitude range. The number of amplitude values in the individual ranges is counted and the result is displayed as a histogram.

Alternatively, the Complementary Cumulative Distribution Function (CCDF) can be displayed. It shows the probability that the mean signal power amplitude will be exceeded in percent.

Only one of the signal statistic functions can be switched on at a time. When a statistic function is switched on, the R&S FSW is set into zero span mode automatically. The R&S FSW measures the statistics of the signal applied to the RF input with the defined analysis bandwidth. To avoid affecting the peak amplitudes the video bandwidth is automatically set to 10 times the analysis bandwidth. The sample detector is used for detecting the video voltage.

Statistic measurements on pulsed signals can be performed using a gated trigger. For details see chapter 4.7.4, "APD and CCDF Basics - Gated Triggering", on page 143.

4.7.2 Typical Applications

Digital modulated signals are similar to white noise within the transmit channel, but are different in their amplitude distribution. In order to transmit the modulated signal without distortion, all amplitudes of the signal have to be transmitted linearly from the output power amplifier. Most critical are the peak amplitude values. Degradation in transmit quality caused by a transmitter two port network is dependent on the amplitude of the peak values as well as on their probability.

If modulation types are used that do not have a constant envelope in zero span, the transmitter has to handle peak amplitudes that are greater than the average power. This includes all modulation types that involve amplitude modulation, QPSK for example. CDMA transmission modes in particular may have power peaks that are large compared to the average power.

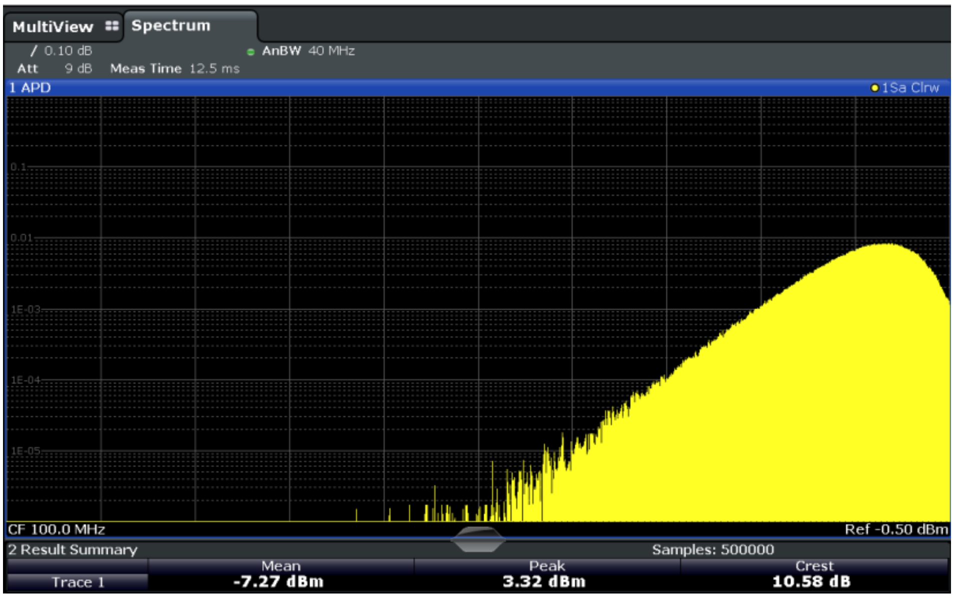
For signals of this kind, the transmitter must provide large reserves for the peak power to prevent signal compression and thus an increase of the bit error rate at the receiver. The peak power or the crest factor of a signal is therefore an important transmitter design criterion. The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal. To reduce power consumption and cut costs, transmitters are not designed for the largest power that could ever occur, but for a power that has a specified probability of being exceeded (e.g. 0.01 %).

The statistical functions provide information on such signal criteria.

4.7.3 APD and CCDF Results

Amplitude Probability Distribution (APD)

As a result of the Amplitude Probability Distribution (APD) function, the probability of measured amplitude values is displayed. During a selectable measurement time all measured amplitude values are assigned to an amplitude range. The number of amplitude values in the specific ranges is counted and the result is displayed as a histogram. Each bar of the histogram represents the percentage of measured amplitudes within the specific amplitude range. The x-axis represents the amplitude values and is scaled in absolute values (dBm).



In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:
  – Mean amplitude
  – Peak amplitude
  – Crest factor
    The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal.

Complementary Cumulative Distribution Function (CCDF)

The Complementary Cumulative Distribution Function (CCDF) shows the probability that the mean signal power amplitude will be exceeded in percent. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

A red line indicates the ideal Gaussian distribution for the measured amplitude range.

The displayed amplitude range is indicated as "Mean Pwr + <x dB>"

In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:

Mean	Mean power
Peak	Peak power
Crest	Crest factor (peak power – mean power)
10 %	Level values over 10 % above mean power
1 %	Level values over 1 % above mean power
0,1 %	Level values over 0,1 % above mean power
0,01 %	Level values over 0,01 % above mean power

Percent marker

In addition to the results for specific percentages in the table, a percent marker can be activated for a freely selectable percentage. This marker indicates how many level values are over <x> % above the mean power.

Percent marker

As all markers, the percent marker can be moved simply by selecting it with a finger or mouse cursor and dragging it to the desired position.

Diagram Scaling

The scaling for both the x-axis and y-axis of the statistics diagram can be configured. In particular, you can restrict the range of amplitudes to be evaluated and the probabilities to be displayed.

SCPI commands:

CALCulate<n>:STATistics:CCDF:X<t>? on page 593

CALCulate:STATistics:RESult<t>? on page 593

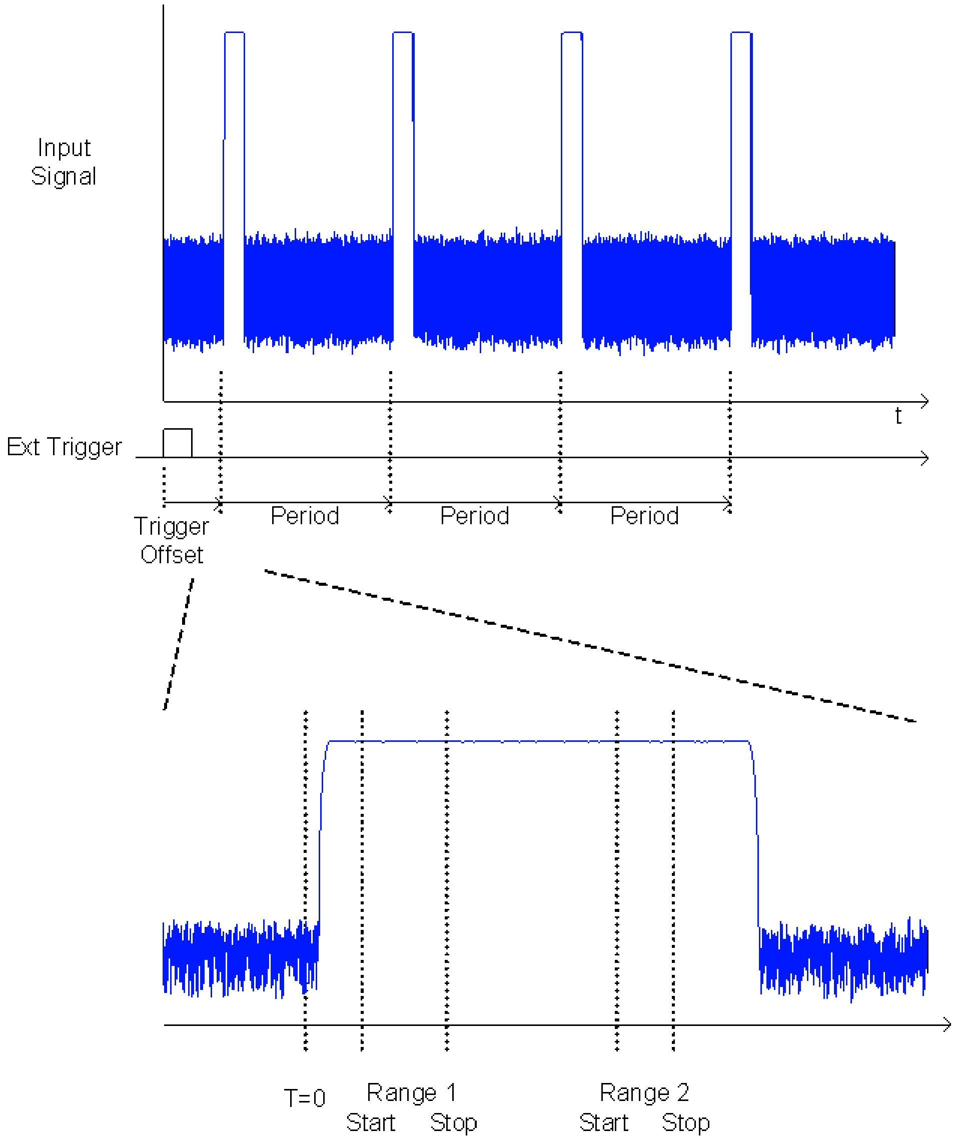
4.7.4 APD and CCDF Basics - Gated Triggering

Statistic measurements on pulsed signals can be performed using a gated trigger. An external frame trigger is required as a time (frame) reference.

The gate ranges define the part of the measured data taken into account for the statistics calculation. These ranges are defined relative to a reference point T=0. The gate interval is repeated for each period until the end of the capture buffer.

The reference point T=0 is defined by the external trigger event and the instrument's trigger offset.

For each trace you can define up to 3 separate ranges of a single period to be traced.



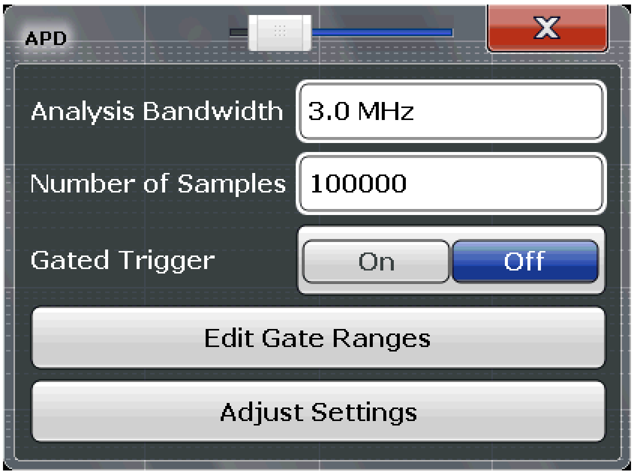
4.7.5 APD and CCDF Configuration

Configuration consists of the following settings:

4.7.5.1 Basic Settings

APD measurements are selected via the "APD" button in the "Select Measurement" dialog box. CCDF measurements are selected via the "CCDF" button in the "Select Measurement" dialog box. The measurements are started immediately with the default settings. They can be configured via the MEAS CONFIG key or in the "APD/CCDF" dialog boxes, which are displayed as a tab in the "Analysis" dialog box or when you select the "APD Config" softkey from the "APD" menu or the "CCDF Config" softkey from the "CCDF" menu.

The remote commands required to perform these tasks are described in chapter 10.3.8, "Analyzing Statistics (APD, CCDF)", on page 586.



Both dialog boxes are identical except for the "Percent Marker" setting, which is only available for CCDF measurements.

Percent Marker (CCDF only)
Defines a probability value. Thus, the power which is exceeded with a given probability can be determined very easily. If marker 1 is deactivated, it is switched on automatically.

SCPI command:
`CALCulate<n>:MARKer<m>:Y:PERCent` on page 587

Analysis Bandwidth
Defines the analysis bandwidth.

For correct measurement of the signal statistics, the analysis bandwidth has to be wider than the signal bandwidth in order to measure the peaks of the signal amplitude correctly. To avoid influencing the peak amplitudes, the video bandwidth is automatically set to 10 MHz. The sample detector is used for detecting the video voltage.

The calculated measurement time is displayed for reference only.

SCPI command:
`[SENSe:]BANDwidth|BWIDth[:RESolution]` on page 632

Number of Samples
Defines the number of power measurements that are taken into account for the statistics.

For statistics measurements with the R&S FSW, the number of samples to be measured is defined instead of the sweep time. Since only statistically independent samples contribute to statistics, the sweep or measurement time is calculated automatically and displayed in the channel bar ("Meas Time"). The samples are statistically independent if the time difference is at least 1/RBW. The measurement time is, therefore, expressed as follows:

Meas Time = $N_{Samples}$/RBW

SCPI command:
`CALCulate<n>:STATistics:NSAMples` on page 588

Gated Trigger
Activates and deactivates gating for statistics functions for the ACP and the CCDF measurements. If activated, the trigger source is changed to "External Trigger 1". The gate ranges are defined using the Edit Gate Ranges function.

SCPI command:
`[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]` on page 589

Edit Gate Ranges
Opens a dialog box to configure up to 3 gate ranges for each trace. For details see chapter 4.7.5.2, "Gate Range Definition for APD and CCDF", on page 146.

Adjust Settings
Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

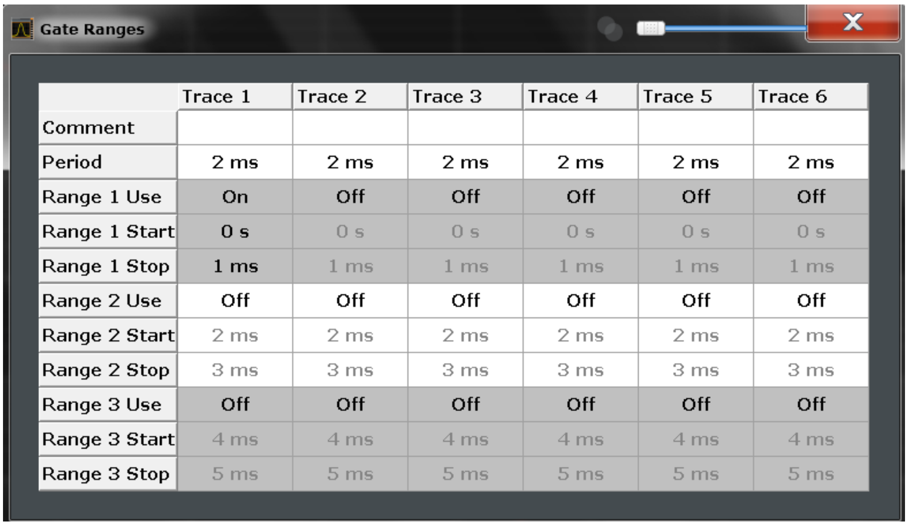
SCPI command:
`CALCulate<n>:STATistics:SCALe:AUTO ONCE` on page 591

4.7.5.2 Gate Range Definition for APD and CCDF

Gate ranges for gated triggering in statistical measurements can be configured in the "Gate Ranges" dialog box, which is displayed when you select the "Edit Gate Ranges" button in the "APD" or "CCDF" configuration dialog boxes.

For background information on defining gate ranges see chapter 4.7.4, "APD and CCDF Basics - Gated Triggering", on page 143.

The remote commands required to perform these tasks are described in chapter 10.3.8.3, "Using Gate Ranges for Statistical Measurements", on page 588.



	Trace 1	Trace 2	Trace 3	Trace 4	Trace 5	Trace 6
Comment						
Period	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 1 Use	On	Off	Off	Off	Off	Off
Range 1 Start	0 s	0 s	0 s	0 s	0 s	0 s
Range 1 Stop	1 ms	1 ms	1 ms	1 ms	1 ms	1 ms
Range 2 Use	Off	Off	Off	Off	Off	Off
Range 2 Start	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 2 Stop	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
Range 3 Use	Off	Off	Off	Off	Off	Off
Range 3 Start	4 ms	4 ms	4 ms	4 ms	4 ms	4 ms
Range 3 Stop	5 ms	5 ms	5 ms	5 ms	5 ms	5 ms

Up to three ranges can be defined for each of the six available traces.

Comment

An optional comment can be defined for the gate range settings of each trace.

SCPI command:

`[SENSe:]SWEep:EGATe:TRACe<k>:COMMent` on page 588

Period

Length of the period to be traced. The period is the same for all traces. If you change the period for one trace, it is automatically changed for all traces.

Make sure the defined period is not longer than the total measurement time of the current measurement. Keep in mind that the measurement time depends on the bandwidth and the number of samples (see "Number of Samples" on page 145). The current measurement time is indicated as "Meas Time" in the channel bar.

SCPI command:

`[SENSe:]SWEep:EGATe:TRACe:PERiod` on page 588

Range <x> Use

Activates tracing of the defined range during a gated measurement.

SCPI command:

`[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>]` on page 589

Range <x> Start/Stop

Defines the start and stop points of the range within the tracing period. Make sure the value for the stopping time is smaller than the length of the period.

Note: You can define the time values with a greater numerical resolution than is displayed; the values are only rounded for display.

SCPI command:

`[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range>` on page 589

`[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range>` on page 589

4.7.5.3 Scaling for Statistics Diagrams

The diagram scaling for statistical measurements can be configured in the "Scaling" dialog box, which is displayed when you select the AMPT key and then the "Scale Config" softkey.

The remote commands required to perform these tasks are described in chapter 10.3.8.4, "Scaling the Diagram", on page 590.

In statistical diagrams, the x-axis displays the signal level values (= y-axis in standard display), while the y-axis displays the probability of the values.

X-Axis

Defines the scaling settings for signal level values.

Range ← X-Axis

Defines the level range in dB to be evaluated by the statistics measurement.

SCPI command:

`CALCulate<n>:STATistics:SCALe:X:RANGe` on page 591

Ref Level ← X-Axis

Defines the reference level for the signal levels in the currently active unit (dBm, dBµV, etc).

For the APD function this value corresponds to the right diagram border. For the CCDF function there is no direct representation of this value on the diagram as the x-axis is scaled relatively to the measured mean power.

SCPI command:

`CALCulate<n>:STATistics:SCALe:X:RLEVel` on page 591

Shifting the Display (Offset) ← X-Axis

Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the x-axis is changed accordingly. The setting range is ±200 dB in 0.1 dB steps.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet` on page 639

Y-Axis

Defines the scaling settings for the probability distribution.

Y-Unit ← Y-Axis

Defines the scaling type of the y-axis as either percentage or absolute. The default value is absolute scaling.

SCPI command:

`CALCulate<n>:STATistics:SCALe:Y:UNIT` on page 592

Y-Max / Y-Min ← Y-Axis

Defines the upper (max) and lower (min) limit of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. The minimum value must be in the range:

1E-9 < Y-Min < 0.1

The distance between Y-max and Y-min must be at least one decade.

SCPI command:

`CALCulate<n>:STATistics:SCALe:Y:UPPer` on page 592

`CALCulate<n>:STATistics:SCALe:Y:LOWer` on page 592

Default Settings

Resets the x- and y-axis scalings to their preset values.

x-axis ref level:	-10 dBm
x-axis range APD:	100 dB
x-axis range CCDF:	20 dB
y-axis upper limit:	1.0
y-axis lower limit:	1E-6

SCPI command:
`CALCulate<n>:STATistics:PRESet` on page 590

Adjust Settings
Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

SCPI command:
`CALCulate<n>:STATistics:SCALe:AUTO ONCE` on page 591

4.7.6 How to Perform an APD or CCDF Measurement

To start a basic statistic measurement

1. Press the MEAS key, then select the "APD" or "CCDF" measurement.
2. Start a sweep.

   As soon as the defined number of samples have been measured, the statistical evaluation is displayed.

To perform a statistic measurement using gate ranges

For pulsed signals, the transmission intervals should not be included in the statistical evaluation. Thus, you must define gate ranges to be included in the measurement.

1. Press the MEAS CONFIG key, then select the "APD Config" or "CCDF Config" softkey.

   The "APD" or "CCDF" dialog box is displayed.
2. Select the "Edit Gate Ranges" button.
3. Define the time period for which the input signal is to be analyzed, for example the duration of 3 signal pulses.
4. For each active trace, define up to three ranges within the time period to be measured. In the example covering 3 pulses, you could define one range for each pulse.
   a) Assuming the external trigger determines T=0 as the start of the first pulse, define the start time of range 1 at 0 s.
   b) Define the stop time of range 1 at the duration of the first pulse.

c) Activate range 1 by setting "Range 1 Use" to *On*.
d) Define the start time of range 2 as (duration of pulse 1 + duration of interval)
e) Define the stop time of range 2 as (start time of range 2 + duration of pulse 2)
f) Activate range 2 by setting "Range 2 Use" to *On*.
g) Define the third range in the same way.

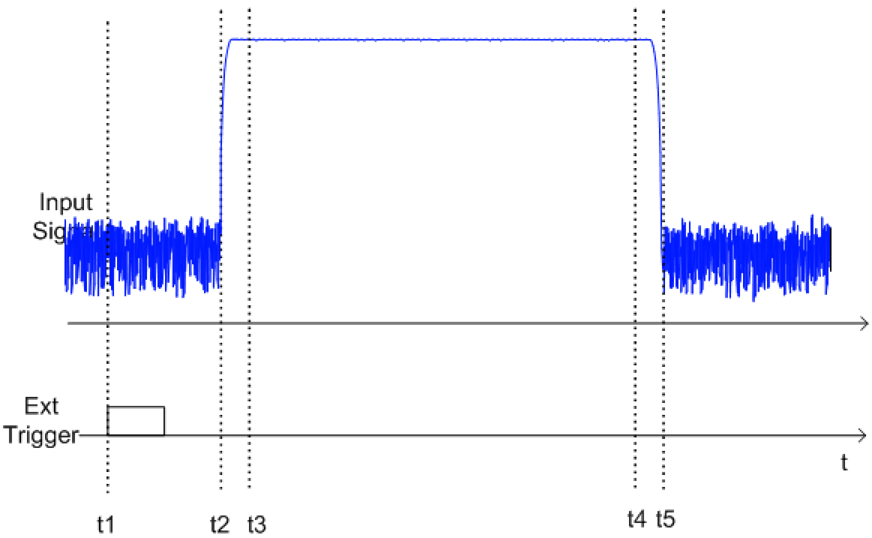
5. Start a sweep.

   As soon as the defined number of samples have been measured, the statistical evaluation is displayed. Only the signal levels within the pulse periods are considered.

4.7.7 Examples

4.7.7.1 Configuration Example: Gated Statistics

A statistics evaluation has to be done over the useful part of the signal between t3 and t4. The period of the GSM signal is 4.61536 ms.



t1: External positive trigger slope

t2: Begin of burst (after 25 µs)

t3: Begin of useful part, to be used for statistics (after 40 µs)

t4: End of useful part, to be used for statistics (after 578 µs)

t5: End of burst (after 602 µs)

The instrument has to be configured as follows:

Trigger Offset	t2 – t1 = 25 µs	now the gate ranges are relative to t2
Range1 Start	t3 – t2 = 15 µs	start of range 1 relative to t2
Range1 End	t4 – t2 = 553 µs	end of range 1 relative to t2

4.7.7.2 Measurement Example – Measuring the APD and CCDF of White Noise Generated by the R&S FSW

Setting the RBW

When the amplitude distribution is measured, the analysis bandwidth must be set so that the complete spectrum of the signal to be measured falls within the bandwidth. This is the only way of ensuring that all the amplitudes will pass through the IF filter without being distorted. If the selected bandwidth is too small for a digitally modulated signal, the amplitude distribution at the output of the IF filter becomes a Gaussian distribution according to the central limit theorem and thus corresponds to a white noise signal. The true amplitude distribution of the signal therefore cannot be determined.

1. Preset the R&S FSW.
2. Set the reference level to *-60 dBm*.

   The R&S FSW's intrinsic noise is displayed at the top of the screen.
3. Select the "APD" measurement function from the "Select Measurement" dialog box.

   The R&S FSW sets the frequency span to 0 Hz and measures the amplitude probability distribution (APD). The number of uncorrelated level measurements used for the measurement is 100000. The mean power and the peak power are displayed in dBm. The crest factor (peak power – mean power) is output as well.

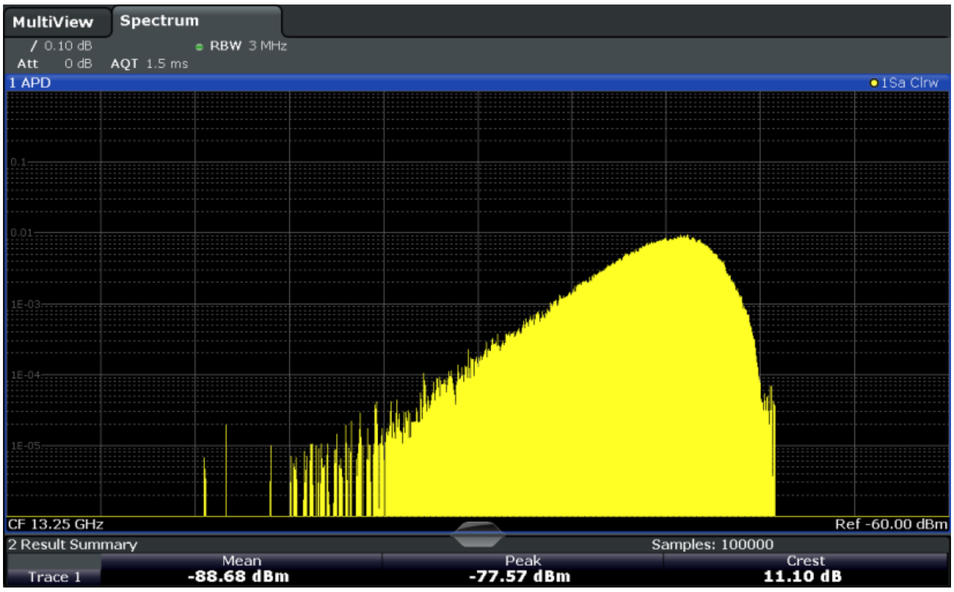


Fig. 4-12: Amplitude probability distribution of white noise

4. Now select the "CCDF" measurement function from the "Select Measurement" dialog box.

Fig. 4-13: CCDF of white noise

The CCDF trace indicates the probability that a level will exceed the mean power. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

4.7.8 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Make sure the defined bandwidth is wide enough for the signal bandwidth of the device under test to be fully analyzed (see "Analysis Bandwidth" on page 145).
- If the complete signal is be measured, increase the number of samples so that the resulting measurement time is longer than one period of a bursted signal.
- If only parts of the signal are to be examined, define a trigger source and a gate.

4.8 Time Domain Power Measurement

The R&S FSW can determine the power of a signal in the time domain using the Time Domain Power measurement function.

4.8.1 About the Measurement

Using the Time Domain Power measurement function, the R&S FSW determines the power of the signal in zero span by summing up the power at the individual measurement points and dividing the result by the number of measurement points. Thus it is possible to measure the power of TDMA signals during transmission, for example, or during the muting phase. Both the mean power and the RMS power can be measured.

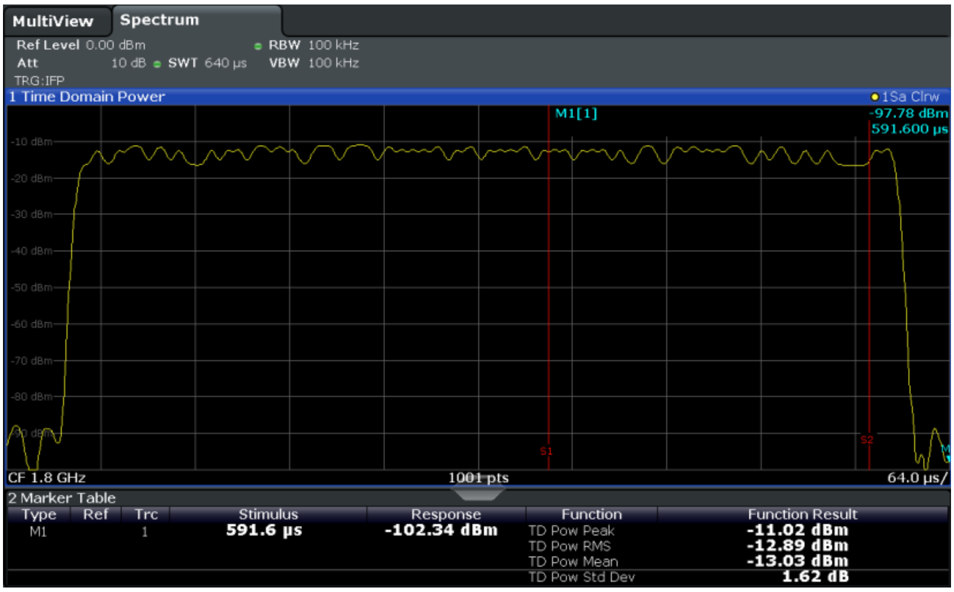
For this measurement, the sample detector is activated.

4.8.2 Time Domain Power Results

Several different power results can be determined simultaneously:

Mode	Description
Peak	Peak value from the points of the displayed trace or a segment thereof.
RMS	RMS value from the points of the displayed trace or a segment thereof.
Mean	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated. For example to measure the mean power during a GSM burst
Std Dev	The standard deviation of the measurement points from the mean value.

The result is displayed in the marker results, indicated by "Power" and the selected power mode, e.g. "RMS". The measured values are updated after each sweep or averaged over a user-defined number of sweeps (trace averaging).



The results can also be queried using the remote commands described in chapter 10.3.9, "Measuring the Time Domain Power", on page 595.

4.8.3 Time Domain Power Basics - Range Definition Using Limit Lines

The range of the measured signal to be evaluated for the power measurement can be restricted using limit lines. The left and right limit lines (S1, S2) define the evaluation range and are indicated by vertical red lines in the diagram. If activated, the power results are only calculated from the levels within the limit lines.

For example, if both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase. The ratio between signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and then varying the measurement range.

In order to get stable measurement results for a limited evaluation range, usually a trigger is required.

4.8.4 Time Domain Power Configuration

Time Domain Power measurements are selected via the "Time Domain Power" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Time Domain Power" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Time Dom Power Config" softkey from the "Time Dom Pwr" menu.

The remote commands required to perform these tasks are described in chapter 10.3.9, "Measuring the Time Domain Power", on page 595.

Results

Activates the power results to be evaluated from the displayed trace or a limited area of the trace.

"Peak"	Peak power over several measurements (uses trace averaging, Max Hold)
"RMS"	RMS value from the points of the displayed trace or a segment thereof.
"Mean"	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated.

"Std Dev" The standard deviation of the measurement points from the mean value.
The measurement of the mean power is automatically switched on at the same time.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe]` on page 597
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?` on page 600
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe]` on page 597
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?` on page 601
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe]` on page 597
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?` on page 599

Limit State
Switches the limitation of the evaluation range on or off. Default setting is off.

If deactivated, the entire sweep time is evaluated. If switched on, the evaluation range is defined by the left and right limit. If only one limit is set, it corresponds to the left limit and the right limit is defined by the stop frequency. If the second limit is also set, it defines the right limit.

SCPI command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 712

Left Limit / Right Limit
Defines a power level limit for line S1 (left) or S2 (right).

SCPI command:
`CALCulate:MARKer:X:SLIMits:LEFT` on page 712
`CALCulate:MARKer:X:SLIMits:RIGHT` on page 713

4.8.5 How to Measure Powers in the Time Domain

To measure the power in the time domain

1. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
2. Select the type of power measurement results to be determined by selecting the corresponding softkeys.
3. To restrict the power evaluation range, define limits:
   a) Select the "Time Dom Power Config" softkey to display the "Time Domain Power" configuration dialog box.
   b) Switch on the limits by setting the "Limit State" to "On".
   The limit lines S1 and S2 are displayed.
   c) Define the left limit (limit line S1), the right limit (S2), or both.

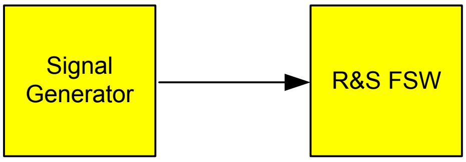
4. Start a sweep.

   The measured powers are displayed in the marker results.

4.8.6 Measurement Example

This measurement example demonstrates the time domain power calculation for a GSM burst.

Test setup:



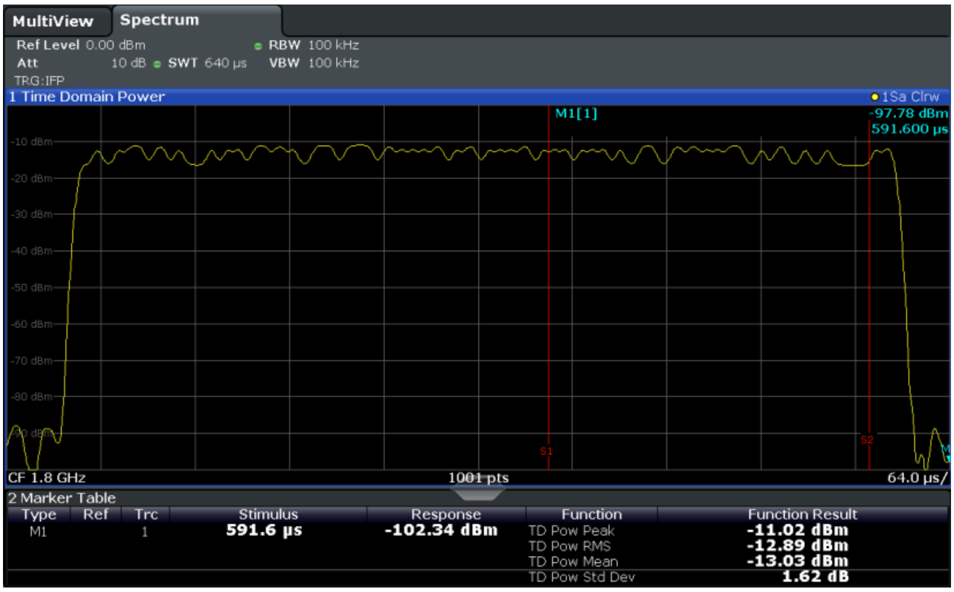
Signal generator settings (e.g. R&S FSW SMU):

Frequency:	1.8 GHz
Level:	-10 dBm
Modulation:	GSM/EDGE

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *1.8 GHz*.
3. Set the RBW to *100 kHz*.
4. Set the sweep time to *640 µs*.
5. Set the trigger source to "IF Power".
6. Define a trigger offset of *-50 µs*.
7. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
8. In the Time Domain Power configuration dialog box, set all four results to "ON".
9. Set the "Limit State" to "ON".
10. Define the left limit at *326 µs* and the right limit at *538 µs*.
    This range corresponds to the useful part of the GSM burst.

    The mean power of the useful part of the GSM burst is calculated to be -13 dBm.



4.9 Harmonic Distortion Measurement

The harmonics and their distortion can be measured using the "Harmonic Distortion" function.

4.9.1 About the Measurement

With this measurement it is possible to measure the harmonics easily, for example from a VCO. In addition, the total harmonic distortion (THD) is calculated.

For measurements in the frequency domain, the Harmonic Distortion measurement starts with an automatic search for the first harmonic (= peak) within the set frequency range. The center frequency is set to this frequency and the reference level is adjusted accordingly.

For measurements in zero span, the center frequency remains unchanged.

The Harmonic Distortion measurement then performs zero span sweeps at the center frequency and at each harmonic, i.e. at frequencies that are a multiple of the center frequency.

As a result, the zero span sweeps on all harmonics are shown, as well as the RMS values and the total harmonic distortion (THD).

4.9.2 Harmonic Distortion Basics

Measuring the harmonics of a signal is a frequent problem which can be solved best using a signal analyzer. In general, every signal contains harmonics. Harmonics are generated by nonlinear characteristics, which add frequencies to a pure sinewave. They can often be reduced by low pass filters. Since the signal analyzer itself has a nonlinear characteristic, for example in its first mixer, measures must be taken to ensure that harmonics produced in the signal analyzer do not cause spurious results. If necessary, the fundamental wave must be attenuated selectively with respect to the other harmonics with a high pass filter. Harmonics are particularly critical regarding high-power transmitters such as transceivers because large harmonics can interfere with other radio services.

Harmonic distortion can be determined as the level of the individual components, or as the root mean square of all components together, the total harmonic distortion (THD). The THD is set in relation to the power of the fundamental frequency (= center frequency).

Obtainable dynamic range

When harmonics are being measured, the obtainable dynamic range depends on the second harmonic intercept of the signal analyzer. The second harmonic intercept is the virtual input level at the RF input mixer at which the level of the 2nd harmonic becomes equal to the level of the fundamental wave. In practice, however, applying a level of this magnitude would damage the mixer. Nevertheless the available dynamic range for measuring the harmonic distance of a DUT can be calculated relatively easily using the second harmonic intercept.

As shown in figure 4-14, the level of the 2nd harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

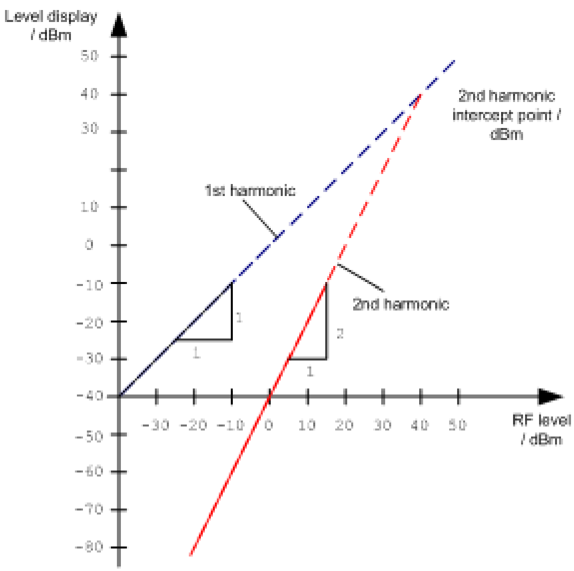


Fig. 4-14: Extrapolation of the 1st and 2nd harmonics to the 2nd harmonic intercept at 40 dBm

The following formula for the obtainable harmonic distortion d_2 in dB is derived from the straight-line equations and the given intercept point:

d_2 = S.H.I – P_I (1)

where:

d_2	=	harmonic distortion
S.H.I.	=	second harmonic intercept
P_I	=	mixer level/dBm

The mixer level is the RF level applied to the RF input minus the set RF attenuation.

The formula for the internally generated level P_1 at the 2nd harmonic in dBm is:

$P_1 = 2 * P_I – S.H.I.$ (2)

The lower measurement limit for the harmonic is the noise floor of the signal analyzer. The harmonic of the measured DUT should – if sufficiently averaged by means of a video filter – be at least 4 dB above the noise floor so that the measurement error due to the input noise is less than 1 dB.

Rules for measuring high harmonic ratios

The following rules for measuring high harmonic ratios can be derived:

- Select the smallest possible IF bandwidth for a minimal noise floor.
- Select an RF attenuation which is high enough to measure the harmonic ratio only.

The maximum harmonic distortion is obtained if the level of the harmonic equals the intrinsic noise level of the receiver. The level applied to the mixer, according to (2), is:

$$P_I = \frac{P_{noise} / dBm + IP2}{2}$$

At a resolution bandwidth of 10 Hz (noise level -143 dBm, S.H.I. = 40 dBm), the optimum mixer level is – 51.5 dBm. According to (1) a maximum measurable harmonic distortion of 91.5 dB minus a minimum S/N ratio of 4 dB is obtained.

Detecting the origin of harmonics

If the harmonic emerges from noise sufficiently (approx. >15 dB), it is easy to check (by changing the RF attenuation) whether the harmonics originate from the DUT or are generated internally by the signal analyzer. If a harmonic originates from the DUT, its level remains constant if the RF attenuation is increased by 10 dB. Only the displayed noise is increased by 10 dB due to the additional attenuation. If the harmonic is exclusively generated by the signal analyzer, the level of the harmonic is reduced by 20 dB or is lost in noise. If both – the DUT and the signal analyzer – contribute to the harmonic, the reduction in the harmonic level is correspondingly smaller.

High-sensitivity harmonics measurements

If harmonics have very small levels, the resolution bandwidth required to measure them must be reduced considerably. The sweep time is, therefore, also increased considerably. In this case, the measurement of individual harmonics is carried out with the R&S FSW set to a small span. Only the frequency range around the harmonics will then be measured with a small resolution bandwidth.

Required measurement time

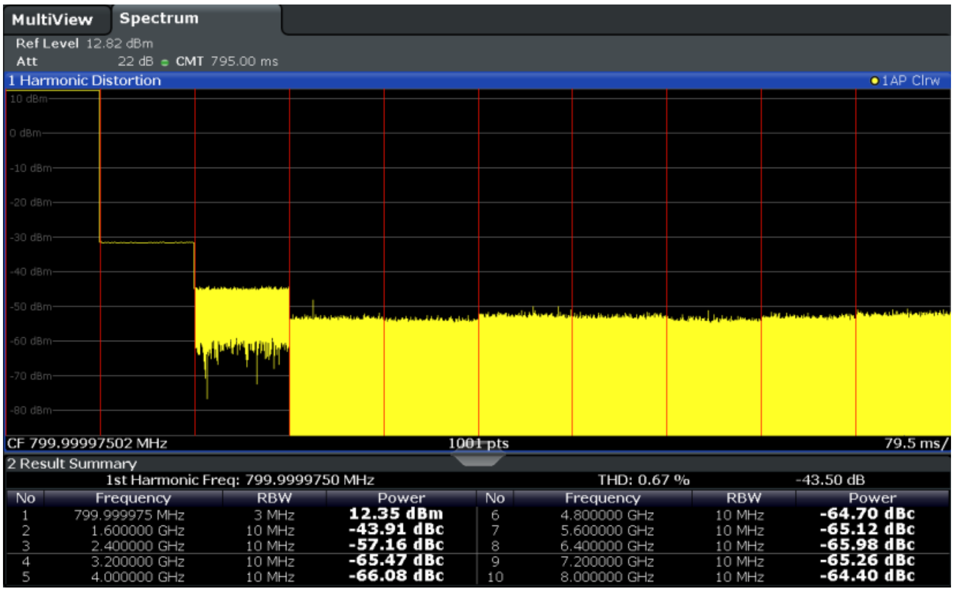
During the harmonics measurement, zero span sweeps are performed at the center frequency and at each harmonic. The duration of each sweep ("Harmonic Sweep Time", **SWT**) and the "Number of Harmonics" (n) are defined in the "Harmonic Distortion" configuration dialog box. Thus, the required measurement time for the harmonic distortion measurement (*Cumulated Measurement Time*, **CMT**) is:

*CMT = n*SWT*

The required measurement time is indicated as "CMT" in the channel bar.

4.9.3 Harmonic Distortion Results

As a result of the harmonics distortion measurement, the zero span sweeps of all detected harmonics are shown in the diagram, separated by red display lines. This provides a very good overview of the measurement.



In addition, a result table is displayed providing the following information:

- First harmonic frequency
- THD (total harmonic distortion), relative and absolute values
- For each detected harmonic:
  - Frequency
  - RBW
  - Power

Remote commands

The results can also be queried using remote commands.

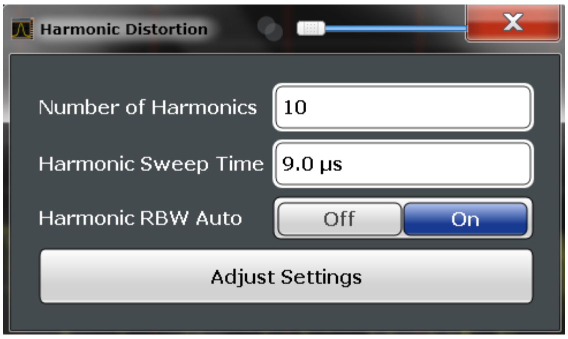
The first harmonic frequency can be read out via the general center frequency command `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 627.

THD: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion?` on page 605

List of harmonics: `CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?` on page 605

4.9.4 Harmonic Distortion Configuration

Harmonic Distortion measurements are selected via the "Harmonic Distortion" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Harmonic Distortion" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Harmonic Distortion Config" softkey from the "Harm Dist" menu.



The remote commands required to perform these tasks are described in chapter 10.3.10, "Measuring the Harmonic Distortion", on page 603.

No. of Harmonics

Defines the number of harmonics to be measured. The range is from 1 to 26. Default is 10.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics` on page 604

Harmonic Sweep Time

Defines the sweep time for the zero span measurement on each harmonic frequency. This setting is identical to the normal sweep time for zero span, see also "Sweep Time" on page 246.

SCPI command:

[SENSe:]SWEep:TIME:AUTO on page 637

Harmonic RBW Auto

Enables/disables the automatic adjustment of the resolution bandwidth for Normal (3dB) (Gaussian) and 5-Pole filter types. The automatic adjustment is carried out according to:

"$RBW_n = RBW_1 * n$"

If RBW_n is not available, the next higher value is used.

SCPI command:

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO on page 604

Adjust Settings

If harmonic measurement was performed in the frequency domain, a new peak search is started in the frequency range that was set before starting the harmonic measurement. The center frequency is set to this frequency and the reference level is adjusted accordingly.

If harmonic measurement was performed in the time domain, this function adjusts the reference level only.

SCPI command:

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet on page 604

4.9.5 How to Determine the Harmonic Distortion

In chapter 6.4.4, "Measurement Example: Measuring Harmonics Using Marker Functions", on page 348, measuring harmonics was described using marker functions. This task can be performed much simpler using the Harmonic Distortion measurement, as described in the following procedure.

1. Select the "Harmonic Distortion" measurement function from the "Select Measurement" dialog box.
2. Define the number of harmonics to be determined using the "No. of Harmonics" softkey.
3. Perform a sweep.

   The trace for the determined harmonics are displayed in the diagram, separated by red display lines. The measured power for each harmonic in relation to the fundamental is indicated in the result table.

4. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

4.10 Third Order Intercept (TOI) Measurement

The third order intercept point of the R&S FSW can be determined if a two-tone signal with equal carrier levels is applied to the input.

4.10.1 About the TOI Measurement

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic. The intermodulation products of lower order have a special effect since their level is largest and they are near the useful signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the useful signals and the 2nd harmonic of the second useful signal in case of two-tone modulation.

In order to measure the third order intercept point (TOI), a two-tone signal with equal carrier levels is expected at the R&S FSW input. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Marker 3 and marker 4 are placed on the intermodulation products.

The R&S FSW calculates the third order intercept point from the level difference between the first 2 markers and the markers 3 and 4 and displays it in the marker field.

4.10.2 TOI Basics

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic.

The frequencies of the intermodulation products are above and below the useful signals. The figure 4-15 shows intermodulation products P_{S1} and P_{S2} generated by the two useful signals P_{U1} and P_{U2}.

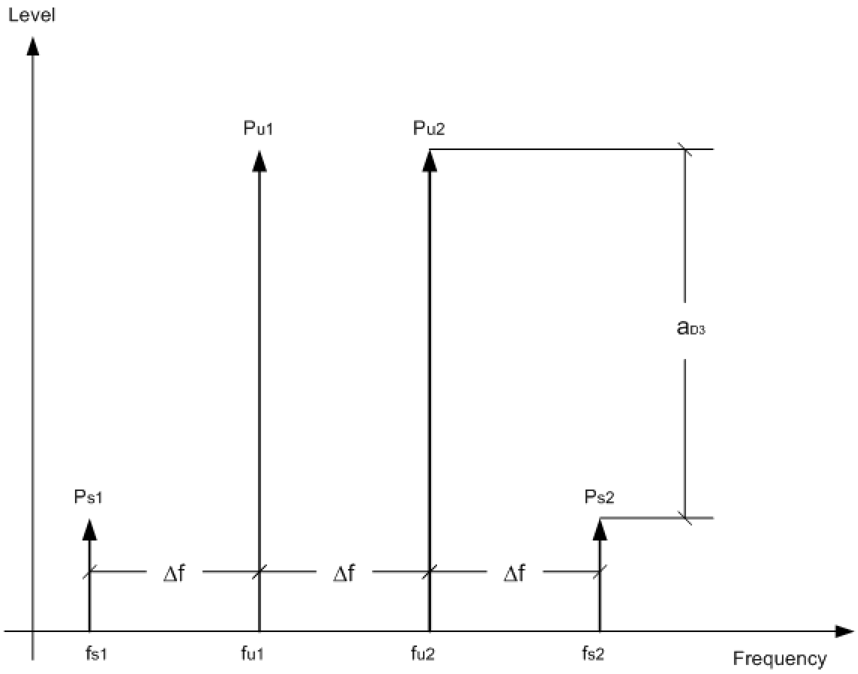


Fig. 4-15: Intermodulation products Ps1 and Ps2

The intermodulation product at f_{i2} is generated by mixing the 2nd harmonic of useful signal P_{U2} and signal P_{U1}.

Tthe intermodulation product at f_{i1} is generated by mixing the 2nd harmonic of useful signal P_{U1} and signal P_{U2}.

$f_{i1} = 2 \times f_{u1} - f_{u2}$ (1)

$f_{i2} = 2 \times f_{u2} - f_{u1}$ (2)

Dependency on level of useful signals

The level of the intermodulation products depends on the level of the useful signals. If the two useful signals are increased by 1 dB, the level of the intermodulation products increases by 3 dB, which means that the spacing a_{D3} between intermodulation signals and useful signals is reduced by 2 dB. This is illustrated in figure 4-16.

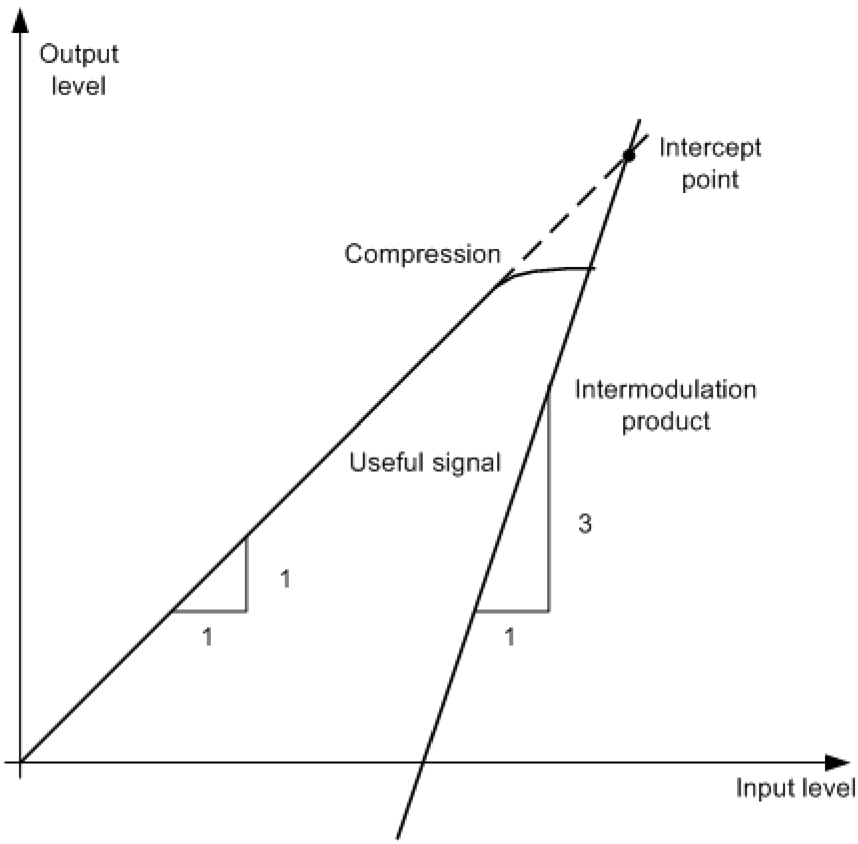


Fig. 4-16: Dependency of intermodulation products on level of useful signals

The useful signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly since the useful level is previously limited by the maximum two-port output power.

Calculation method

However, the intercept point can be calculated from the known line slopes and the measured spacing a_{D3} at a given level according to the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_N$$

The third order intercept point (TOI), for example, is calculated for an intermodulation of 60 dB and an input level P_U of -20 dBm according to the following formula:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm$$

Intermodulation-free dynamic range

The "Intermodulation-free dynamic range", i.e. the level range in which no internal intermodulation products are generated if two-tone signals are measured, is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor, i.e. the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the resolution bandwidth that has been selected. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum and so the maximum range is obtained. However, a large increase in sweep time is required for small resolution bandwidths. It is therefore best to select the largest resolution bandwidth possible to obtain the range that is required. Since phase noise decreases as the carrier-offset increases, its influence decreases with increasing frequency offset from the useful signals.

The following diagrams illustrate the intermodulation-free dynamic range as a function of the selected bandwidth and of the level at the input mixer (= signal level – set RF attenuation) at different useful signal offsets.

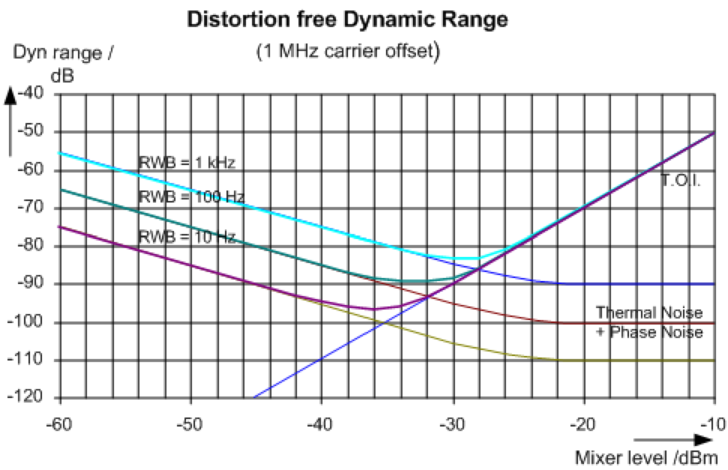


Fig. 4-17: Intermodulation-free range as a function of level at the input mixer and the set resolution bandwidth

(Useful signal offset = 1 MHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz)

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approx. -35 dBm and at 1 kHz increases to approx. -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 and 100 kHz (see figure 4-18). At greater bandwidths, the influence of the phase noise is greater than it would be with small bandwidths. The optimum mixer level at the bandwidths under consideration becomes almost independent of bandwidth and is approx. -40 dBm.

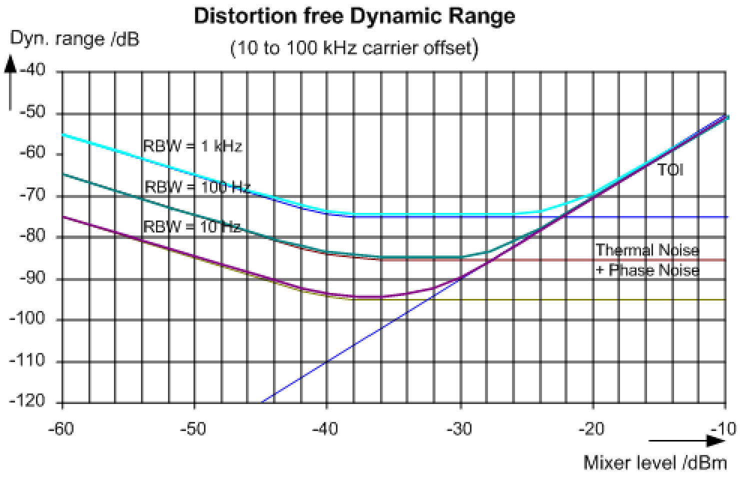


Fig. 4-18: Intermodulation-free dynamic range as a function of level at the input mixer and of the selected resolution bandwidth

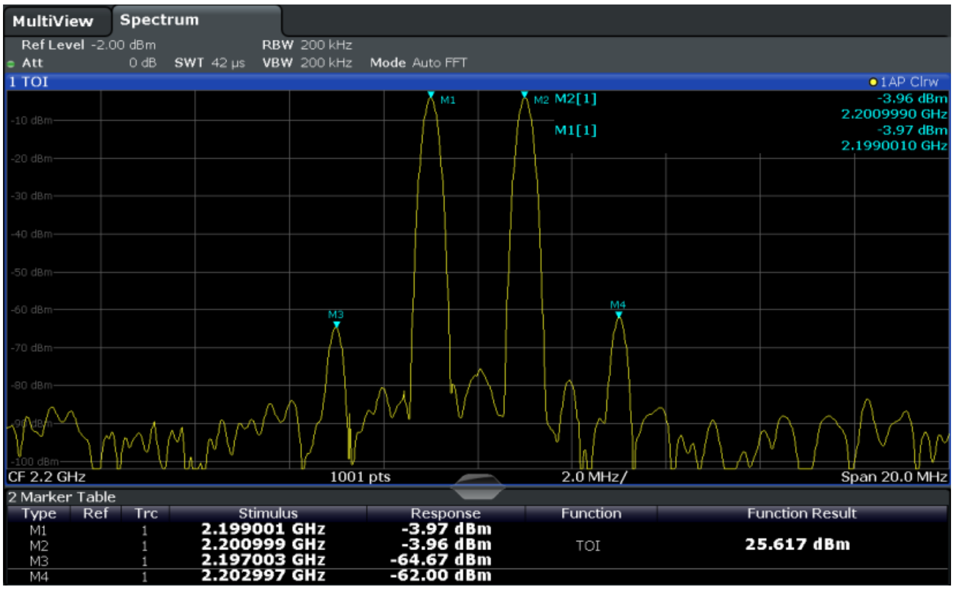
(Useful signal offset = 10 to 100 kHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz).

If the intermodulation products of a DUT with a very high dynamic range are to be measured and the resolution bandwidth to be used is therefore very small, it is best to measure the levels of the useful signals and those of the intermodulation products separately using a small span. The measurement time will be reduced, in particular if the offset of the useful signals is large. To find signals reliably when frequency span is small, it is best to synchronize the signal sources and the R&S FSW.

4.10.3 TOI Results

As a result of the TOI measurement, the following values are displayed in the marker area of the diagram:

Label	Description
TOI	Third-order intercept point
M1	Maximum of first useful signal
M2	Maximum of second useful signal
M3	First intermodulation product
M4	Second intermodulation product

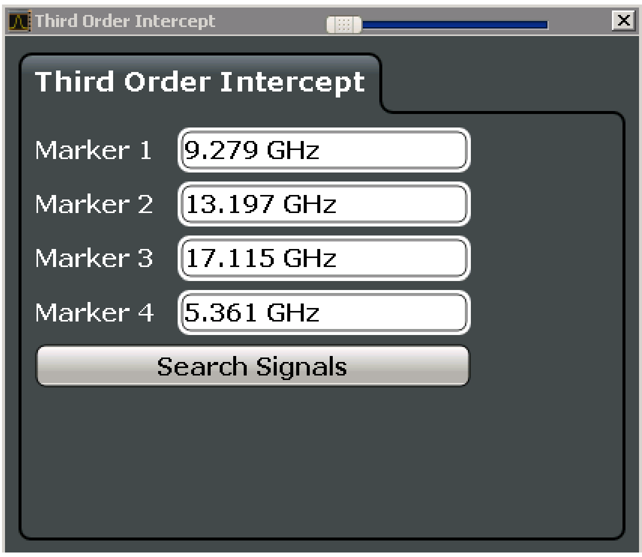


Remote command

The TOI can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?` on page 607.

4.10.4 TOI Configuration

Third Order Intercept (TOI) measurements are selected via the "Third Order Intercept" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Third Order Intercept" dialog box, which is displayed as a tab in the "Analysis" dialog box, or when you select the "TOI Config" softkey from the "TOI" menu.



The remote commands required to perform these tasks are described in chapter 10.3.11, "Measuring the Third Order Intercept Point", on page 606.

Marker 1/2/3/4
Indicates the detected characteristic values as determined by the TOI measurement (see chapter 4.10.3, "TOI Results", on page 168).

The marker positions can be edited; the TOI is then recalculated according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

SCPI command:

`CALCulate<n>:MARKer<m>:X` on page 709
`CALCulate<n>:DELTamarker<m>:X` on page 708
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 720

Search Signals
Performs a new search on the input signals and recalculates the TOI according to the measured values.

SCPI command:

`CALCulate:MARKer:FUNCtion:TOI:SEARchsignal ONCE` on page 607

4.10.5 How to Determine the Third Order Intercept

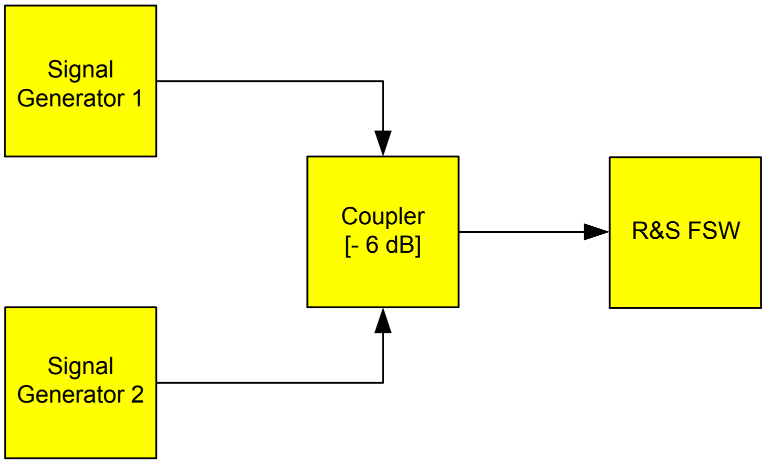
The precise TOI for the R&S FSW in relation to the input signals is provided in the data sheet.

1. Apply a two-tone signal with equal carrier levels to the R&S FSW input.
2. On the R&S FSW, press the MEAS key.
3. Select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

   The calculated TOI is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically and restart the calculation of the TOI.

4.10.6 Measurement Example – Measuring the R&S FSW's Intrinsic Intermodulation

Test setup:



Signal generator settings (e.g. R&S FSW SMU):

Device	Level	Frequency
Signal generator 1	-4 dBm	799.6 MHz
Signal generator 2	-4 dBm	800.4 MHz

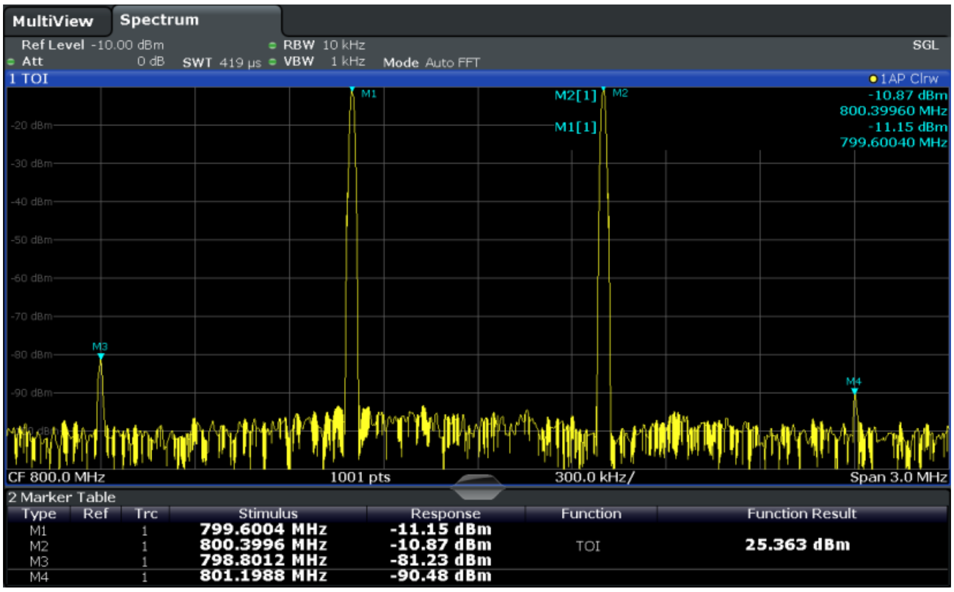
Setting up the measurement

1. Preset the R&S FSW.
2. Set the center frequency to *800 MHz* and the frequency span to *3 MHz*.
3. Set the reference level to *-10 dBm* and RF attenuation to *0 dB*.
4. Set the resolution bandwidth to *10 kHz*.
   The noise is reduced, the trace is smoothed further and the intermodulation products can be seen clearly.
5. Set the VBW to "1 kHz".

Measuring intermodulation using the Third Order Intercept (TOI) measurement function

1. Press the MEAS key and select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

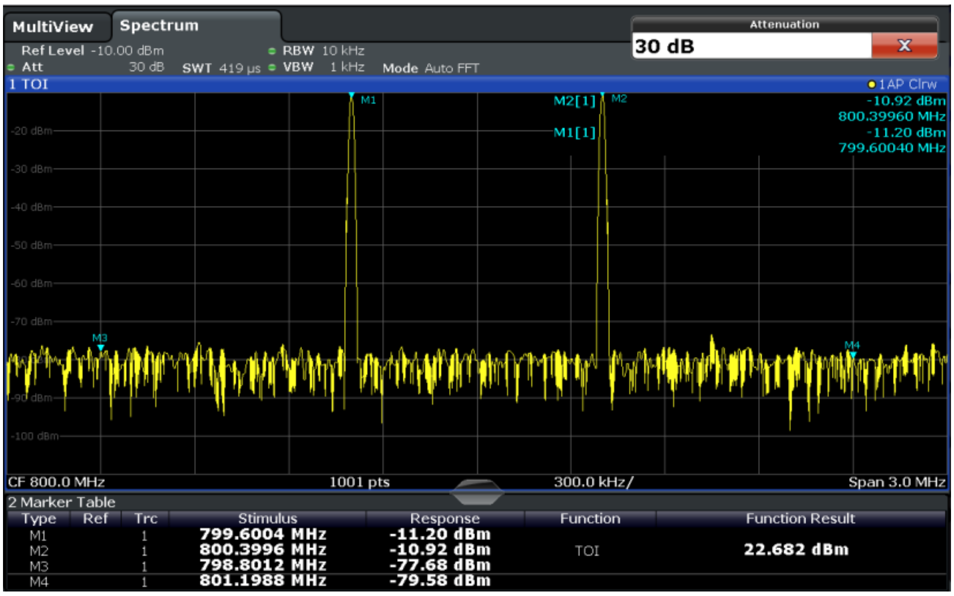
   The R&S FSW activates four markers to measure the intermodulation distance. Two markers are positioned on the useful signals and two on the intermodulation products. The TOI is calculated from the level difference between the useful signals and the intermodulation products. It is then displayed on the screen:



The third order intercept (TOI) is displayed in the marker information.

2. The level of a signal analyzer's intrinsic intermodulation products depends on the RF level of the useful signals at the input mixer. When the RF attenuation is added, the mixer level is reduced and the intermodulation distance is increased. With an additional RF attenuation of 10 dB, the levels of the intermodulation products are reduced by 20 dB. The noise level is, however, increased by 10 dB.
   Increase the RF attenuation to 20 dB to reduce intermodulation products.

   The R&S FSW's intrinsic intermodulation products disappear below the noise floor.



4.11 AM Modulation Depth Measurement

Using the R&S FSW you can measure the AM modulation depth of a modulated signal.

4.11.1 About the Measurement

The AM modulation depth, also known as a modulation index, indicates how much the modulated signal varies around the carrier amplitude. It is defined as:

M_{Depth} = peak signal amplitude / unmodulated carrier amplitude

So for M_{Depth} = 0.5, for example, the carrier amplitude varies by 50% above and below its unmodulated level, and for M_{Depth} = 1.0 it varies by 100%.

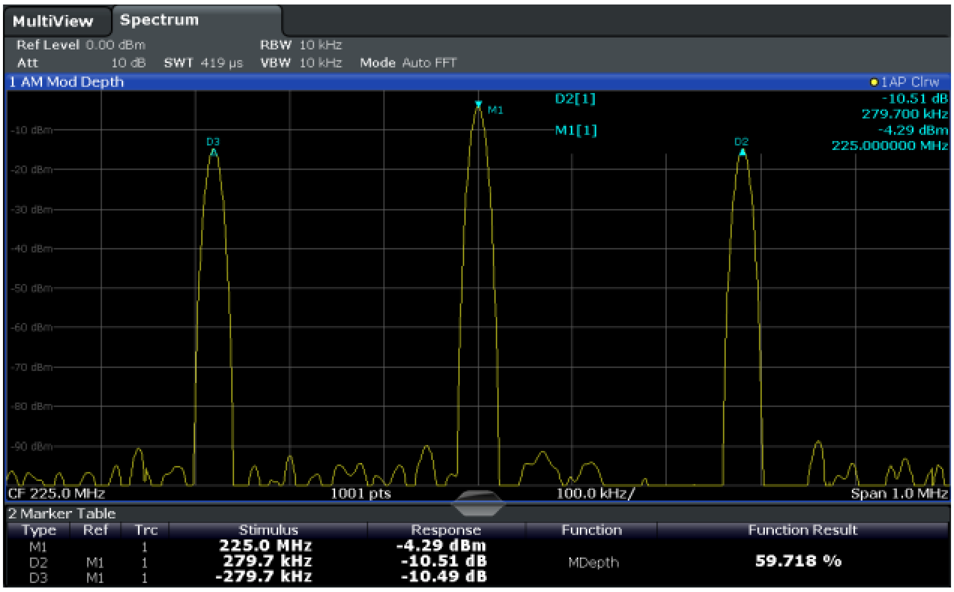
When this measurement is activated, marker 1 is set to the peak level, which is considered to be the carrier level. Delta markers 2 and 3 are automatically set symmetrically to the carrier on the adjacent peak values of the trace. The markers can be adjusted manually, if necessary.

The R&S FSW calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated as the ratio between the power values at the reference marker and at the delta markers. If the powers of the two AM side bands are unequal, the mean value of the two power values is used for AM modulation depth calculation.

4.11.2 AM Modulation Depth Results

As a result of the AM Modulation Depth measurement, the following values are displayed in the marker area of the diagram:

Label	Description
MDepth	AM modulation depth in percent
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

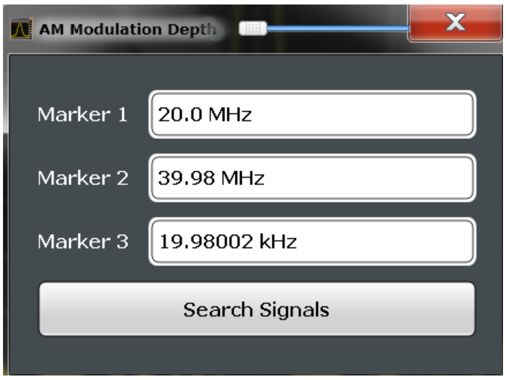


SCPI command:

The AM modulation depth can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?` on page 609.

4.11.3 AM Modulation Depth Configuration

AM Modulation Depth measurements are selected via the "AM Modulation Depth" button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "AM Modulation Depth" dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "AM Mod Depth Config" softkey from the "AM Mod Depth" menu.



The remote commands required to perform these tasks are described in chapter 10.3.12, "Measuring the AM Modulation Depth", on page 608.

Marker 1/2/3

Indicates the detected characteristic values as determined by the AM Modulation Depth measurement:

Marker	Description
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

The marker positions can be edited; the modulation depth is then recalculated according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

Note: Moving the marker positions manually. When the position of delta marker 2 is changed, delta marker 3 is moved symmetrically with respect to the reference marker 1. Delta marker 3, on the other hand, can be moved for fine adjustment independantly of marker 2.

Marker 1 can also be moved manually for re-adjustment without affecting the position of the delta markers.

SCPI command:

`CALCulate<n>:MARKer<m>:X` on page 709

`CALCulate<n>:DELTamarker<m>:X` on page 708

`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 720

Search Signals

Performs a new search on the input signal and recalculates the AM Modulation Depth according to the measured values.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE`
on page 609

4.11.4 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Set the center frequency to the frequency of the device under test.
- Adjust the span so the peaks to the left and right of the carrier, produced by the AM modulated signal, are clearly visible.
  If the span is too wide, these signals may fall together with the carrier and the measurement can not be performed.
  If the span is too narrow, theses signals are outside of the measured span and the delta markers can not find these peaks.
  The rule of thumb is to set the span to three times the value of the AM modulation frequency.

4.11.5 How to Determine the AM Modulation Depth

1. Apply a modulated carrier signal to the R&S FSW input.
2. On the R&S FSW, press the MEAS key.
3. Select the "AM Modulation Depth" measurement function from the "Select Measurement" dialog box.

   The calculated AM Modulation Depth is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the AM Modulation Depth measurement, use the "Search Signals" function to start a new peak search automatically and restart the calculation of the AM Modulation Depth.

4.12 Basic Measurements

Basic measurements are common sweeps in the time or frequency domain which provide an overview of the basic input signal characteristics.

If no other measurement function is selected, or if all measurement functions are switched off, the R&S FSW performs a basic frequency or time sweep. After a preset, a frequency sweep is performed.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see chapter 5, "Common Measurement Settings", on page 181).

4.12.1 How to Perform a Basic Sweep Measurement

To perform one or more single sweeps

1. Configure the frequency and span to be measured ("Frequency" dialog box, see chapter 5.3, "Frequency and Span Configuration", on page 222).
2. Configure the number of sweeps to be performed in a single measurement ("Sweep Config" dialog box, see "Sweep/Average Count" on page 247).
3. If necessary, configure how the signal is processed internally ("Bandwidth" dialog box, see "Sweep Type" on page 248).
4. If necessary, configure a trigger for the measurement ("Trigger/Gate Settings" dialog box, see chapter 5.6, "Trigger and Gate Configuration", on page 252).
5. Define how the results are evaluated for display ("Trace" dialog box, see chapter 6.3.2.1, "Trace Settings", on page 293).
6. If necessary, configure the vertical axis of the display ("Amplitude" dialog box, see chapter 5.4, "Amplitude and Vertical Axis Configuration", on page 229).

7. To start the measurement, select one of the following:
   - RUN SINGLE key
   - "Single Sweep" softkey in the "Sweep" menu

   The defined number of sweeps are performed, then the measurement is stopped. While the measurement is running, the RUN SINGLE key is highlighted. To abort the measurement, press the RUN SINGLE key again. The key is no longer highlighted. The results are not deleted until a new measurement is started.
8. To repeat the same number of sweeps without deleting the last trace, select the "Continue Single Sweep" softkey in the "Sweep" menu.

To start continuous sweeping

1. If you want to average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Average/Sweep Count" ("Sweep Config" dialog box, see "Sweep/Average Count" on page 247).
2. To start the measurement, select one of the following:
   - RUN CONT key
   - "Continuous Sweep" softkey in the "Sweep" menu

   After each sweep is completed, a new one is started automatically. While the measurement is running, the RUN CONT key is highlighted. To stop the measurement, press the RUN CONT key again. The key is no longer highlighted. The results are not deleted until a new measurement is started.

4.12.2 Measurement Example – Measuring Levels at Low S/N Ratios

The minimum signal level a signal analyzer can measure is limited by its intrinsic noise. Small signals can be swamped by noise and therefore cannot be measured. For signals that are just above the intrinsic noise, the accuracy of the level measurement is influenced by the intrinsic noise of the signal analyzer.

The displayed noise level of a signal analyzer depends on its noise figure, the selected RF attenuation, the selected reference level, the selected resolution and video bandwidth and the detector.

For details see:

- chapter 5.4.1.2, "RF Attenuation", on page 230
- chapter 5.4.1.1, "Reference Level", on page 229
- chapter 5.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 238
- chapter 5.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 239
- chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282

This measurement example shows the different factors influencing the S/N ratio.

Signal generator settings (e.g. R&S SMU):

Frequency:	128 MHz
Level:	- 95 dBm

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 MHz*.
4. Set the reference level to-*30 dBm*.
5. Set the RF attenuation to *0 dB*.

   The signal is measured with the auto peak detector and is completely hidden in the intrinsic noise of the R&S FSW.

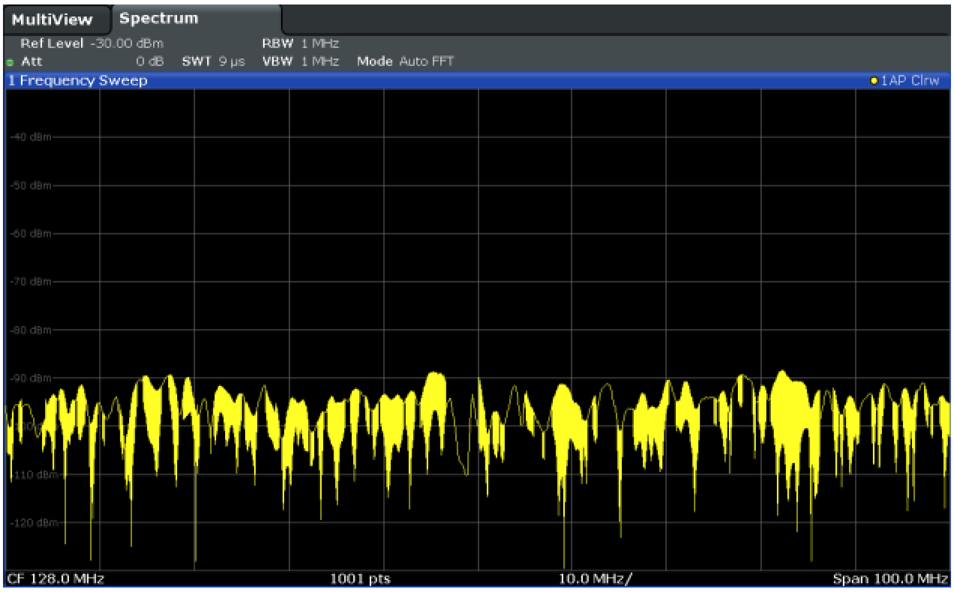


Fig. 4-19: Sine wave signal with low S/N ratio

6. To suppress noise spikes, average the trace. In the "Traces" configuration dialog, set the "Trace mode" to "Average" (see "Trace Mode" on page 294).

   The traces of consecutive sweeps are averaged. To perform averaging, the R&S FSW automatically switches on the sample detector. The RF signal, therefore, can be more clearly distinguished from noise.

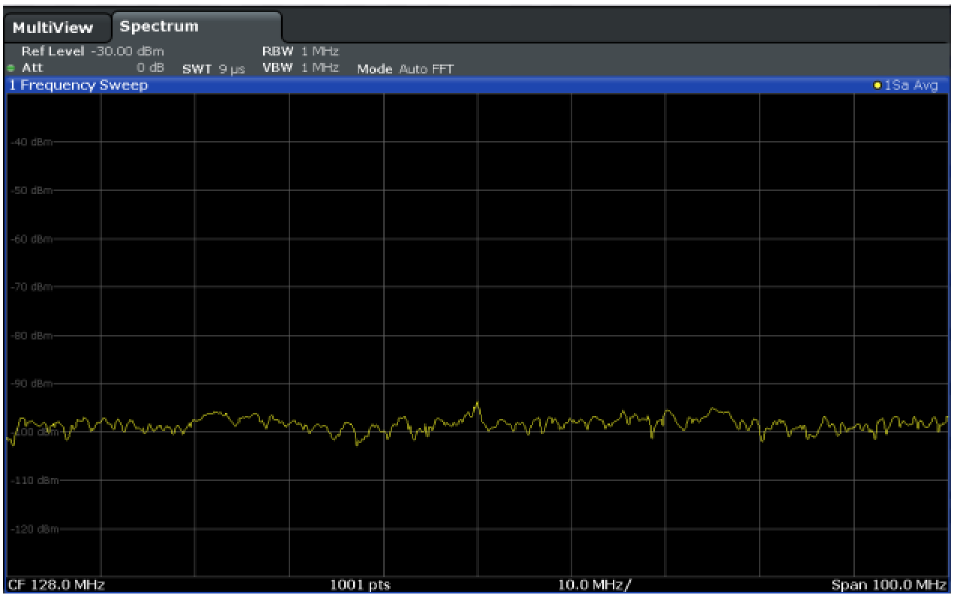


Fig. 4-20: RF sine wave signal with low S/N ratio with an averaged trace

7. Instead of trace averaging, you can select a video filter that is narrower than the resolution bandwidth. Set the trace mode back to "Clear Write", then set the VBW to *10 kHz* manually in the "Bandwidth" configuration dialog.

   The RF signal can be distinguished from noise more clearly.

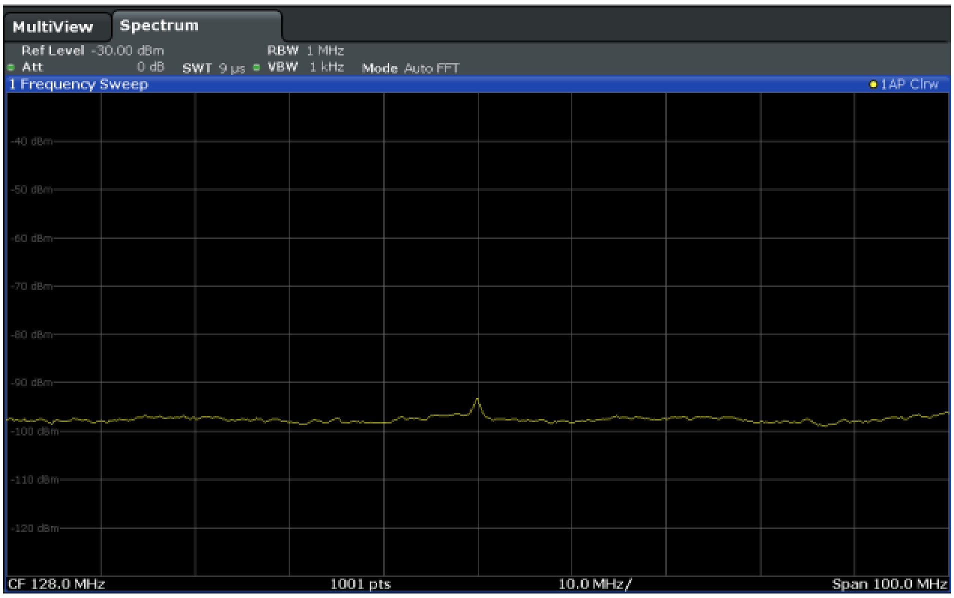


Fig. 4-21: RF sine wave signal with low S/N ratio with a smaller video bandwidth

8. By reducing the resolution bandwidth by a factor of 10, the noise is reduced by 10 dB. Set the RBW to *100 kHz*.

The displayed noise is reduced by approx. 10 dB. The signal, therefore, emerges from noise by about 10 dB. Compared to the previous setting, the video bandwidth has remained the same, i.e. it has increased relative to the smaller resolution bandwidth. The averaging effect of the video bandwidth is therefore reduced. The trace will be noisier.

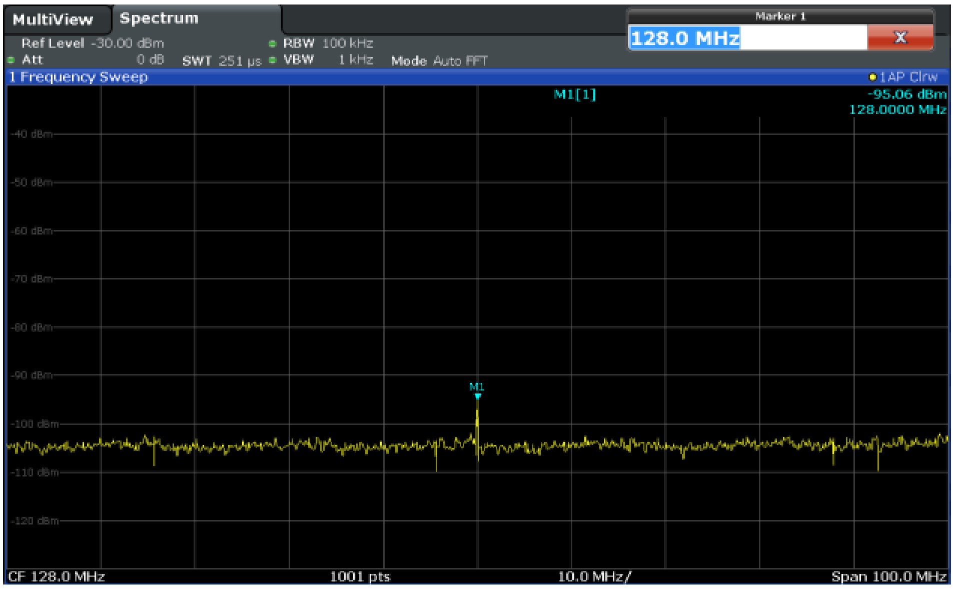
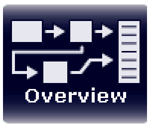


Fig. 4-22: Reference signal at a smaller resolution bandwidth

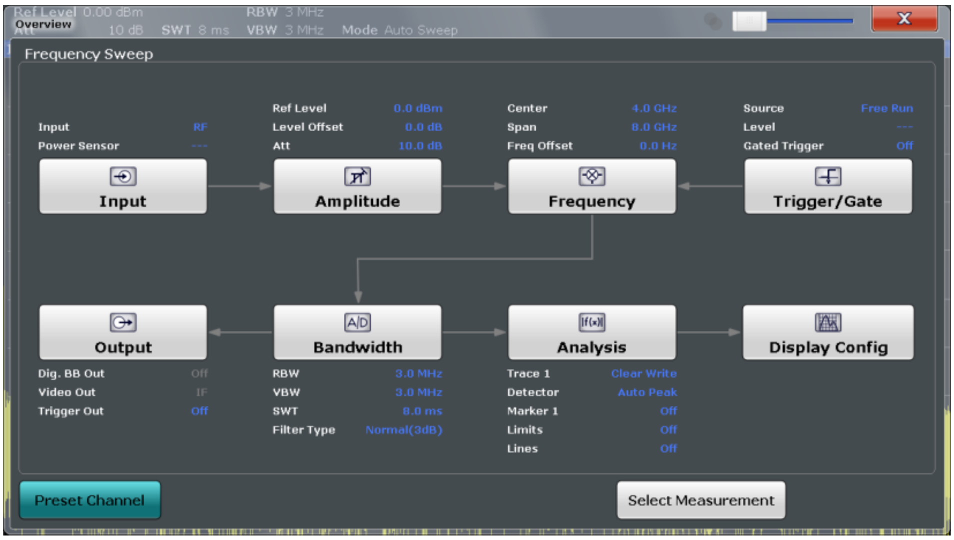
5 Common Measurement Settings

Basic measurement settings that are common to many measurement tasks, regardless of the application or operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings that may deviate from these common settings.

5.1 Configuration Overview



Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the configuration "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

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

1. "Select Measurement"

See chapter 4.1, "Available Measurement Functions", on page 31

2. Input
   See chapter 5.2.2, "Input Settings", on page 185
3. Amplitude
   See chapter 5.4, "Amplitude and Vertical Axis Configuration", on page 229
4. Frequency
   See chapter 5.3, "Frequency and Span Configuration", on page 222
5. (Optionally:) Trigger/Gate
   See chapter 5.6, "Trigger and Gate Configuration", on page 252
6. Bandwidth
   See chapter 5.5.2, "Bandwidth, Filter and Sweep Settings", on page 243
   (For SEM measurements: SEM Setup, see chapter 4.5.5, "SEM Configuration", on page 104)
   (For Spurious measurements: Spurious Setup, see chapter 4.6.4, "Spurious Emissions Measurement Configuration", on page 130)
7. (Optionally:) Outputs
   See chapter 5.2.5, "Data Output", on page 219
8. Analysis
   See chapter 6, "Common Analysis and Display Functions", on page 273
9. Display
   See chapter 6.1, "Result Display Configuration", on page 273

To configure settings

► Select any button to open the corresponding dialog box. To configure a particular setting displayed in the "Overview", simply select the setting on the touch screen. The corresponding dialog box is opened with the focus on the selected setting.

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 on the front panel restores all measurements **in all measurement channels** on the R&S FSW to their default values!

For details see chapter 7.1, "Restoring the Default Instrument Configuration (Preset)", on page 364.

SCPI command:

`SYSTem:PRESet:CHANnel[:EXECute]` on page 768

5.2 Data Input and Output

The R&S FSW can analyze signals from different input sources (such as RF, power sensors etc.) and provide various types of output (such as video or trigger signals).

5.2.1 Receiving Data Input and Providing Data Output

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

5.2.1.1 RF Input Protection

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

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

5.2.1.2 Input from Noise Sources

The R&S FSW provides a connector (NOISE SOURCE CONTROL) with a voltage supply for an external noise source. By switching the supply voltage for an external noise source on or off in the firmware, you can activate or deactive the device as required.

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

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S FSW and measure the total noise power. From this value you can determine the noise power of the R&S FSW. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

The noise source is controlled in the "Output" settings, see "Noise Source" on page 220

5.2.1.3 Receiving and Providing Trigger Signals

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

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

External trigger as input

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

Trigger output

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

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

Manual triggering

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

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

5.2.1.4 IF and Video Signal Output

The measured IF signal or displayed video signal (i.e. the filtered and detected IF signal) can be sent to the IF/VIDEO/DEMOD output connector.

The **video output** is a signal of 1 V. It can be used, for example, to control demodulated audio frequencies.

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

Restrictions

Note the following restrictions for IF output:

- IF and video output is only available in the time domain (zero span).

- For I/Q data and in FFT mode, only IF output is available.
- IF output is not available if any of the following conditions apply:
  – The Digital Baseband Interface (R&S FSW-B17) is active (for input or output)
  – MSRA operating mode is active
  – The wideband extension is used (hardware option R&S FSW-B160 / U160; used automatically for bandwidths > 80 MHz; in this case use the IF WIDE OUTPUT connector)
  – The sample rate is larger than 200 MHz (upsampling)

IF WIDE OUTPUT

If the optional hardware R&S FSW-B160/ -U160 for **bandwidth extension** is installed and activated (i.e. for bandwidths > 80 MHz), the IF output is not sent to the IF/VIDEO/ DEMOD output connector, but rather to the additional **IF WIDE OUTPUT** connector provided by the option.

In this case, the IF output frequency cannot be defined manually, but is determined automatically depending on the center frequency. For details on the used frequencies see the data sheet. The currently used output frequency is indicated in the field otherwise used to define the frequency manually (in the "Output" settings dialog box, see "IF (Wide) Out Frequency" on page 220).

5.2.2 Input Settings

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

Input settings can be configured via the INPUT/OUTPUT key, in the "Input" dialog box.

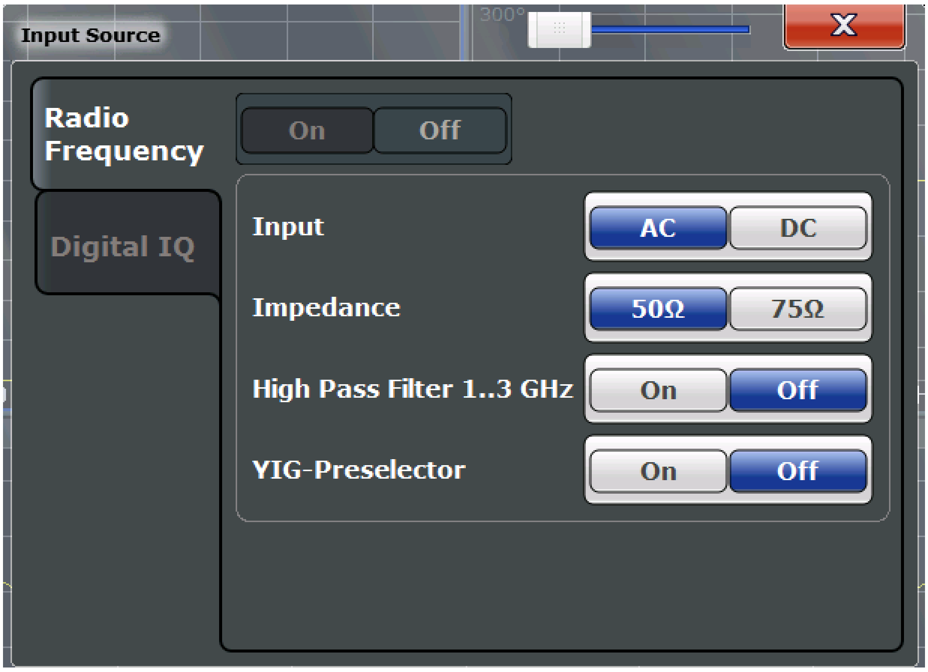
Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

The Digital IQ input source is only available in applications that support I/Q data processing and is described in detail in the R&S FSW I/Q Analyzer User Manual.

External mixers are not supported in MSRA mode.

5.2.2.1 Radio Frequency Input

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



Radio Frequency State

Activates input from the RF INPUT connector.

SCPI command:

`INPut:SELect` on page 660

Input Coupling

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

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

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

SCPI command:

`INPut:COUPling` on page 659

Impedance

The reference impedance for the measured levels of the R&S FSW 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 (see "Reference Level" on page 232).

SCPI command:

`INPut:IMPedance` on page 660

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 R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires option R&S FSW-B13.

(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.)

SCPI command:

`INPut:FILTer:HPASs[:STATe]` on page 659

YIG-Preselector

Activates or deactivates the YIG-preselector.

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

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

`INPut:FILTer:YIG[:STATe]` on page 660

5.2.3 Power Sensors

The R&S FSW can also analyze data from a connected power sensor.

5.2.3.1 Basics on Power Sensors

For precise power measurement up to 4 power sensors can be connected to the instrument via the power sensor interface (on the front panel). Both manual operation and remote control are supported.

Currently, only R&S NRP-Zxy power sensors are supported. For a detailed list of supported sensors see the data sheet.

Power sensors can also be used to trigger a measurement at a specified power level, e.g. from a signal generator (see "Using a Power Sensor as an External Power Trigger" on page 189).

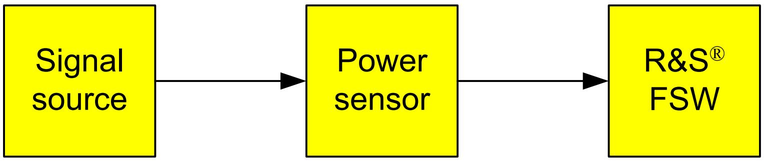


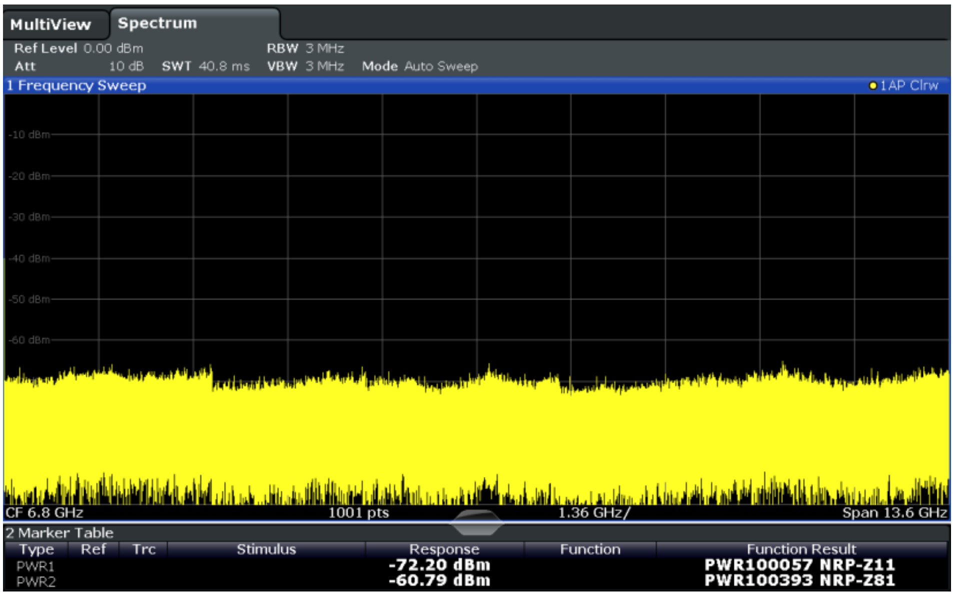
Fig. 5-1: Power sensor support – standard test setup

Using the power sensor with several applications

The power sensor cannot be used from the R&S FSW firmware and the R&S Power Viewer (virtual power meter for displaying results of the R&S NRP power sensors) simultaneously. After using the Power Viewer, close the application, then unplug and replug the sensor. Afterwards the power sensor can be used by the R&S FSW again.

Result display

The results of the power sensor measurements are displayed in the marker table. For each power sensor, a row is inserted. The sensor index is indicated in the "Type" column.



Using a Power Sensor as an External Power Trigger

Power sensors can be used to trigger a measurement at a specified power level, e.g. from a signal generator.

Currently, only the following power sensors are supported as power triggers:

- R&S NRP-Z81
- R&S NRP-Z85
- R&S NRP-Z86

With the R&S FSW, the power sensors can be connected to the "Power Sensor" interface directly, and no further cables are required. They can then be configured as an external power sensor trigger.

Fig. 5-2: Connecting a power sensor using the POWER SENSOR interface

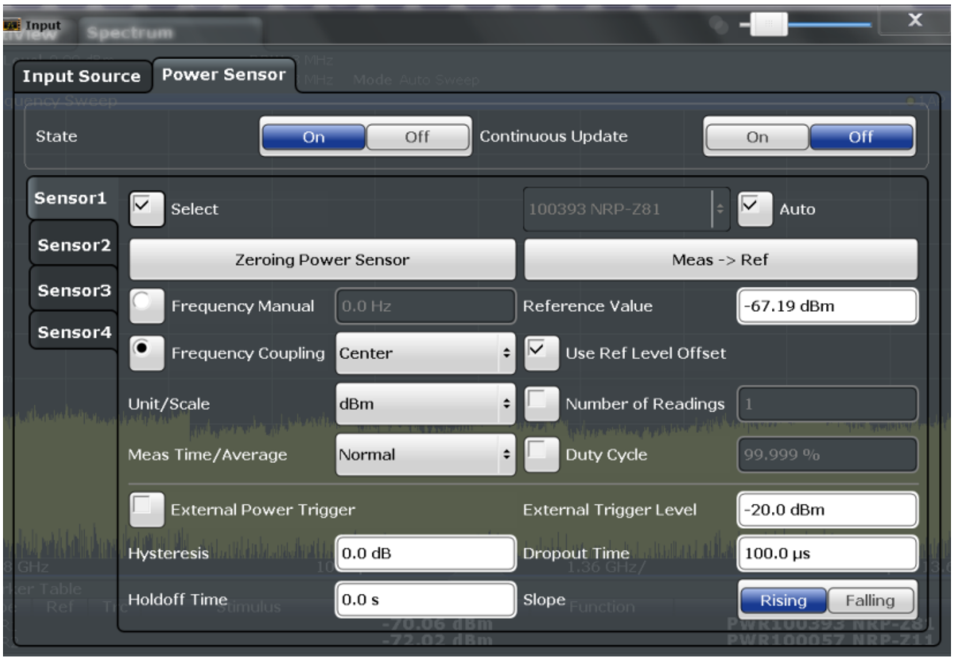
The R&S FSW receives an external trigger signal when the defined trigger level is measured by the power sensor. Power measurement results are provided as usual.

The "Gate Mode" *Level* is not supported for R&S power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on gating see chapter 5.6.1.2, "Gated Measurements", on page 255.

For details see "How to Configure a Power Sensor as an External (PSE) Trigger" on page 196.

5.2.3.2 Power Sensor Settings

Power sensor settings are available in the "Power Sensor" tab of the "Input" dialog box. Each sensor is configured on a separate tab.



State

Switches the power measurement for all power sensors on or off. Note that in addition to this general setting, each power sensor can be activated or deactivated individually by the Select setting on each tab. However, the general setting overrides the individual settings.

SCPI command:

`[SENSe:]PMETer<p>[:STATe]` on page 682

Continuous Value Update

If activated, the power sensor data is updated continuously during a sweep with a long sweep time, and even after a single sweep has completed.

This function cannot be activated for individual sensors.

If the power sensor is being used as a trigger (see "Using the power sensor as an external trigger" on page 193), continuous update is not possible; this setting is ignored.

SCPI command:

`[SENSe:]PMETer<p>:UPDate[:STATe]` on page 682

Select

Selects the individual power sensor for usage if power measurement is generally activated (State function).

The detected **serial numbers** of the power sensors connected to the instrument are provided in a selection list. For each of the four available power sensor indexes ("Power Sensor 1"..."Power Sensor 4"), which correspond to the tabs in the configuration dialog, one of the detected serial numbers can be assigned. The physical sensor is thus assigned to the configuration setting for the selected power sensor index.

By default, serial numbers not yet assigned are automatically assigned to the next free power sensor index for which "Auto Assignment" is selected.

Alternatively, you can assign the sensors manually by deactivating the "Auto" option and selecting a serial number from the list.

SCPI command:

`[SENSe:]PMETer<p>[:STATe]` on page 682

`SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine` on page 676

`SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe]` on page 675

`SYSTem:COMMunicate:RDEVice:PMETer:COUNt?` on page 675

Zeroing Power Sensor

Starts zeroing of the power sensor.

For details on the zeroing process refer to "How to Zero the Power Sensor" on page 196.

SCPI command:
CALibration:PMETer<p>:ZERO:AUTO ONCE on page 677

Frequency Manual
Defines the frequency of the signal to be measured. The power sensor has a memory with frequency-dependent correction factors. This allows extreme accuracy for signals of a known frequency.

SCPI command:
[SENSe:]PMETer<p>:FREQuency on page 679

Frequency Coupling
Selects the coupling option. The frequency can be coupled automatically to the center frequency of the instrument or to the frequency of marker 1.

SCPI command:
[SENSe:]PMETer<p>:FREQuency:LINK on page 680

Unit/Scale
Selects the unit with which the measured power is to be displayed. Available units are dBm, dB, W and %.

If dB or % is selected, the display is relative to the reference value that is defined with either the "Meas -> Ref" setting or the "Reference Value" setting.

SCPI command:
UNIT<n>:PMETer<p>:POWer on page 682
UNIT<n>:PMETer<p>:POWer:RATio on page 683

Meas Time/Average
Selects the measurement time or switches to manual averaging mode. In general, results are more precise with longer measurement times. The following settings are recommended for different signal types to obtain stable and precise results:

"Short" Stationary signals with high power (> -40dBm), because they require only a short measurement time and short measurement time provides the highest repetition rates.

"Normal" Signals with lower power or modulated signals

"Long" Signals at the lower end of the measurement range (<-50 dBm) or Signals with lower power to minimize the influence of noise

"Manual" Manual averaging mode. The average count is set with the Average Count (Number of Readings) setting.

SCPI command:
[SENSe:]PMETer<p>:MTIMe on page 680
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] on page 681

Setting the Reference Level from the Measurement (Meas->Ref)

Sets the currently measured power as a reference value for the relative display. The reference value can also be set manually via the Reference Value setting.

SCPI command:

`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE` on page 678

Reference Value

Defines the reference value for relative measurements in the unit dBm.

SCPI command:

`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]` on page 677

Use Ref Lev Offset

If activated, takes the reference level offset defined for the analyzer into account for the measured power (see "Shifting the Display (Offset)" on page 232). If deactivated, takes no offset into account.

SCPI command:

`[SENSe:]PMETer<p>:ROFFset[:STATe]` on page 681

Average Count (Number of Readings)

Defines the number of readings (averages) to be performed after a single sweep has been started. This setting is only available if manual averaging is selected (Meas Time/Average setting).

The values for the average count range from 0 to 256 in binary steps (1, 2, 4, 8, …). For average count = 0 or 1, one reading is performed. The general averaging and sweep count for the trace are independent from this setting.

Results become more stable with extended average, particularly if signals with low power are measured. This setting can be used to minimize the influence of noise in the power sensor measurement.

SCPI command:

`[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt` on page 681

Duty Cycle

Sets the duty cycle to a percent value for the correction of pulse-modulated signals and activates the duty cycle correction. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power.

SCPI command:

`[SENSe:]PMETer<p>:DCYCle[:STATe]` on page 679

`[SENSe:]PMETer<p>:DCYCle:VALue` on page 679

Using the power sensor as an external trigger

If activated, the power sensor creates a trigger signal when a power higher than the defined "External Trigger Level" is measured. This trigger signal can be used as an external power trigger by the R&S FSW.

This setting is only available in conjunction with a compatible power sensor.

For details on using a power sensor as an external trigger, see "Using a Power Sensor as an External Power Trigger" on page 189.

SCPI command:

[SENSe:]PMETer<p>:TRIGger[:STATe] on page 685

TRIG:SOUR PSE, see TRIGger[:SEQuence]:SOURce on page 649

External Trigger Level ← Using the power sensor as an external trigger

Defines the trigger level for the power sensor trigger.

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

SCPI command:

[SENSe:]PMETer<p>:TRIGger:LEVel on page 684

Hysteresis ← Using the power sensor as an external trigger

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

SCPI command:

[SENSe:]PMETer<p>:TRIGger:HYSTeresis on page 684

Trigger Holdoff ← Using the power sensor as an external trigger

Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

SCPI command:

[SENSe:]PMETer<p>:TRIGger:HOLDoff on page 684

Drop-Out Time ← Using the power sensor as an external trigger

Defines the time the input signal must stay below the trigger level before triggering again.

Slope ← Using the power sensor as an external trigger

Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

SCPI command:

[SENSe:]PMETer<p>:TRIGger:SLOPe on page 685

5.2.3.3 How to Work With a Power Sensor

The following step-by-step instructions demonstrate how to set up a power sensor. For details on individual functions and settings see chapter 5.2.3.2, "Power Sensor Settings", on page 190.

The remote commands required to perform these tasks are described in chapter 10.5.6.3, "Working with Power Sensors", on page 675.

Power sensors can also be used to trigger a measurement at a specified power level, e.g. from a signal generator. This is described in "How to Configure a Power Sensor as an External (PSE) Trigger" on page 196.

How to Set Up a Power Sensor

Up to 4 external power sensors can be configured separately and used for precise power measurement, as a trigger, or both. All power sensors can be activated and deactivated individually.

The following procedure describes in detail how to configure and activate power sensors.

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
   - Select "Input" from the "Overview".
   - Select the INPUT/OUTPUT key and then the "Power Sensor Config" softkey.
2. Select the tab for the power sensor index you want to configure, e.g. "Sensor 1".
3. Press "Select" to analyze the power sensor data according to the current configuration when power measurement is activated.
4. From the selection list with serial numbers of connected power sensors, select the sensor you want to configure.
   To have newly connected power sensors assigned to a tab automatically (default), select "Auto".
5. Define the frequency of the signal whose power you want to measure.
   a) To define the frequency manually, select "Frequency Manual" and enter a frequency.
   b) To determine the frequency automatically, select "Frequency Coupling" and then either "Center", to use the center frequency, or "Marker", to use the frequency defined by marker 1.
6. Select the unit for the power result display.
7. Select the measurement time for which the average is calculated, or define the number of readings to average. To define the number of readings to be taken into account manually, select "Manual" and enter the number in the "Number of Readings" field.
8. To activate the duty cycle correction, select "DutyCycle" and enter a percentage as the correction value.
9. If you selected "dB" or "%" as units (relative display), define a reference value:
   a) To set the currently measured power as a reference value, press the "Meas -> Ref" button.
   b) Alternatively, enter a value manually in the "Reference Value" field.
   c) Optionally, select the "Use Ref Level Offset" option to take the reference level offset set for the analyzer into account for the measured power.
10. To use the power sensor as an external power trigger, select the "External Power Trigger" option and define the trigger settings.

For details see "How to Configure a Power Sensor as an External (PSE) Trigger" on page 196.

11. If necessary, repeat steps 3-10 for another power sensor.
12. Set the "Power Sensor State" at the top of the "Power Sensor" tab to "On" to activate power measurement for the selected power sensors.

    The results of the power measurement are displayed in the marker table (Function: "Sensor<1...4>").

How to Zero the Power Sensor

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
    - Select "Input" from the "Overview".
    - Select the INPUT/OUTPUT key and then the "Power Sensor Config" softkey.
2. Select the tab that is assigned to the power sensor you want to zero.
3. Press the "Zeroing Power Sensor" button.
   A dialog box is displayed that prompts you to disconnect all signals from the input of the power sensor.
4. Disconnect all signals sending input to the power sensor and press ENTER to continue.
5. Wait until zeroing is complete.
   A corresponding message is displayed.

How to Configure a Power Sensor as an External (PSE) Trigger

The following step-by-step instructions demonstrate how to configure a power sensor to be used as an external power sensor trigger.

To configure a power sensor as an external power sensor (PSE) trigger

1. Connect a compatible power sensor to the "Power Sensor" interface on the front panel of the R&S FSW. (For details on supported sensors see "Using a Power Sensor as an External Power Trigger" on page 189).
2. Set up the power sensor as described in "How to Set Up a Power Sensor" on page 195.
3. In the "Power Sensor" tab of the "Input" dialog box, select the "External Power Trigger" option.
4. Enter the power level at which a trigger signal is to be generated ("External Trigger Level") and the other trigger settings for the power sensor trigger.
5. Press the TRIG key on the front panel of the instrument and then select "Trigger / Gate Config".

6. In the "Trigger and Gate" dialog box, select "Signal Source" = "PSE".

   The R&S FSW is configured to trigger when the defined conditions for the power sensor occur. Power measurement results are provided as usual.

5.2.4 External Mixer (Option R&S FSW-B21)

If the R&S FSW External Mixer option (R&S FSW-B21) is installed, an external mixer can be connected to the R&S FSW to increase the available frequency range. In this case, the input to measure is not taken from the RF input connector, but from the EXT MIXER connector(s).

5.2.4.1 Basics on External Mixers

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

Frequency Ranges

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

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

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

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

where:

$\mathbf{f_{in}}$: frequency of input signal

n: order of harmonic used for conversion

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

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

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

For the band "USER", the order of harmonic is defined by the user. The order of harmonic can be between 2 and 61, the lowest usable frequency being 16.53 GHz.

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

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

Extending predefined ranges

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

Additional ranges

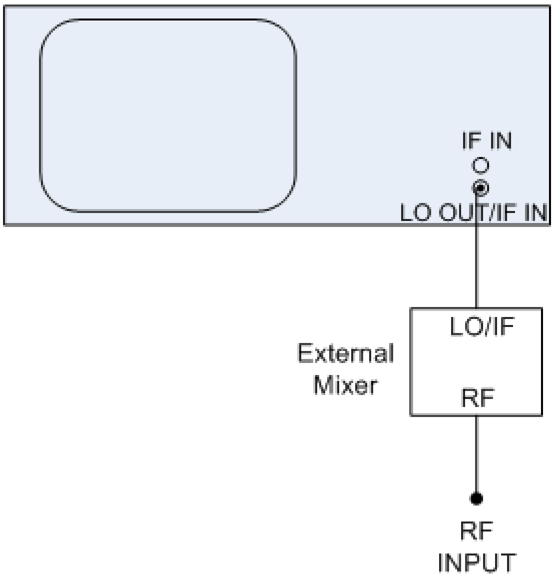
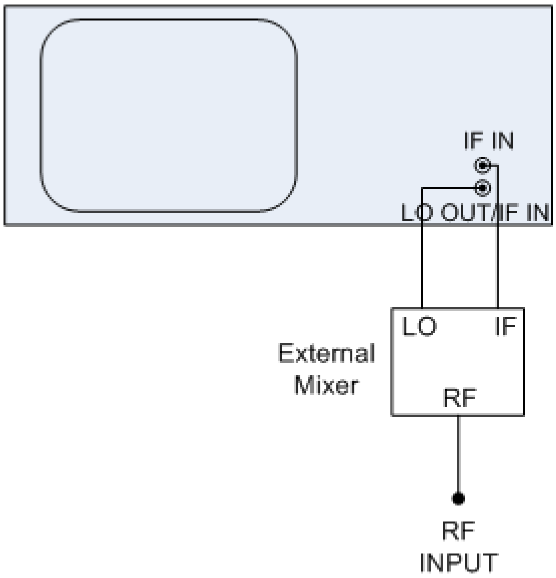
If due to the LO frequency the conversion of the input signal is not possible using one harmonic, the band must be split. An adjacent, partially overlapping frequency range can be defined using different harmonics. In this case, the sweep begins using the harmonic defined for the first range, and at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

Which harmonics are supported depends on the mixer type.

Two-port and Three-port Mixers

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

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

Two-port mixer	Three-port mixer
	

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

Bias Current

Single-diode mixers generally require a DC voltage which is applied via the LO line. This DC voltage is to be tuned to the minimum conversion loss versus frequency. Such a DC voltage can be set via the "BIAS" function using the D/A converter of the R&S FSW. The value to be entered is not the voltage but the short-circuit current. The current is defined in the "Bias Settings" or set to the value of the conversion loss table (see "Bias Settings" on page 207 and "Bias" on page 213.

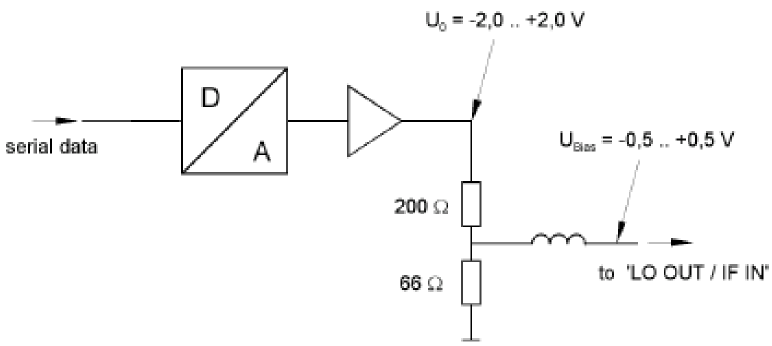


Fig. 5-3: Bias circuit of the R&S FSW

The voltage U_0 at the output of the operational amplifier can be set in the range –2.0 to +2.0 V. An open-circuit voltage V_{bias} of –0.5 to +0.5 V is obtained accordingly at the output of the voltage divider. A short-circuit current of $I_{short} = V_0 / 200\ \Omega$ = 10 mA to + 10 mA is obtained for a short circuit at the output of the voltage divider. In order to use biasing it is not important to know the exact current flowing through the diode since the conversion loss must be set to a minimum with the frequency. Therefore, it makes no difference whether the setting is performed by an open-circuit voltage or by a short-circuit current. A DC return path is ensured via the 66 Ω resistor, which is an advantage in some mixers.

Conversion Loss Tables

Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. Correction values for frequencies between the reference values are obtained by interpolation. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table the conversion loss is assumed to be the same as that for the first and last reference value (see figure 5-4).

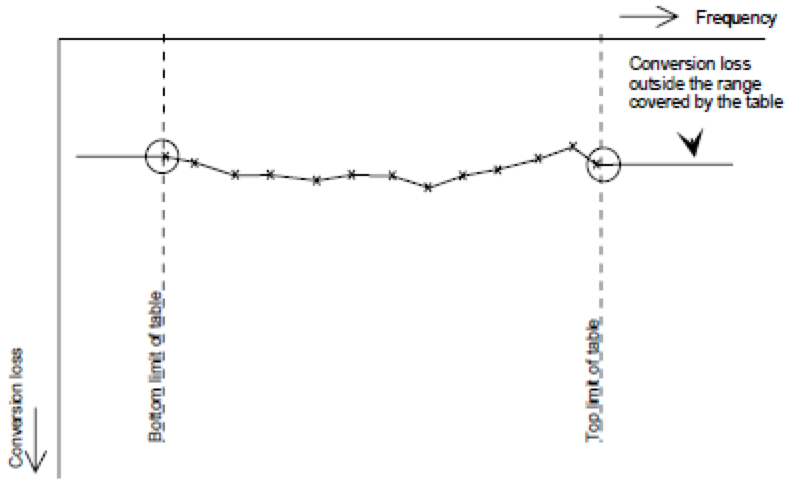


Fig. 5-4: Conversion loss outside the band's frequency range

Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S FSW. Alternatively, you can define your own conversion loss tables. Conversion loss tables are configured and managed in the "Conversion loss Table Settings" tab of the "External Mixer Configuration" dialog box (see "Managing Conversion Loss Tables" on page 210).

Importing CVL tables

The conversion loss table to be used for a particular range is also defined in the "External Mixer Configuration" dialog box. All tables stored on the instrument in the `C:\r_s\instr\user\cvl\` directory are offered for selection. A validation check is then performed on the selected table to ensure that it complies with the settings. In particular, the following is checked:

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

Reference level

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

Automatic Signal Identification

Automatic signal identification allows you to compare the upper and lower band results of the mixer, thus detecting unwanted mixer products due to conversion.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

Signal ID function

Two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep), trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

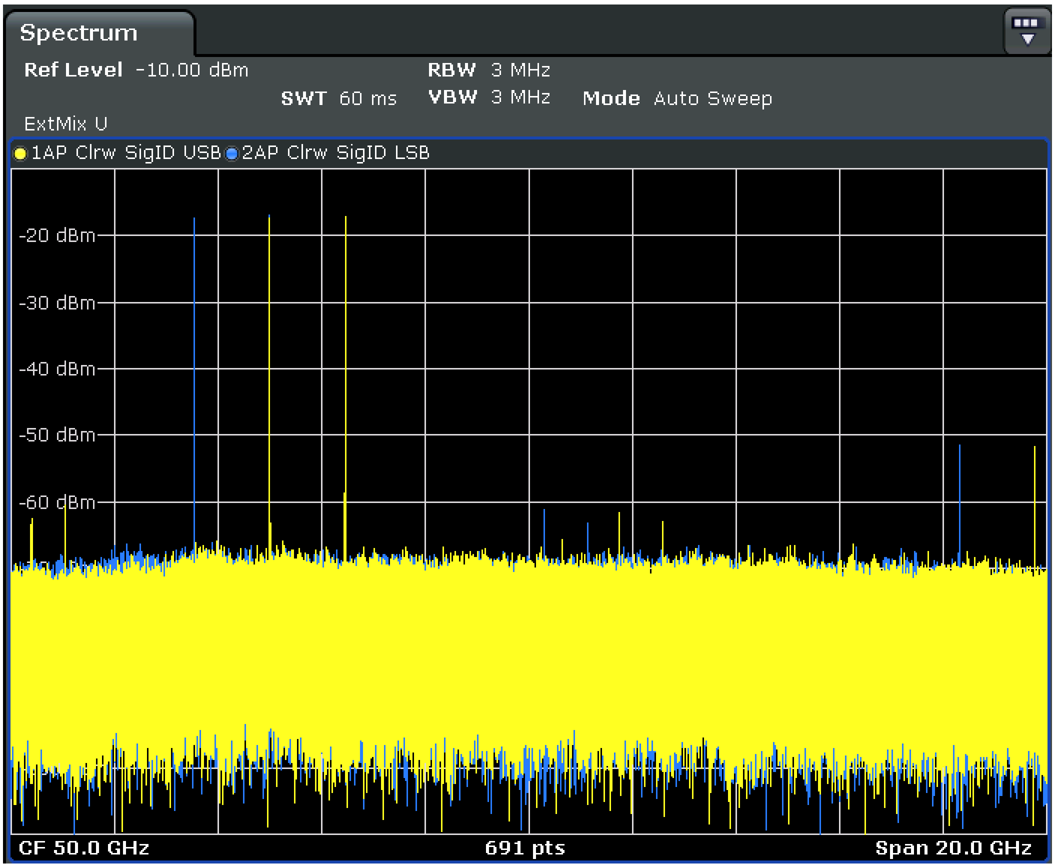


Fig. 5-5: Signal identification function (Signal ID) with external mixer (B21)

The reference sweep is performed using an LO setting shifted downwards by 2*IF/<Harmonic order>. Input signals in the desired sideband that are converted using the specified harmonic are displayed in both traces at the same position on the frequency axis. Image signals and mixer products caused by other harmonics are displayed at different positions in both traces. The user identifies the signals visually by comparing the two traces.

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from the test sweep. Therefore the signal *level* should only be measured in the test sweep (trace 1).

Auto ID function

The Auto ID fucntion basically functions like Signal ID function. However, the test and reference sweeps are converted into a single trace by a comparison of maximum peak values of each sweep point. The result of this comparison is displayed in trace 3 if "Signal ID" is active at the same time. If "Signal ID" is not active, the result can be displayed in any of the traces 1 to 3. Unwanted mixer products are suppressed in this calculated trace.

Test sweep and reference sweep traces

Depending on which of the automatic signal identification functions are used, the traces are used to display either the test sweep (the upper side-band sweep) or the reference sweep (lower side-band sweep).

Function	Trace 1	Trace 2	Trace 3
Signal ID	Signal ID upper side-band	Signal ID lower side-band	-
Auto ID	Auto ID	-	-
Signal ID + Auto ID	Signal ID upper side-band	Signal ID lower side-band	Auto ID

Tolerance for the comparison of test sweep and reference

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from that of the test sweep. This is due to the fact that the LO output power of the R&S FSW varies with the frequency, and also due to the non-ideal characteristics of the mixer. A certain tolerance should therefore be permitted for the comparison of the signal levels in the test sweep and reference sweep. A user-defined threshold is used to determine deviations.

Auto ID detection threshold

Real input signals are displayed at the same frequency in the test and reference sweeps, i.e. theoretically, identical signal levels are expected at the frequency of the real mixer product in both sweeps. If the level difference is lower than the the user-defined threshold, the signal obtained in the test sweep is displayed. If a signal occurs only in the test sweep or reference sweep, it is an unwanted mixer product. The level of this signal is compared to the noise floor in the other sweep. If the S/N ratio is sufficiently large, the threshold is exceeded. This means that the signal with the lower level, i.e. noise in this case, is displayed.

Note that the Auto ID method operates according to the fail-safe principle, i.e. unwanted mixer products may not be detected as such but signals which are in fact real input signals are not blanked out.

Time-constant spectrum

The automatic comparison of the test sweep and reference sweep with the Auto ID function can only be applied usefully for signals with a time-constant spectrum since the two sweeps are always required to determine the actual spectrum.

Mixer products with low S/N ratio

If the S/N ratio of a mixer product is lower than the user-defined thereshold, the level difference between the test sweep and reference sweep at the frequency of this mixer product is always within limits, even if the signal occurs in one of the sweeps only. Such mixer products cannot be identified by the Auto ID function. It is therefore recommended that you perform a visual comparison of the test sweep and reference sweep using the Signal ID function.

Examining unwanted mixer products with small span

With large spans in which non-modulated sinewave signals are represented as single lines, unwanted mixer products are generally completely blanked out. However, if you examine the frequency range containing a blanked signal in detail using a small span, e.g. an image-frequency response, part of the signal may nevertheless be displayed. This happens when the displayed components of a blanked signal have a level difference which is smaller than the user-defined threshold when compared with the noise floor. These components are therefore not blanked out.

An unwanted signal with a S/N ratio that corresponds approximately to the user-defined threshold may not be blanked out permanently. Due to the fact that the noise display varies from one sweep to another, the S/N ratio changes and thus the level difference between the test sweep and reference sweep measured at a frequency changes as well. As a result, the criterion for detecting unwanted signals is not fulfilled. To blank out unwanted signals permanently, an almost constant noise indication is therefore required. This can be achieved by reducing the video bandwidth. Since the average noise indication lies well below the generated noise peak values, the minimum level diminishes. For identification using the Auto ID function, signals should have this minimum noise level.

Display of mixer products at the same frequency

If the input signal consists of a very large number of spectral components, it will become more and more probable that two different unwanted mixer products will be displayed at the same frequency in the test sweep and reference sweep.

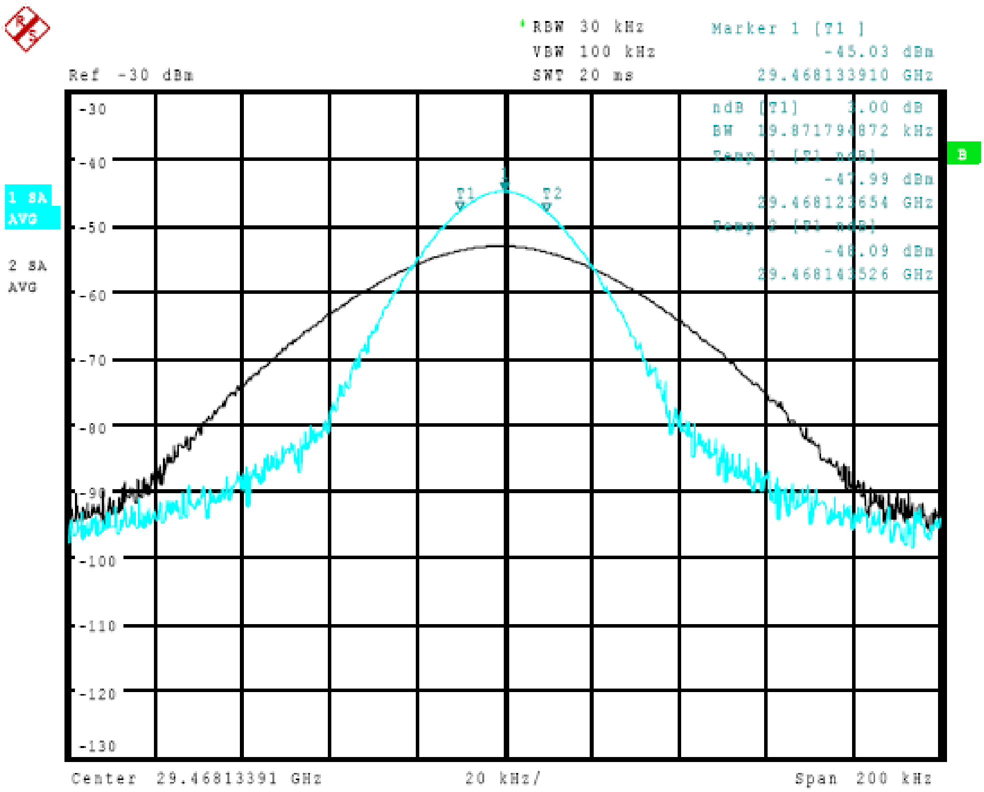


Fig. 5-6: Different mixer products displayed at the same frequency in the test sweep and reference sweep (large span)

Example:

The external mixer is set to use the 2nd order harmonic. The signal recorded in the test sweep is displayed by trace 1. The IF filter of the R&S FSW is represented at a 3 dB bandwidth of 20 kHz, the real IF bandwidth being 30 kHz. If, however, the 3 dB bandwidth of the signal recorded in the reference sweep is examined (trace 2), it will be found to be larger exactly by a factor of 2. This shows that the two products were generated by mixing with LO harmonics of different orders. The signal recorded in the test sweep was generated by mixing with the 3rd order harmonic. Since the frequency axis scaling is based on the 2nd order, the mixer product or the resulting diagram of the IF filter is compressed by a factor of 2/3. The signal recorded in the reference sweep was generated by mixing with the fundamental of the LO signal. Since the frequency axis scaling is based on the 2nd order, the mixer product or the resulting diagram of the IF filter is expanded by a factor of 2.

Automatic identification with a large span is not possible since the two mixer products are displayed at the same frequency. The diagram shown in figure 5-7 is obtained when examining products with a narrow span using the Auto ID function. You can easily recognize unwanted mixer products in the diagram obtained using one of the automatic detection functions.

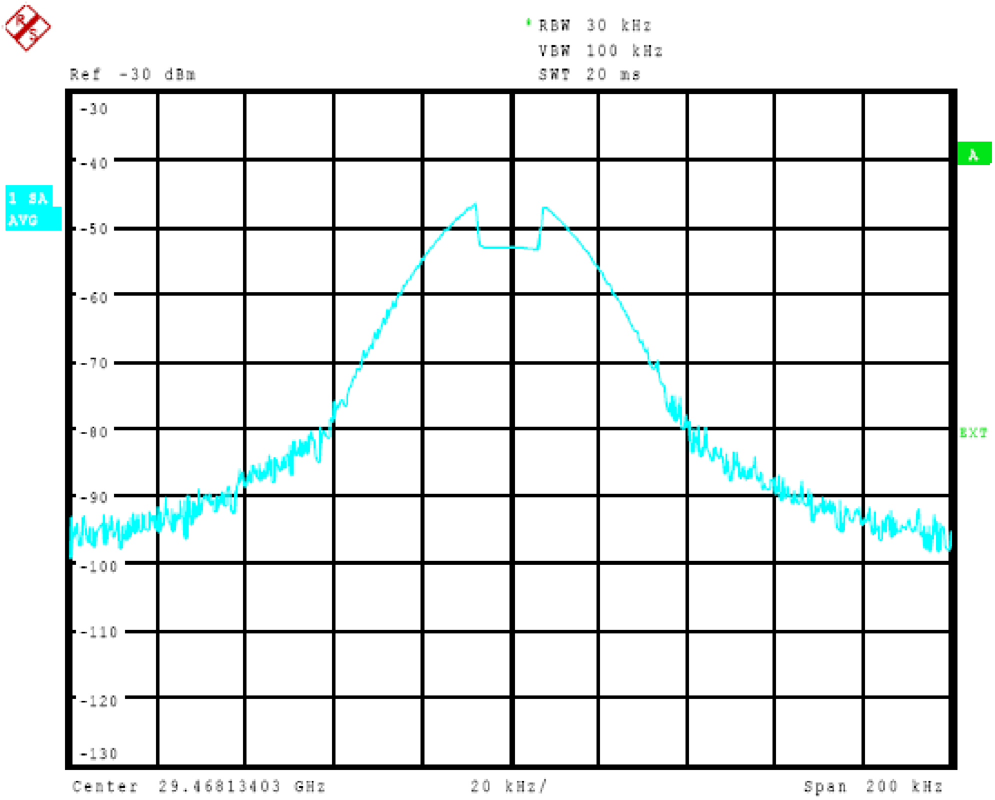


Fig. 5-7: Unwanted mixer products displayed for small span

5.2.4.2 External Mixer Settings

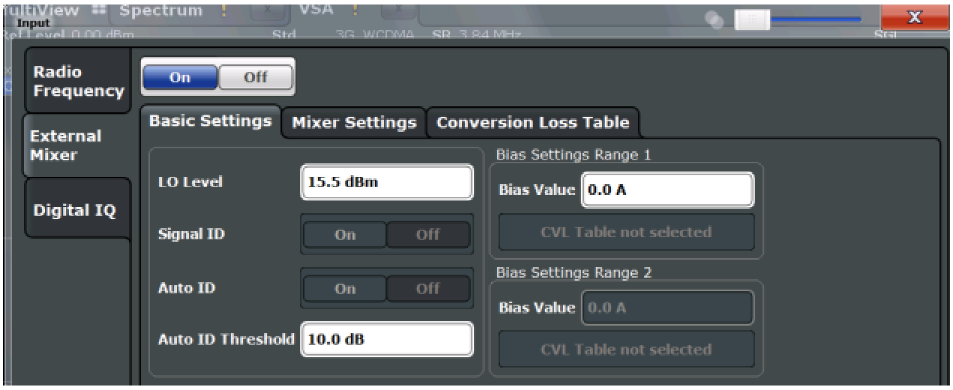
The external mixer is configured in the "External Mixer" tab of the "Input" dialog box which is available when you do one of the following, if the R&S FSW-B21 option is installed:

- Press the INPUT/OUTPUT key, then select the "External Mixer Config" softkey.
- From the "Overview", select "Input", then switch to the "External Mixer" tab under "Input Source".

Note that external mixers are not supported in MSRA mode.

Basic Settings

The basic settings concern general use of an external mixer.



External Mixer State

Activates or deactivates the external mixer for input. If activated, "ExtMix" is indicated in the channel bar of the application, together with the used band (see "Band" on page 208).

SCPI command:

[SENSe:]MIXer[:STATe] on page 662

LO Level

Defines the LO level of the external mixer's LO port. Possible values are from 13.0 dBm to 17.0 dBm in 0.1 dB steps. Default value is 15.5 dB.

SCPI command:

[SENSe:]MIXer:LOPower on page 663

Signal ID

Activates or deactivates visual signal identification. Two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep), trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

(See also "Automatic Signal Identification" on page 201).

Mathematical functions with traces and trace copy cannot be used with the Signal ID function.

SCPI command:

[SENSe:]MIXer:SIGNal on page 663

Auto ID

Activates or deactivates automatic signal identification.

Auto ID basically functions like Signal ID. However, the test and reference sweeps are converted into a single trace by a comparison of maximum peak values of each sweep point. The result of this comparison is displayed in trace 3 if "Signal ID" is active at the same time. If "Signal ID" is not active, the result can be displayed in any of the traces 1 to 3. Unwanted mixer products are suppressed in this calculated trace.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

(See also "Automatic Signal Identification" on page 201).

SCPI command:
`[SENSe:]MIXer:SIGNal` on page 663

Auto ID Threshold
Defines the maximum permissible level difference between test sweep and reference sweep to be corrected during automatic comparison ("Auto ID" on page 206 function). The input range is between 0.1 dB and 100 dB. Values of about 10 dB (i.e. default setting) generally yield satisfactory results.

(See also "Automatic Signal Identification" on page 201).

SCPI command:
`[SENSe:]MIXer:THReshold` on page 663

Bias Settings
Define the bias current for each range, which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

The trace is adapted to the settings immediately so you can check the results. To store the bias setting in the currently selected conversion loss table, select the Write to <CVL table name> button.

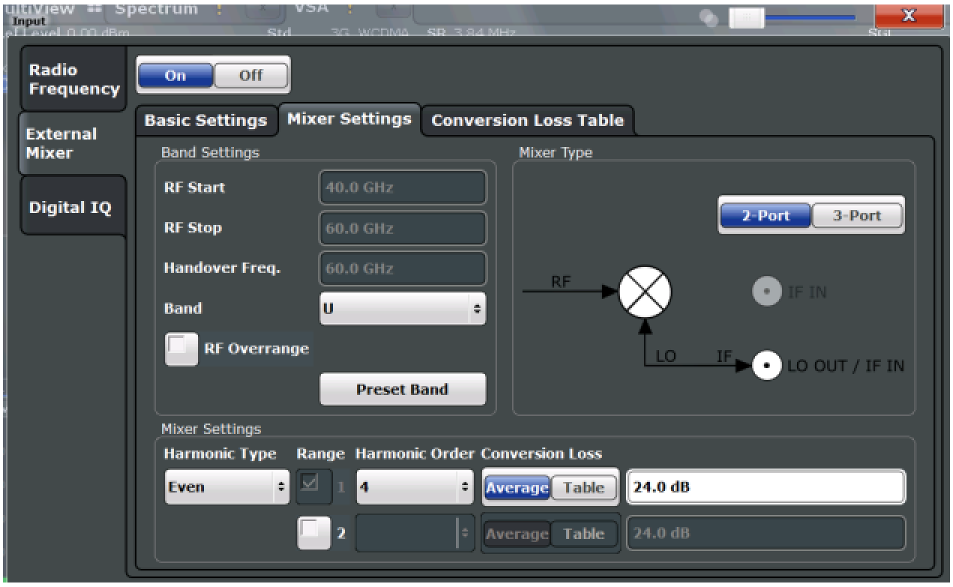
SCPI command:
`[SENSe:]MIXer:BIAS[:LOW]` on page 662
`[SENSe:]MIXer:BIAS:HIGH` on page 662

Write to <CVL table name> ← Bias Settings
Stores the bias setting in the currently selected "Conversion loss table" for the range (see "Managing Conversion Loss Tables" on page 210). If no conversion loss table is selected yet, this function is not available ("CVL Table not selected").

SCPI command:
`[SENSe:]CORRection:CVL:BIAS` on page 669

Mixer Settings

In this tab you configure the band and specific mixer settings.



RF Start / RF Stop

Displays the start and stop frequency of the selected band (read-only).

The frequency range for the user-defined band is defined via the harmonics configuration (see "Range 1/2" on page 209).

For details on available frequency ranges see table 10-3.

SCPI command:

[SENSe:]MIXer:FREQuency:STARt? on page 664

[SENSe:]MIXer:FREQuency:STOP? on page 664

Handover Freq.

Defines the frequency at which the mixer switches from one range to the next (if two different ranges are selected). The handover frequency can be selected freely within the overlapping frequency range.

SCPI command:

[SENSe:]MIXer:FREQuency:HANDover on page 664

Band

Defines the waveguide band or user-defined band to be used by the mixer.

The start and stop frequencies of the selected band are displayed in the "RF Start" and "RF Stop" fields.

For a definition of the frequency range for the pre-defined bands, see table 10-3).

The mixer settings for the user-defined band can be selected freely. The frequency range for the user-defined band is defined via the harmonics configuration (see "Range 1/2" on page 209).

SCPI command:
[SENSe:]MIXer:HARMonic:BAND[:VALue] on page 665

RF Overrange
If enabled, the frequency range is not restricted by the band limits ("RF Start" and "RF Stop"). In this case, the full LO range of the selected harmonics is used.

SCPI command:
[SENSe:]MIXer:RFOVerrange[:STATe] on page 668

Preset Band
Restores the presettings for the selected band.

Note: changes to the band and mixer settings are maintained even after using the PRESET function. This function allows you to restore the original band settings.

SCPI command:
[SENSe:]MIXer:HARMonic:BAND:PRESet on page 665

Mixer Type
The R&S FSW option B21 supports the following external mixer types:

"2 Port"	LO and IF data use the same port
"3 Port"	LO and IF data use separate ports

SCPI command:
[SENSe:]MIXer:PORTs on page 668

Mixer Settings (Harmonics Configuration)
The harmonics configuration determines the frequency range for user-defined bands (see "Band" on page 208).

Harmonic Type ← Mixer Settings (Harmonics Configuration)
Defines if only even, only odd, or even and odd harmonics can be used for conversion. Depending on this selection, the order of harmonic to be used for conversion changes (see "Harmonic Order" on page 210). Which harmonics are supported depends on the mixer type.

SCPI command:
[SENSe:]MIXer:HARMonic:TYPE on page 666

Range 1/2 ← Mixer Settings (Harmonics Configuration)
Enables the use of a second harmonic to cover the band's frequency range.

For each range you can define which harmonic to use and how the Conversion loss is handled.

SCPI command:

[SENSe:]MIXer:HARMonic:HIGH:STATe on page 666

Harmonic Order ← Mixer Settings (Harmonics Configuration)

Defines which of the available harmonic orders of the LO is used to cover the frequency range.

By default, the lowest order of the specified harmonic type is selected that allows conversion of input signals in the whole band. If due to the LO frequency the conversion is not possible using one harmonic, the band is split.

For the band "USER", the order of harmonic is defined by the user. The order of harmonic can be between 2 and 61, the lowest usable frequency being 26.5 GHz.

SCPI command:

[SENSe:]MIXer:HARMonic[:LOW] on page 667

[SENSe:]MIXer:HARMonic:HIGH[:VALue] on page 666

Conversion loss ← Mixer Settings (Harmonics Configuration)

Defines how the conversion loss is handled. The following methods are available:

"Average" Defines the average conversion loss for the entire range in dB.

"Table" Defines the conversion loss via the table selected from the list. Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S FSW. Alternatively, you can define your own conversion loss tables. Imported tables are checked for compatibility with the current settings before being assigned.
Conversion loss tables are configured and managed in the Managing Conversion Loss Tables tab.
For details on conversion loss tables, see "Conversion Loss Tables" on page 200.
For details on importing tables, see "Import Table" on page 212.

SCPI command:

Average for range 1:

[SENSe:]MIXer:LOSS[:LOW] on page 668

Table for range 1:

[SENSe:]MIXer:LOSS:TABLe[:LOW] on page 667

Average for range 2:

[SENSe:]MIXer:LOSS:HIGH on page 667

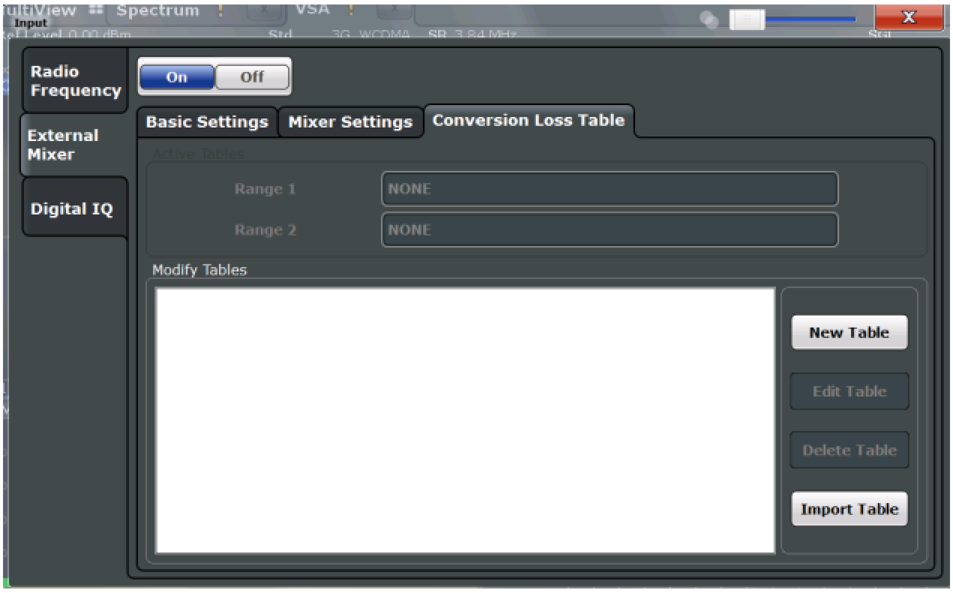
Table for range 2:

[SENSe:]MIXer:LOSS:TABLe:HIGH on page 667

Managing Conversion Loss Tables

In this tab you configure and manage conversion loss tables. Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. The correction values for frequencies between the reference points are obtained via interpolation.

The currently selected table for each range is displayed at the top of the dialog box. All conversion loss tables found in the instrument's `C:\r_s\instr\user\cvl\` directory are listed in the "Modify Tables" list.



New Table

Opens the "Edit Conversion loss table" dialog box to configure a new conversion loss table. For details on table configuration see "Creating and Editing Conversion Loss Tables" on page 212.

SCPI command:

`[SENSe:]CORRection:CVL:SELect` on page 672

Edit Table

Opens the "Edit Conversion loss table" dialog box to edit the selected conversion loss table. For details on table configuration see "Creating and Editing Conversion Loss Tables" on page 212.

SCPI command:

`[SENSe:]CORRection:CVL:SELect` on page 672

Delete Table

Deletes the currently selected conversion loss table after you confirm the action.

SCPI command:

`[SENSe:]CORRection:CVL:CLEAr` on page 670

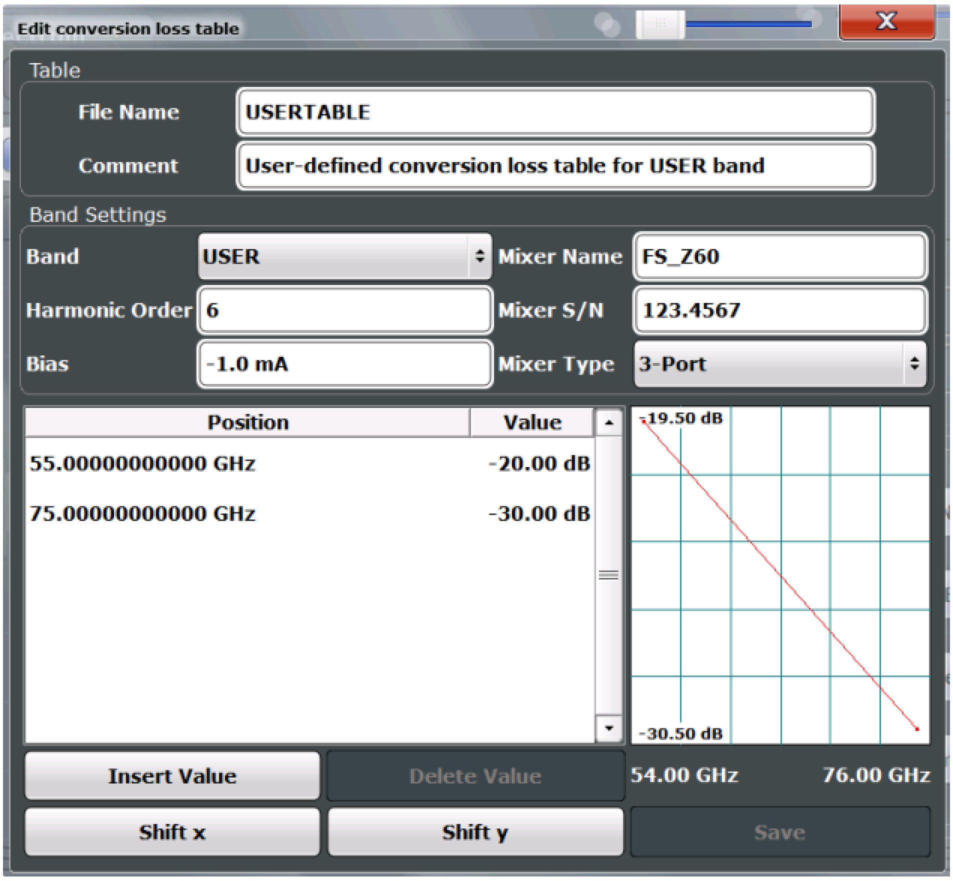
Import Table

Imports a stored conversion loss table from any directory and copies it to the instrument's `C:\r_s\instr\user\cvl\` directory. It can then be assigned for use for a specific frequency range (see "Conversion loss" on page 210).

Creating and Editing Conversion Loss Tables

Conversion loss tables can be defined and edited in the "Edit conversion loss table" dialog box which is displayed when you select the "New Table" button in the "External Mixer > Conversion loss table" settings.

A preview pane displays the current configuration of the conversion loss function as described by the position/value entries.



File Name

Defines the name under which the table is stored in the `C:\r_s\instr\user\cvl\` directory on the instrument. The name of the table is identical with the name of the file (without extension) in which the table is stored. This setting is mandatory. The `.ACL` extension is automatically appended during storage.

SCPI command:

`[SENSe:]CORRection:CVL:SELect` on page 672

Comment

An optional comment that describes the conversion loss table. The comment can be freely defined by the user.

SCPI command:

`[SENSe:]CORRection:CVL:COMMent` on page 670

Band

The waveguide or user-defined band for which the table is to be applied. This setting is checked against the current mixer setting before the table can be assigned to the range.

For a definition of the frequency range for the pre-defined bands, see table 10-3).

SCPI command:

`[SENSe:]CORRection:CVL:BAND` on page 669

Harmonic Order

The harmonic order of the range for which the table is to be applied. This setting is checked against the current mixer setting before the table can be assigned to the range.

SCPI command:

`[SENSe:]CORRection:CVL:HARMonic` on page 671

Bias

The bias current which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

Tip: You can also define the bias interactively while a preview of the trace with the changed setting is displayed, see "Bias Settings" on page 207.

SCPI command:

`[SENSe:]CORRection:CVL:BIAS` on page 669

Mixer Name

Specifies the name of the external mixer for which the table is to be applied. This setting is checked against the current mixer setting before the table can be assigned to the range.

SCPI command:

`[SENSe:]CORRection:CVL:MIXer` on page 671

Mixer S/N

Specifies the serial number of the external mixer for which the table is to be applied.

This setting is checked against the current mixer setting before the table can be assigned to the range.

SCPI command:

`[SENSe:]CORRection:CVL:SNUMber` on page 672

Mixer Type

Specifies whether the external mixer for which the table is to be applied is a two-port or three-port type. This setting is checked against the current mixer setting before the table can be assigned to the range.

SCPI command:

`[SENSe:]CORRection:CVL:PORTs` on page 672

Position/Value

Each position/value pair defines the correction value for conversion loss for a specific frequency. The reference values must be entered in order of increasing frequencies. A maximum of 50 reference values can be entered. To enter a new value pair, tap the "Position/Value" table, or select the Insert Value button.

Correction values for frequencies between the reference values are obtained by interpolation. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table the conversion loss is assumed to be the same as that for the first and last reference value.

The current configuration of the conversion loss function as described by the position/value entries is displayed in the preview pane to the right of the table.

SCPI command:

`[SENSe:]CORRection:CVL:DATA` on page 671

Insert Value

Inserts a new position/value entry in the table.

If the table is empty, a new entry at 0 Hz is inserted.

If entries already exist, a new entry is inserted above the selected entry. The position of the new entry is selected such that it divides the span to the previous entry in half.

Delete Value

Deletes the currently selected position/value entry.

Shift x

Shifts all positions in the table by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the x-axis.

Shift y

Shifts all conversion loss values by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the y-axis.

Save
The conversion loss table is stored under the specified name in the `C:\r_s\instr\user\cvl\` directory of the instrument.

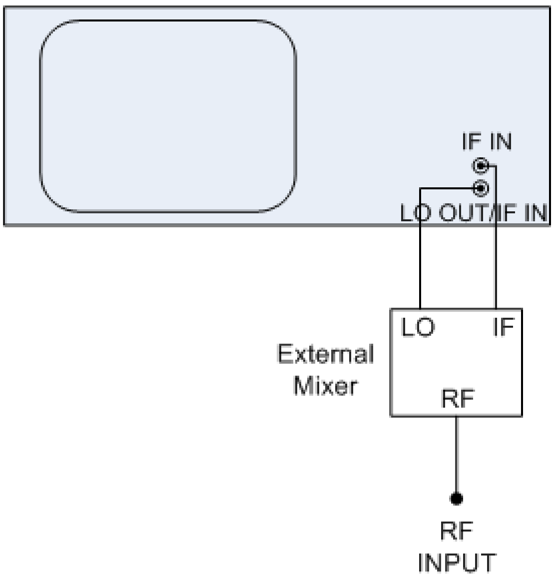
5.2.4.3 How to Work with External Mixers

Connecting the external mixer

External mixers can be connected at the LO OUT/IF IN and IF IN female connectors (option R&S FSW-B21). Both two-port and three-port mixers can be used. Connect the mixer as follows:

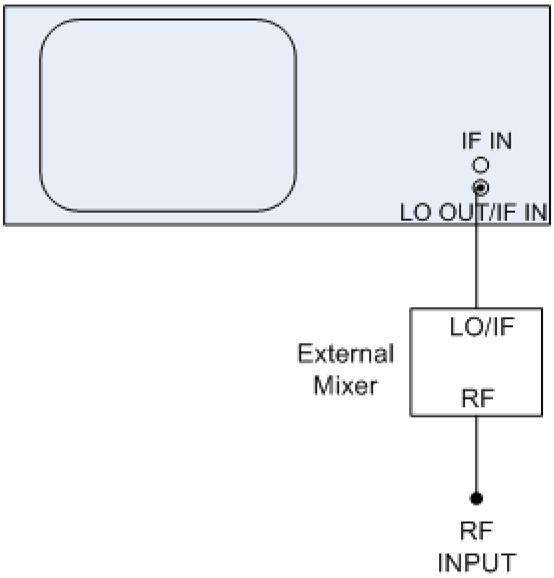
Use the supplied coaxial cable to feed in the LO signal. If no external mixers are connected to the R&S FSW, cover the two front connectors LO OUT / IF IN and IF IN with the SMA caps supplied.

To connect a three-port mixer



1. Connect the LO OUT / IF IN output of the R&S FSW to the LO port of the external mixer.
2. Connect the IF IN input of the R&S FSW to the IF port of the external mixer.
3. Feed the signal to be measured to the RF input of the external mixer.

To connect a two-port mixer



1. 1. Connect the LO OUT / IF IN output of the R&S FSW to the LO/IF port of the external mixer. The nominal LO level is 15.5 dBm.
   Because of the diplexer contained in the R&S FSW, the IF signal can be tapped from the line which is used to feed the LO signal to the mixer.
2. Feed the signal to be measured to the RF input of the external mixer.

5.2.4.4 Measurement Example: Using an External Mixer

The following example demonstrates the operation of external mixers as well as the required settings. A sine wave signal with f = 14.5 GHz is applied to the input of a multiplier. The spectrum at the multiplier output is to be recorded in the range of 52 GHz to 60 GHz using a 2-port mixer for the V band. The mixer used is a double-diode mixer. The example of operation is described in the following steps:

- "To set up the measurement" on page 217
- "To activate and configure the external mixer" on page 217
- "To define a new conversion loss table" on page 218
- "To take into account the cable loss in the IF path" on page 218

To set up the measurement

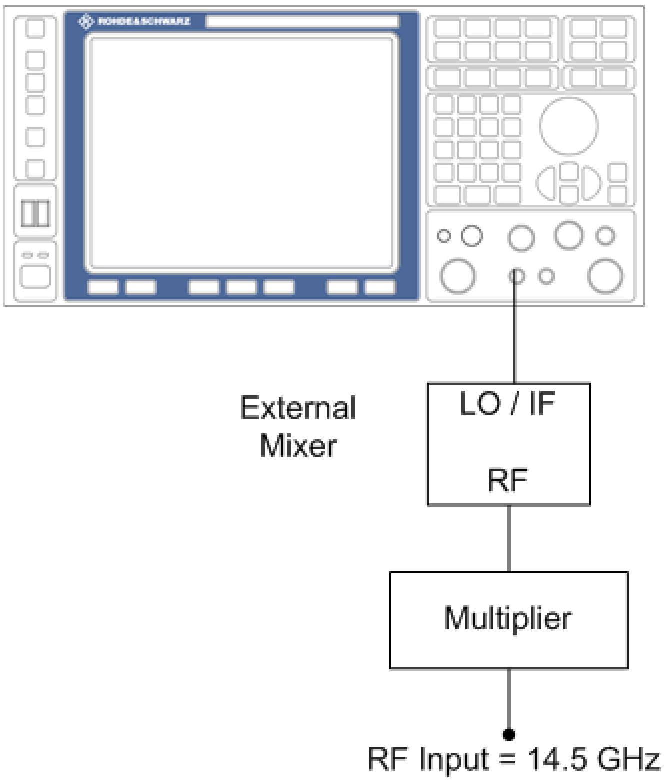


Fig. 5-8: External Mixer test setup

1. 1. Connect the LO OUT / IF IN output of the R&S FSW to the LO/IF port of the external mixer.
2. Connect the multiplier to the RF input of the external mixer.
3. Apply a sine wave signal with *f = 14.5 GHz* to the input of the multiplier.

To activate and configure the external mixer

1. Select "INPUT > Input Source Config > External Mixer: ON" to activate the external mixer for the current application.
2. Select "Mixer Settings > Band" to define the required frequency range.
3. From the "Band" selection list, select the band "V".
4. In the Mixer Settings, select "Conversion Loss: Table" for Range 1 to define frequency-dependent level correction.
5. From the selection list, select a conversion loss table stored on the instrument. No further settings are necessary since the selected file contains all required parameters. If the selected table is not valid for the selected band, an error message is displayed. If no conversion loss table is available yet, create a new table first (as described in "To define a new conversion loss table" on page 218).
6. A span is automatically set which covers the whole V band (50 to 75 GHz).

7. Reduce the video bandwidth by selecting "BW > Video Bandwidth Manual"=*1 MHz*. This allows for correct signal identification using the Auto ID function (see also "Automatic Signal Identification" on page 201).
8. Select "Basic Settings> Auto ID: On" to activate automatic signal identification.
9. Adapt the tolerance limit by selecting "Basic Settings> Auto ID Threshold". The tolerance limit is set to *5 dB* in this example.

To define a new conversion loss table

1. Select "INPUT > Input Source Config > External Mixer > Conversion Loss Table".
2. Select "New Table".
3. Define a file name and, optionally, a comment for the new table.
4. Define the band and mixer settings for which the conversion loss table is to be used. These settings will be compared to the current mixer settings during the validation check when the table is imported.
5. Define the reference values for the frequency-dependant conversion loss:
   a) Select "Insert Value" to add a new row in the table.
   b) Enter the first reference frequency.
   c) Enter the corresponding conversion loss value.
   The conversion loss function is updated and displayed in the preview diagram in the dialog box.
   d) Repeat these steps to define up to 50 reference values.
6. Select "Save".

   The table is stored and is then available for import and assignment to a specific frequency range.

To take into account the cable loss in the IF path

On performing level correction, the conversion loss of the mixer and also the insertion loss a_0 of the cable used to tap off the IF signal are to be taken into account. This additional loss is frequency-dependent.

1. Determine the insertion of the cable at the used intermediate frequency.
2. Increase each reference value in the conversion-loss table by the insertion loss (a_0).
   a) Select "INPUT > Input Source Config > External Mixer > Conversion Loss Table".
   b) Select the assigned conversion loss table.
   c) Select "Edit Table".
   d) Select "Shift y" and enter the insertion loss value <a_0> to shift all y-values in the table by this value.
3. Select "Save".

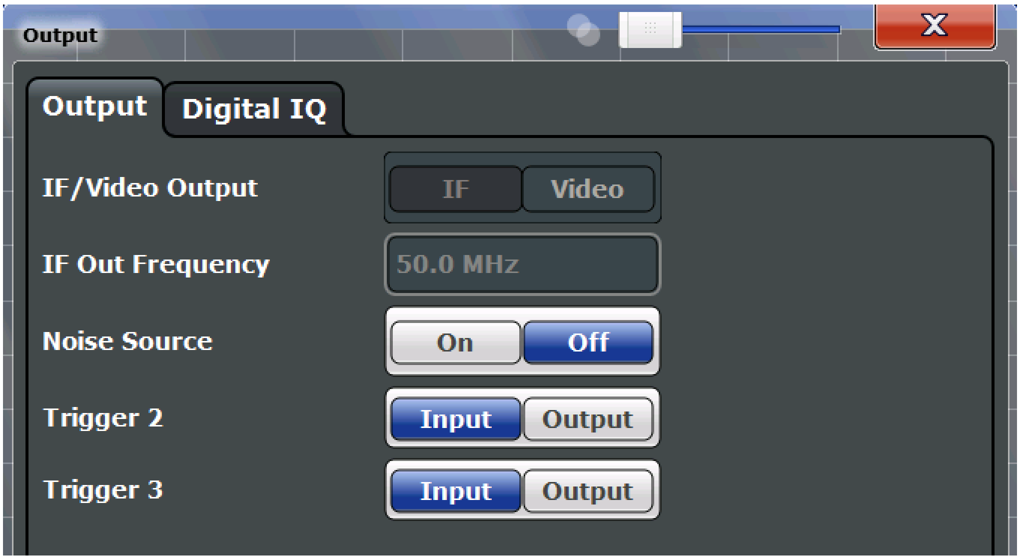
5.2.5 Data Output

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

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

Providing trigger signals as output is described in chapter 5.6.4, "How to Output a Trigger Signal", on page 269.

Output settings can be configured via the INPUT/OUTPUT key or in the "Outputs" dialog box.



IF/Video Output

Defines the type of signal sent to the IF/VIDEO/DEMOD connector on the rear panel of the R&S FSW.

For restrictions and additional information see chapter 5.2.1.4, "IF and Video Signal Output", on page 184.

"IF" Sends the measured IF value at the frequency defined in "IF (Wide) Out Frequency" on page 220 to the IF/VIDEO/DEMOD output connector.

"VIDEO" Sends the displayed video signal (i.e. the filtered and detected IF signal) to the IF/VIDEO/DEMOD output connector.
This setting is required to send demodulated audio frequencies to the output.

SCPI command:
`OUTP:IF VID` , see `OUTPut:IF[:SOURce]` on page 686

IF (Wide) Out Frequency
Defines the frequency at which the IF signal level is sent to the IF/VIDEO/DEMOD connector if IF/Video Output is set to "IF".

Note: The IF output frequency of the IF WIDE OUTPUT connector cannot be defined manually, but is determined automatically depending on the center frequency. It is indicated in this field when the IF WIDE OUTPUT connector is used. For details on the used frequencies see the data sheet.
The IF WIDE OUTPUT connector is used automatically instead of the IF/VIDEO/DEMOD connector if the bandwidth extension (hardware option R&S FSW-B160 / -U160) is activated (i.e. for bandwidths > 80 MHz).

For more information see chapter 5.2.1.4, "IF and Video Signal Output", on page 184.

SCPI command:
`OUTPut:IF:IFFRequency` on page 687

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 FSW itself, for example when measuring the noise level of a DUT.

For details see chapter 5.2.1.2, "Input from Noise Sources", on page 183

SCPI command:
`DIAGnostic:SERVice:NSOurce` on page 686

Trigger 2/3
Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

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

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

(Trigger 1 is INPUT only.)

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

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. No further trigger parameters are available for the connector.

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

SCPI command:
`OUTPut:TRIGger<port>:LEVel` on page 654
`OUTPut:TRIGger<port>:DIRection` on page 653

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

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

"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).
For details see "STATus:OPERation Register" on page 451 and the R&S FSW Getting Started manual.

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

SCPI command:
`OUTPut:TRIGger<port>:OTYPe` on page 654

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

SCPI command:
`OUTPut:TRIGger<port>:LEVel` on page 654

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

SCPI command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 655

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, 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.

SCPI command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 654

5.3 Frequency and Span Configuration

The frequency and span settings define the scope of the signal and spectrum to be analyzed with the R&S FSW.

5.3.1 Impact of the Frequency and Span Settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

5.3.1.1 Defining the Scope of the Measurement - Frequency Range

The frequency range defines the scope of the signal and spectrum to be analyzed. It can either be defined as a span around a center frequency, or as a range from a start to a stop frequency. Furthermore, the full span comprising the entire possible frequency range can be selected, or a zero span. The full span option allows you to perform an overview measurement over the entire span. Using the "Last Span" function you can easily switch back to the detailed measurement of a specific frequency range.

For sinusoidal signals, the center frequency can be defined automatically by the R&S FSW as the highest frequency level in the frequency span (see "Adjusting the Center Frequency Automatically (Auto Freq)" on page 271).

5.3.1.2 Stepping Through the Frequency Range - Center Frequency Stepsize

Using the arrow keys you can move the center frequency in discrete steps through the available frequency range. The step size by which the center frequency is increased or decreased is defined by the "Center Frequency Stepsize".

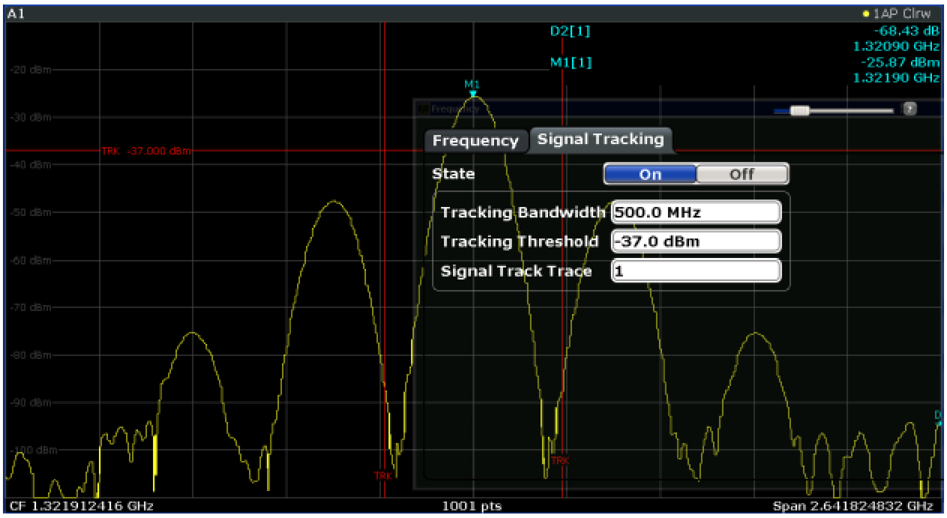
The "Center Frequency Stepsize" also defines the step size by which the value is increased or decreased when you use the rotary knob to change the center frequency; however, the **rotary knob** moves in steps of only **1/10 of the "Center Frequency Stepsize"** to allow for a more precise setting.

By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). In some cases, however, it may be useful to set the step size to other values.

For example, to analyze signal harmonics, you can define the step size to be equal to the center frequency. In this case, each stroke of the arrow key selects the center frequency of another harmonic. Similarly, you can define the step size to be equal to the current marker frequency.

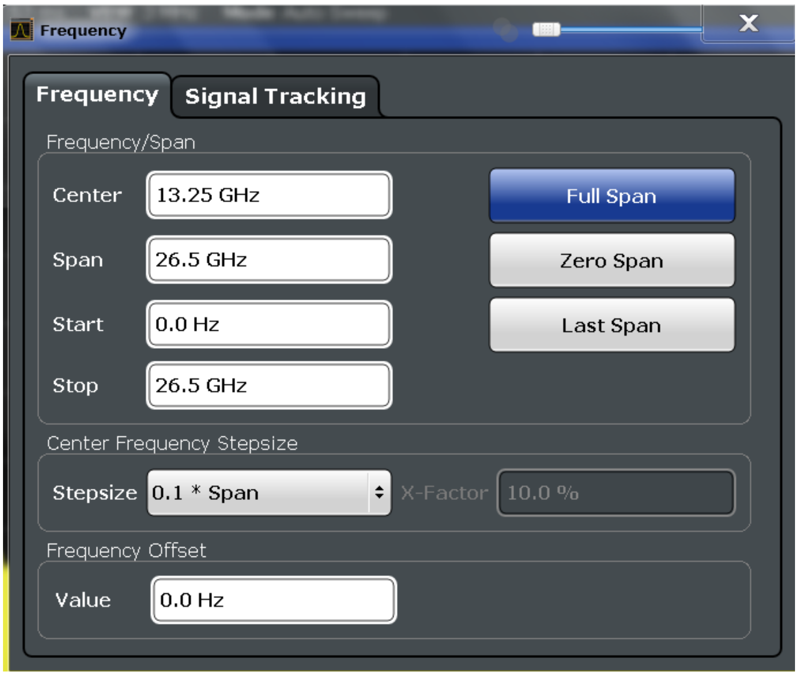
5.3.1.3 Keeping the Center Frequency Stable - Signal Tracking

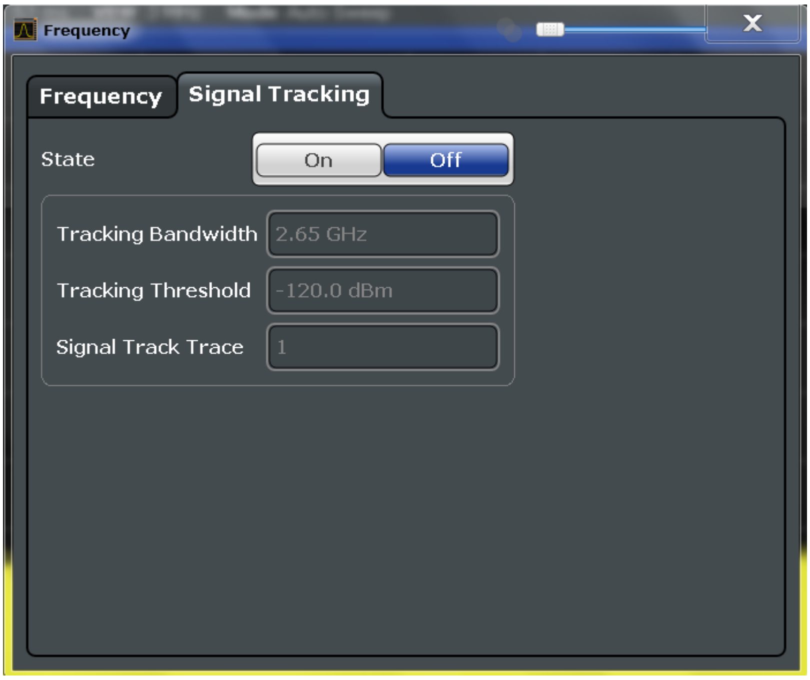
If the signal drifts on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**. In this case, the signal trace is surveyed in a specified bandwidth around the expected center frequency. After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above a defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".



5.3.2 Frequency and Span Settings

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box. For details see chapter 5.3.3, "How To Define the Frequency Range", on page 227.


Frequency
Frequency
Signal Tracking
Frequency/Span
Center
13.25 GHz
Full Span
Span
26.5 GHz
Zero Span
Start
0.0 Hz
Last Span
Stop
26.5 GHz
Center Frequency Stepsize
Stepsize
0.1 * Span
X-Factor
10.0 %
Frequency Offset
Value
0.0 Hz


Frequency
Frequency
Signal Tracking
State
On
Off
Tracking Bandwidth
2.65 GHz
Tracking Threshold
-120.0 dBm
Signal Track Trace
1

Center

Defines the normal center frequency of the signal. The allowed range of values for the center frequency depends on the frequency span.

span > 0: $span_{min}/2 \le f_{center} \le f_{max} - span_{min}/2$

zero span: $0\ Hz \le f_{center} \le f_{max}$

f_{max} and $span_{min}$ are specified in the data sheet.

SCPI command:
`[SENSe:]FREQuency:CENTer` on page 627

Span

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

span = 0: 0 Hz

span >0: $span_{min} \le f_{span} \le f_{max}$

f_{max} and $span_{min}$ are specified in the data sheet.

For more information see chapter 5.3.1.1, "Defining the Scope of the Measurement - Frequency Range", on page 222.

SCPI command:
`[SENSe:]FREQuency:SPAN` on page 629

Start / Stop

Defines the start and stop frequencies. The following range of values is allowed:

$f_{min} \le \mathbf{f_{start}} \le f_{max} - span_{min}$

$f_{min} + span_{min} \le \mathbf{f_{stop}} \le f_{max}$

f_{min}, f_{max} and $span_{min}$ are specified in the data sheet.

SCPI command:
`[SENSe:]FREQuency:STARt` on page 630
`[SENSe:]FREQuency:STOP` on page 630

Full Span

Sets the span to the full frequency range of the R&S FSW specified in the data sheet. This setting is useful for overview measurements.

SCPI command:
`[SENSe:]FREQuency:SPAN:FULL` on page 630

Zero Span

Sets the span to 0 Hz (zero span). The x-axis becomes the time axis with the grid lines corresponding to 1/10 of the current sweep time ("SWT").

For details see chapter 4.12, "Basic Measurements", on page 176.

SCPI command:

`FREQ:SPAN 0Hz`, see `[SENSe:]FREQuency:SPAN:FULL` on page 630

Last Span

Sets the span to the previous value. With this function you can switch between an overview measurement and a detailed measurement quickly.

Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. 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 the span (span > 0) or the resolution bandwidth (span = 0), or it can be manually set to a fixed value.

For more details see chapter 5.3.1.2, "Stepping Through the Frequency Range - Center Frequency Stepsize", on page 222.

"0.1 * Span / RBW"	Sets the step size for the center frequency to 10 % of the span / RBW. This is the default setting.
"0.5 * Span / RBW"	Sets the step size for the center frequency to 50 % of the span / RBW.
"X * Span / RBW"	Sets the step size for the center frequency to a manually defined factor of the span / RBW. The "X-Factor" defines the percentage of the span / RBW. Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.
"= Center"	Sets the step size to the value of the center frequency and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.
"= Marker"	This setting is only available if a marker is active. Sets the step size to the value of the current marker and removes the coupling of the step size to span or resolution bandwidth. 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.

SCPI command:

`[SENSe:]FREQuency:CENTer:STEP:LINK` on page 628
`[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor` on page 629
`[SENSe:]FREQuency:CENTer:STEP` on page 627

Frequency Offset

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

This parameter has no effect on the R&S FSW 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.

SCPI command:
`[SENSe:]FREQuency:OFFSet` on page 629

Signal Tracking
Defines the settings for signal tracking. These settings are only available for spans > 0.

For more details see chapter 5.3.1.3, "Keeping the Center Frequency Stable - Signal Tracking", on page 223.

Signal Tracking State ← Signal Tracking
Activates or deactivates signal tracking. This function is only available for spans > 0.

If activated, after each sweep, the center frequency is set to the maximum level of the specified trace found within the searched bandwidth.

SCPI command:
`CALCulate:MARKer:FUNCtion:STRack[:STATe]` on page 631

Tracking Bandwidth ← Signal Tracking
Defines the search bandwidth for signal tracking around the center frequency.

SCPI command:
`CALCulate:MARKer:FUNCtion:STRack:BANDwidth` on page 631

Tracking Threshold ← Signal Tracking
Defines the threshold value for signal tracking. If the signal level does not pass the threshold, the center frequency is not changed.

SCPI command:
`CALCulate:MARKer:FUNCtion:STRack:THReshold` on page 631

Signal Track Trace ← Signal Tracking
Defines the trace to be tracked.

SCPI command:
`CALCulate:MARKer:FUNCtion:STRack:TRACe` on page 631

5.3.3 How To Define the Frequency Range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see chapter 5.3.2, "Frequency and Span Settings", on page 223.

The remote commands required to perform these tasks are described in chapter 10.5.1, "Defining the Frequency and Span", on page 626.

To configure the frequency and span

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box.

1. To display the "Frequency" dialog box, do one of the following:
   - Select "Frequency" from the "Overview".
   - Select the FREQ key and then the "Frequency Config" softkey.
   - Select the SPAN key and then the "Frequency Config" softkey.
2. Define the frequency range using one of the following methods:
   - Define the "Center frequency" and "Span".
   - Define the "Start frequency" and "Stop frequency".
   - To perform a measurement in the time domain, define the "Center frequency" and select the "Zero span" button.
   - To perform a measurement over the entire available frequency range, select the "Full span" button.
   - To return to the previously set frequency range, select the "Last span" button.

5.3.4 How to Move the Center Frequency through the Frequency Range

In some cases it may be useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. In the "Frequency" dialog box, define the "Center Frequency Stepsize". This is the size by which the center frequency is to be increased or decreased in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, use the center frequency or marker value.
2. Select the "Center Frequency" dialog field.
3. Use the arrow keys to move the center frequency in discrete steps through the available frequency range.

5.3.5 How to Keep the Center Frequency Stable

If the signal is slightly instable on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**.

1. In the "Frequency" dialog box, select the "Signal Tracking" tab.
2. Define the following settings:
   - "Signal Tracking Bandwidth": the frequency range around the center frequency to be tracked
   - "Signal Tracking Threshold": the minimum level the trace must reach to be detected as a maximum

- "Signal Tracking Trace": the trace to be tracked

3. Activate signal tracking by selecting "State: ON".

   After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above the defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".

5.4 Amplitude and Vertical Axis Configuration

In the Spectrum application, measurement results usually consist of the measured signal levels (amplitudes) displayed on the vertical (y-)axis for the determined frequency spectrum or for the measurement time (horizontal, x-axis). The settings for the vertical axis, regarding amplitude and scaling, are described here.

5.4.1 Impact of the Vertical Axis Settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

5.4.1.1 Reference Level

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IFOVL" status display. The reference level should correspond with the maximum expected RF input level.

When determining the expected input level, consider that the power from *all* input signals contribute to the total power. The reference level must be higher than the total power from all signals.

The optimum reference level for the current measurement settings can be set automatically by the R&S FSW (see "Reference Level" on page 232).

The reference level determines the amplitude represented by the topmost grid line in the display. When you change the reference level, the measurement is not restarted; the results are merely shifted in the display. Only if the reference level changes due to a coupled RF attenuation (see "Attenuation Mode / Value" on page 233), the measurement is restarted.

In general, the R&S FSW measures the signal voltage at the RF input. The level display is calibrated in RMS values of an unmodulated sine wave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 186), conversion to other units is possible.

5.4.1.2 RF Attenuation

The attenuation is meant to protect the input mixer from high RF input levels. The level at the input mixer is determined by the set RF attenuation according to the formula:

"$level_{mixer}$ = $level_{input}$ – RF attenuation"

The maximum mixer level allowed is -10 dBm. Mixer levels above this value may lead to incorrect measurement results, which is indicated by the "OVLD" status display. Furthermore, higher input levels may damage the instrument. Therefore, the required RF attenuation is determined automatically according to the reference level by default.

High attenuation levels also avoid intermodulation. On the other hand, attenuation must be compensated for by re-amplifying the signal levels after the mixer. Thus, high attenuation values cause the inherent noise (i.e the noise floor) to rise and the sensitivity of the analyzer decreases.

The sensitivity of a signal analyzer is directly influenced by the selected RF attenuation. The highest sensitivity is obtained at an RF attenuation of 0 dB. Each additional 10 dB step reduces the sensitivity by 10 dB, i.e. the displayed noise is increased by 10 dB. To measure a signal with an improved signal-to-noise ratio, decrease the RF attenuation.

For ideal sinusoidal signals, the displayed signal level is independant of the RF attenuation.

Depending on the type of measurement evaluation that is required, a compromise must be found between a low noise floor and high intermodulation levels, and protecting the instrument from high input levels. This is best done by letting the R&S FSW determine the optimum level automatically (see "Attenuation Mode / Value" on page 233).

Electronic attenuation

If option R&S FSW-B25 is installed, you can also activate an electronic attenuator. For details see "Using Electronic Attenuation (Option B25)" on page 234.

5.4.1.3 Scaling

In a linear display, the measurement values are distributed linearly throughout the grid. That means the entire range of measured values is divided by the number of rows in the grid (10) and each row corresponds to 1/10 of the total range. Linear scaling is useful to determine precise levels for a small range of values. However, if large and small values appear in the same display, it is difficult to determine individual values precisely or to distinguish values that are close together.

In a logarithmic display, smaller values are distributed amoung a much larger area of the display, while large values are condensed to a smaller area. Now it is much easier to distinguish several lower values, as they are spread over a wider area. Logarithmic scaling is useful when large ranges of values must be combined in one display. Logarithmic scaling is best applied to measurement values in logarithmic units (dB, dBm etc.).

In addition to linear or logarithmic scaling, the vertical axis can be set to display either absolute or relative values. Absolute values show the measured levels, while relative values show the difference between the measured level and the defined reference level. Relative values are indicated in percent for linear scaling, and in dB for logarithmic scaling.

5.4.2 Amplitude Settings

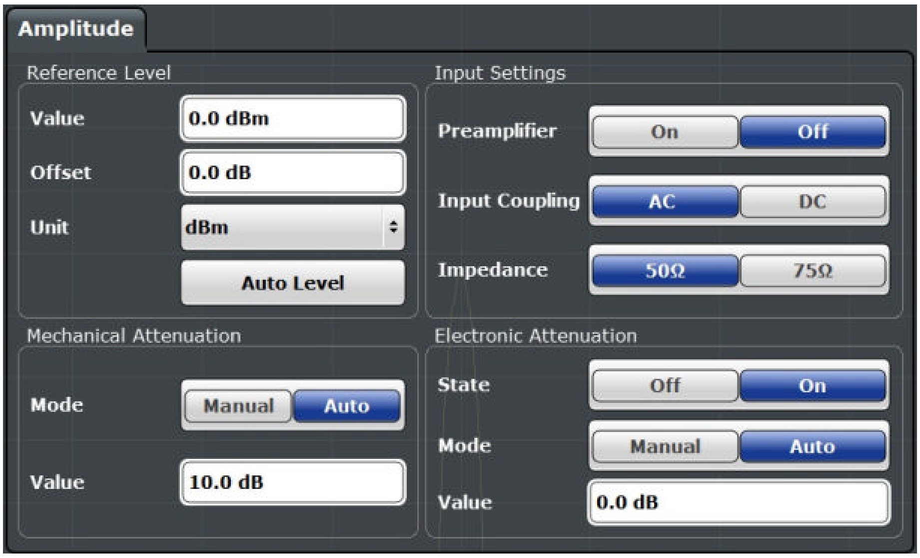
Amplitude settings determine how the R&S FSW must process or display the expected input power levels.

To configure the amplitude settings

Amplitude settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:
  - Select "Amplitude" from the "Overview".
  - Select "Input/Frontend" from the "Overview" and then switch to the "Amplitude" tab.
  - Select the AMPT key and then the "Amplitude Config" softkey.

The remote commands required to define these settings are described in chapter 10.5.3.1, "Amplitude Settings", on page 638.



Reference Level

Defines the expected maximum reference level. Signal levels above this value may not be measured correctly, which is indicated by the "IFOVL" 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 R&S FSW hardware 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).

Note that the "Reference Level" value ignores the Shifting the Display (Offset). It is important to know the actual power level the R&S FSW must handle.

For details see chapter 5.4.1.1, "Reference Level", on page 229.

Note that for input from the External Mixer (R&S FSW-B21) the maximum reference level also depends on the conversion loss, see "Reference level" on page 201.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel` on page 639

Shifting the Display (Offset) ← Reference Level

Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the y-axis is changed accordingly.

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

Note, however, that the Reference Level value ignores the "Reference Level Offset". It is important to know the actual power level the R&S FSW must handle.

To determine the required offset, consider the external attenuation or gain applied to the input signal. A positive value indicates that an attenuation took place (R&S FSW increases the displayed power values) , a negative value indicates an external gain (R&S FSW decreases the displayed power values).

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

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet` on page 639

Unit ← Reference Level

The R&S FSW measures the signal voltage at the RF input. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 186), conversion to other units is possible. The following units are available and directly convertible:

- dBm
- dBmV
- dBμV
- dBμA
- dBpW
- Volt
- Ampere
- Watt

SCPI command:

`INPut:IMPedance` on page 660
`CALCulate<n>:UNIT:POWer` on page 639

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

Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 271).

SCPI command:

`[SENSe:]ADJust:LEVel` on page 658

RF Attenuation

Defines the attenuation applied to the RF input.

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 the optimum RF attenuation is always used. It is the default setting. By default and when Using Electronic Attenuation (Option B25) is not available, mechanical attenuation is applied.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB, also using the rotary knob). 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.

For details see chapter 5.4.1.2, "RF Attenuation", on page 230.

SCPI command:
INPut:ATTenuation on page 640
INPut:ATTenuation:AUTO on page 641

Using Electronic Attenuation (Option B25)
If option R&S FSW-B25 is installed, you can also activate an electronic attenuator.

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

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

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

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

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

SCPI command:
INPut:EATT:STATe on page 642
INPut:EATT:AUTO on page 641
INPut:EATT on page 641

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 5.2.2, "Input Settings", on page 185.

Preamplifier (option B24) ← Input Settings
If option R&S FSW-B24 is installed, a preamplifier can be activated for the RF input signal.

For R&S FSW 26 models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW 8 or 13 models, the following settings are available:

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

"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.

SCPI command:
INPut:GAIN:STATe on page 642
INPut:GAIN[:VALue] on page 642

Noise cancellation

The results can be corrected by the instrument's inherent noise, which increases the dynamic range.

In this case, a reference measurement of the instrument's inherent noise is carried out. The measured noise power is then subtracted from the power in the channel that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the correction function is disabled whenever one of these parameters is changed. A disable message is displayed on the screen. To enable the correction function after changing one of these settings, activate it again. A new reference measurement is carried out.

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors (see "Detector" on page 295):

- RMS
- Average
- Sample
- Positive Peak

SCPI command:

`[SENSe:]POWer:NCORrection` on page 640

5.4.3 Scaling the Y-Axis

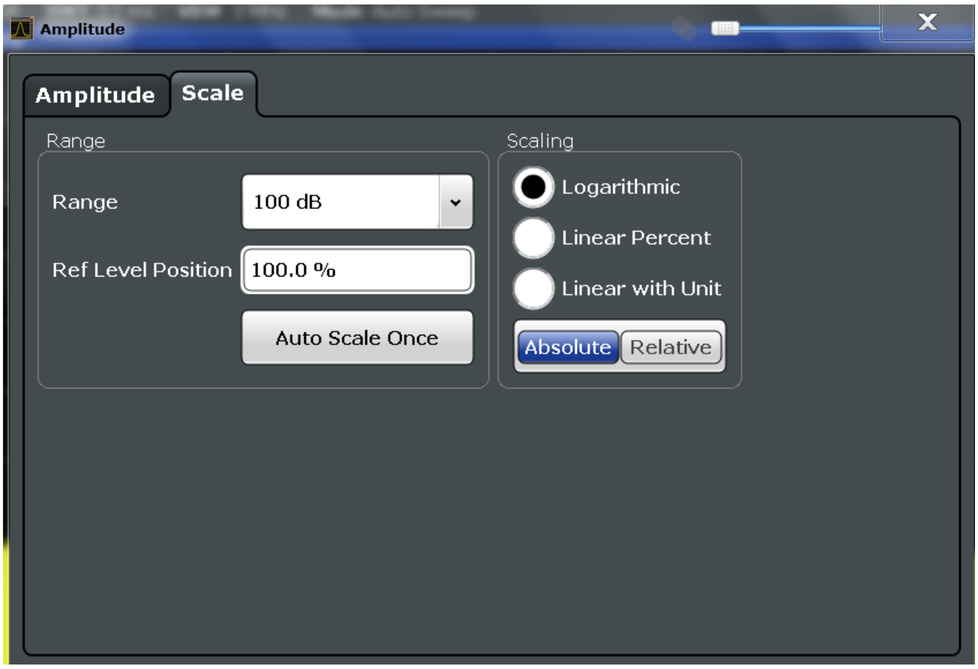
The individual scaling settings that affect the vertical axis are described here.

To configure the y-axis scaling settings

Vertical Axis settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:
  - Select "Amplitude" from the "Overview".
  - Select the AMPT key and then the "Scale Config" softkey.

The remote commands required to define these settings are described in chapter 10.5.3, "Configuring the Vertical Axis (Amplitude, Scaling)", on page 638.



Range

Defines the displayed y-axis range in dB (frequency domain) or Hz (time domain).

The default value is 100 dB or 500 kHz.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]` on page 643

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.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RPOSition` on page 644

Auto Scale Once

Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE` on page 643

Scaling

Defines the scaling method for the y-axis.

For more information see chapter 5.4.1.3, "Scaling", on page 230.

"Logarithmic"	Logarithmic scaling (only available for logarithmic units - dB...)
"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.

SCPI command:

`DISPlay[:WINDow<n>]:TRACe:Y:SPACing` on page 644

`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MODE` on page 644

5.4.4 How to Optimize the Amplitude Display

This section gives you some advice on how to optimize the display of the measured signal amplitudes depending on the required evaluation.

1. Perform a measurement with the default settings to get an impression of the values to be expected.
2. Use the "Auto Level" function (AUTO menu) to optimize the reference level.
3. Use the "Auto Scale" function (AUTO menu) to optimize the scaling.
4. **To determine a precise level at a specific point in the signal:**
   - Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Ref Level Position" so the required range remains visible.
   - Select "Linear Unit" scaling.

   Now you can set a marker at the point in question and read the result.
5. **To detect a spurious signal close to the noise floor:**
   - Set the "RF attenuation" to "Manual" mode and reduce the "Value" to lower the noise floor.
   - Select "Relative - Logarithmic" scaling.

   Now you can determine if any spurious levels of a certain size are visible.

5.5 Bandwidth, Filter and Sweep Configuration

The basic bandwidth, filter and sweep settings that apply to most measurements are described here. These parameters define how the data is measured: how much data is collected internally and which filters are used.

5.5.1 Impact of the Bandwidth, Filter and Sweep Settings

The bandwidth, filter and sweep settings are closely related and interdependant. The values available for resolution bandwidth and video bandwidth depend on the selected filter type. In addition, these settings have an impact on other measurement parameters. The following equation shows the interdependency of these settings:

$\mathbf{T_{sweepMIN} = K*Span/RBW^2}$

where K = Filter constant

By default, a Gaussian filter is used. The resolution bandwidth, the video bandwidth and the sweep time are set automatically according to the set span, and default coupling is used. Thus, the following settings are applied:

RBW = 100 * Span

VBW = RBW = 100 * Span

Sweep time = T_{min} for set Span, RBW, VBW

When defining the bandwidth and filter settings, consider the impact of the individual settings on the other settings and the measurement result, as described in more detail in the following sections.

5.5.1.1 Separating Signals by Selecting an Appropriate Resolution Bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

A basic feature of a signal analyzer is being able to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component. Smaller resolution bandwidths, however, increase the required measurement time.

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display screen shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity as well as by the resolution bandwidth that has been selected. The measure of selectivity used for signal analyzers is the ratio of the 60 dB bandwidth to the 3 dB bandwidth (= shape factor).

For the R&S FSW, the shape factor for bandwidths is < 5, i.e. the 60 dB bandwidth of the 30 kHz filter is <150 kHz.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The noise increases.

If the RBW is too small, parts of the signal are lost. As the displayed signal always reflects the shape of the filter, select a bandwidth large enough so the displayed signal reflects the entire shape of the filter.

5.5.1.2 Smoothing the Trace Using the Video Bandwidth

The video filters are responsible for smoothing the displayed trace. Using video bandwidths that are small compared to the resolution bandwidth, only the signal average is displayed and noise peaks and pulsed signals are repressed. If pulsed signals are to be measured, it is advisable to use a video bandwidth that is large compared to the resolution bandwidth (VBW = 10 x RBW) for the amplitudes of pulses to be measured correctly.

The level of a sine wave signal is not influenced by the video bandwidth. A sine wave signal can therefore be freed from noise by using a video bandwidth that is small compared with the resolution bandwidth, and thus be measured more accurately.

RMS/Average detector and VBW

If an RMS or average detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS or average detector. Normally, if the RMS or average detector is used the sweep time should be increased to get more stable traces.

5.5.1.3 Coupling VBW and RBW

The video bandwidth can be coupled to the resolution bandwidth automatically. In this case, if the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

Coupling is recommended if a minimum sweep time is required for a selected resolution bandwidth. Narrow video bandwidths require longer sweep times due to the longer settling time. Wide bandwidths reduce the signal/noise ratio.

Table 5-1: Overview of RBW/VBW ratios and recommendations for use

Ratio RBW/VBW	Recommendation for use
1/1	Recommended for sinusoidal signals This is the default setting for automatic coupling.
0.1	Recommended when the amplitudes of pulsed signals are to be measured correctly. The IF filter is exclusively responsible for the pulse shape. No additional evaluation is performed by the video filter.
10	Recommended to suppress noise and pulsed signals in the video domain.
Manually set (0.001 to 1000)	Recommended for other measurement requirements

5.5.1.4 Coupling Span and RBW

The resolution bandwidth can be coupled to the span setting, either by a manually defined factor or automatically. If the span is changed, the resolution bandwidth is automatically adjusted. The automatic coupling adapts the resolution bandwidth to the currently set frequency span/100. The 6 dB bandwidths 200 Hz, 9 kHz and 120 kHz and the available channel filters are not changed by the coupling.

With a span/RBW ratio of 100 and a screen resolution of 1000 pixels, each frequency in the spectrum is displayed by 10 pixels. A span/RBW ratio of 1000 provides the highest resolution.

A higher span/RBW ratio (i.e. low RBW values and large frequency spans), however, results in large amounts of data.

5.5.1.5 How Data is Measured: the Sweep Type

In a standard analog **frequency sweep**, the local oscillator of the analyzer sweeps the input data quasi analog from the start to the stop frequency to determine the frequency spectrum.

Alternatively, the analyzer can sample signal levels at a defined frequency and transform the data by Fast Fourier Transformation (**FFT sweep**). This measurement method provides very precise results without spurious effects. However, the calculations add to the overall measurement time, so that measurements with long sweep times and large numbers of sweep points may take longer than a common frequency sweep.

By default (Auto mode), the R&S FSW automatically uses the optimal sweep type depending on the current measurement settings.

Restrictions for FFT mode

FFT mode is not available when using 5-Pole filters, Channel filters or RRC filters, or the Quasi peak detector. In this case, sweep mode is used.

FFT Filter Mode

In order to convert a signal in the time domain to a spectrum of frequencies (e.g. in FFT sweep mode), FFT analysis is performed. Several analysis steps are required to cover the entire span. The partial span which is covered by one FFT analysis is defined by the FFT filter. Narrow filters provide a better frequency resolution. On the other hand, the narrower the filter, the more steps are required to cover the entire span, thus increasing analysis time.

This allows you to perform measurements near a carrier with a reduced reference level due to a narrower analog prefilter.

5.5.1.6 Which Data May Pass: Filter Types

While the filter is irrelevant when measuring individual narrowband signals (as long as the signal remains within the RBW), the measurement result for broadband signals is very dependant on the selected filter type and its shape. If the filter is too narrow, the signal is distorted by the filter. If the filter is too wide, multiple signals can no longer be distinguished. Generally, the smaller the filter width and the steeper its edges, the longer the settling time and thus the longer the sweep time must be.

All resolution bandwidths are realized with digital filters. Normal (3dB) Gaussian filters are set by default. Some communication standards require different filters.

FFT Filters

FFT filters are not supported as resolution or video filters in the R&S FSW. However, when FFT sweeps are performed (Sweep type = FFT, see chapter 5.5.1.5, "How Data is Measured: the Sweep Type", on page 240), FFT filters are used. The "FFT Filter Mode" setting refers to the filter bandwidth in this sweep mode.

For a list of available filter types, see chapter 5.5.3, "Reference: List of Available RRC and Channel Filters", on page 250.

Normal (3dB) Gaussian filters

Gaussian filters provide a good compromise between steep edges and a short settling time. This filter is suitable for most measurement tasks and is used by default.

The available Gaussian (3dB) sweep filters are listed in the R&S FSW data sheet.

Channel filters

Channel filters are fairly steep but require a long settling time; they are useful for pulse measurements in the time domain.

RRC filters

Root raised cosine filters are similar in shape to channel filters and are required by some measurement standards.

5-Pole filters

5-Pole filters are very broad and allow for a large bandwidth to pass.

5.5.1.7 How Long the Data is Measured: Sweep Time

Each filter has a settling time that must be awaited in order to obtain correct results. Since the resolution bandwidth and video bandwidth define the filter, the smaller of the two determines the minimum sweep time required for the measurement. Allowed values depend on the ratio of span to RBW and RBW to VBW.

If the selected sweep time is too short for the selected bandwidth and span, level measurement errors will occur. In this case, the R&S FSW displays the error message "Sweep time too low" and marks the indicated sweep time with a red bullet. Furthermore, a status bit indicates an error (see "STATus:QUEStionable:TIMe Register" on page 458).

The sweep time can be coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW) automatically. If the span, resolution bandwidth or video bandwidth is changed, the sweep time is automatically adjusted.

5.5.1.8 How Much Data is Measured: Sweep Points and Sweep Count

By default, 1001 data points are determined in a single sweep. During the next sweep, 1001 new data points are collected, and so on. The number of **sweep points** defines how much of the entire span is covered by a single data point. By increasing the number of sweep points you can increase the reliability of the individual data points and thus the accuracy of the analyzed results. However, these data points are all stored on the instrument, occupying a large amount of memory, and each sweep point increases the overall measurement time. Up to 200 000 points can be swept at once.

The number of sweeps to be performed in single sweep mode is defined by the "Sweep Count". Values from 0 to 32767 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in a diagram.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, the "sweep/average count" also determines the number of averaging or maximum search procedures (see chapter 6.3.1.2, "Analyzing Several Traces - Trace Mode", on page 284).

For details on how the number of sweep points and the sweep count affect the trace results on the screen, see chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282.

5.5.1.9 How Often Data is Measured: Sweep Mode

How often the spectrum is swept depends on the sweep mode. Either a certain number of sweeps can be defined ("Sweep Count") which are performed in "Single Sweep" mode, or the sweep is repeated continuously ("Continuous Sweep" mode).

By default, the data is collected for the specified number of sweeps and the corresponding trace is displayed. When the next sweep is started, the previous trace is deleted.

However, the data from a single sweep run can also be retained and displayed together with the new data ("Continue Single Sweep" mode). This is particularly of interest when using the trace configurations "Average" or "Max Hold" to take previously recorded measurements into account for averaging/maximum search (see chapter 6.3.1.2, "Analyzing Several Traces - Trace Mode", on page 284).

5.5.2 Bandwidth, Filter and Sweep Settings

To configure the bandwidth, filter and sweep

Bandwidth and filter settings can be configured via the "Bandwidth" tab of the "Bandwidth" dialog box.

Sweep settings can be configured in the Sweep dialog box or via the "Sweep" tab of the "Bandwidth" dialog box.

1. To display the "Bandwidth" dialog box, do one of the following:
   - Select "Bandwidth" from the "Overview".
   - Select the BW key and then the "Bandwidth Config" softkey.
   - Select the SWEEP key and then the "Sweep Config" softkey.
2. To display the "Sweep" dialog box, do one of the following:
   - Select "Bandwidth" from the "Overview" and switch to the "Sweep" tab in the "Bandwidth" dialog box.
   - Select the SWEEP key and then the "Sweep Config" softkey.

The remote commands required to define these settings are described in chapter 10.5.2, "Configuring Bandwidth and Sweep Settings", on page 632.

How to perform a basic sweep measurement is described in chapter 4.12.1, "How to Perform a Basic Sweep Measurement", on page 176.

Fig. 5-9: Bandwidth dialog box

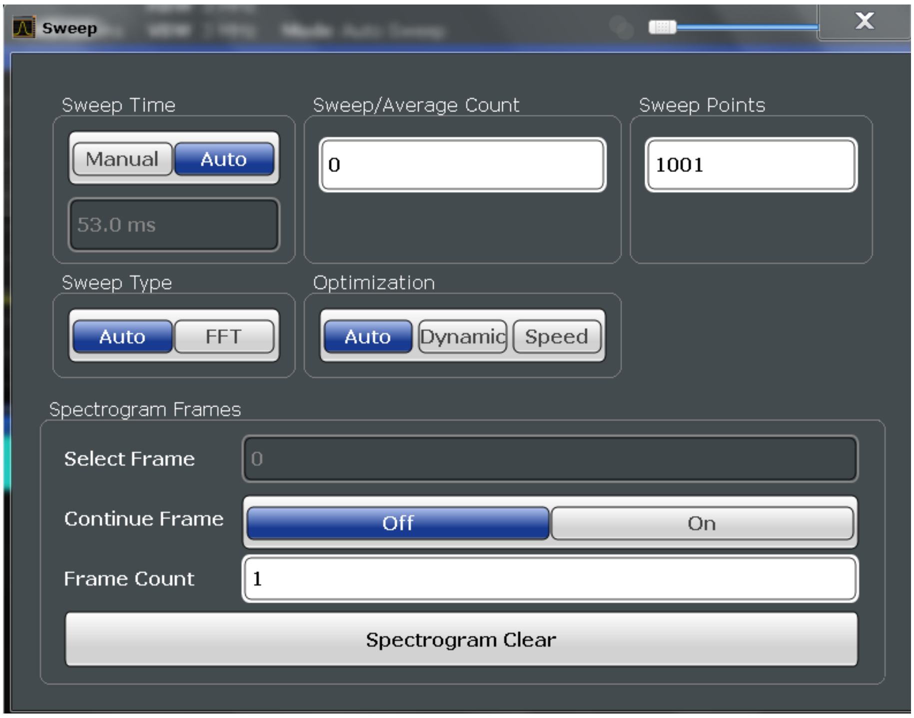


Fig. 5-10: Sweep dialog box for spectrogram display

RBW

Defines the resolution bandwidth automatically or manually.

For more information see chapter 5.5.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 238.

For measurements on I/Q data in the frequency domain, the maximum RBW is 1 MHz.

"Auto" Couples the resolution bandwidth to the selected span (for span > 0). If the span is changed, the resolution bandwidth is automatically adjusted.

"Manual" For manual mode, define the bandwidth value. The available resolution bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.
If the resolution bandwidth is defined manually, a green bullet is displayed next to the "RBW" display in the channel bar.

SCPI command:

`[SENSe:]BANDwidth|BWIDth[:RESolution]` on page 632

`[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO` on page 632

VBW

Defines the video bandwidth automatically or manually.

For more information see chapter 5.5.1.2, "Smoothing the Trace Using the Video Bandwidth", on page 239.

"Auto" The video bandwidth is coupled to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

"Manual" For manual mode, define the bandwidth value. The available video bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.
If the video bandwidth is defined manually, a green bullet is displayed next to the "VBW" display in the channel bar.

SCPI command:

`[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO` on page 634

`[SENSe:]BANDwidth|BWIDth:VIDeo` on page 633

Sweep Time

Defines the duration of a single sweep, during which the defined number of sweep points are measured. The sweep time can be defined automatically or manually.

The allowed sweep times depend on the device model; refer to the data sheet.

For more information see chapter 5.5.1.7, "How Long the Data is Measured: Sweep Time", on page 242.

"Auto" The sweep time is coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW). If the span, resolution bandwidth or video bandwidth is changed, the sweep time is automatically adjusted.

"Manual" For manual mode, define the sweep time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

SCPI command:

`[SENSe:]SWEep:TIME:AUTO` on page 637

`[SENSe:]SWEep:TIME` on page 636

Span/RBW

Sets the coupling ratio if RBW is set to auto mode.

For more information see chapter 5.5.1.4, "Coupling Span and RBW", on page 240.

"Auto [100]" "resolution bandwidth = span/100"
This coupling ratio is the default setting of the R&S FSW.

"Manual" The coupling ratio is defined manually.
The span/resolution bandwidth ratio can be set in the range from 1 to 10000.

SCPI command:

`[SENSe:]BANDwidth|BWIDth[:RESolution]:RATio` on page 633

RBW/VBW

Sets the coupling ratio between the resolution bandwidth and the video bandwidth.

This setting is only effective if VBW is set to auto mode.

For more information see chapter 5.5.1.3, "Coupling VBW and RBW", on page 240.

"Sine [1/1]" "video bandwidth = resolution bandwidth"
This is the default setting for the coupling ratio RBW/VBW and is recommended if sinusoidal signals are to be measured.

"Pulse [.1]" "video bandwidth = 10 × resolution bandwidth"
or
"video bandwidth = 10 MHz (= max. VBW)"
Recommended for pulse signals

"Noise [10]" "video bandwidth = resolution bandwidth/10"
Recommended for noise measurements

"Manual" The coupling ratio is defined manually.
The RBW/VBW ratio can be set in the range of 0.001 to 1000.

SCPI command:
[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO on page 634
[SENSe:]BANDwidth|BWIDth:VIDeo:RATio on page 634

Filter Type
Defines the filter type.

The following filter types are available:

- Normal (3dB)
- Channel
- RRC
- 5-Pole (not available for sweep type "FFT")

For more information see chapter 5.5.1.6, "Which Data May Pass: Filter Types", on page 241.

SCPI command:
[SENSe:]BANDwidth|BWIDth[:RESolution]:TYPE on page 633

Default Coupling
Sets all coupled functions to the default state ("AUTO"). In addition, the ratio "RBW/VBW" is set to "SINE [1/1]" and the ratio "SPAN/RBW" to *100.*

For more information see chapter 5.5.1.3, "Coupling VBW and RBW", on page 240.

SCPI command:
[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO on page 632
[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO on page 634
[SENSe:]SWEep:TIME:AUTO on page 637

Sweep/Average Count
Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in all diagrams.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweeps. For sweep count =1, no averaging, maxhold or minhold operations are performed.

For more information see chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242.

For spectrogram displays, the sweep count determines how many sweeps are combined in one frame in the spectrogram, i.e. how many sweeps the R&S FSW performs to plot one trace in the spectrogram result display. For more details see "Time Frames" on page 289.

SCPI command:
[SENSe:]SWEep:COUNt on page 635
[SENSe:]AVERage:COUNt on page 692

Sweep Points

Defines the number of measured values to be collected during one sweep.

For details see chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242.

All values from 101 to 200 000 can be set. The default value is 1001 sweep points.

SCPI command:
`[SENSe:]SWEep:POINts` on page 636

Optimization

Defines the filter mode to be used for FFT sweep mode by defining the partial span size. The partial span is the span which is covered by one FFT analysis.

"Auto" Automatically applies the sweep optimization mode that is best for the current measurement.

"Dynamic" Optimizes the sweep mode for a large dynamic range.

"Speed" Optimizes the sweep mode for high performance.

SCPI command:
`[SENSe:]SWEep:OPTimize` on page 635

Sweep Type

Defines the sweep type.

"Auto" Automatically sets the fastest available sweep type for the current measurement (Frequency or FFT). Auto mode is set by default.

"FFT" The FFT sweep samples on a defined frequency value and transforms it to the spectrum by fast Fourier transformation (FFT) (see also "Optimization" on page 248).
FFT is not available when using 5-Pole filters, Channel filters or RRC filters, or when using the Quasi peak detector. In this case, frequency sweep is used.

SCPI command:
`[SENSe:]SWEep:TYPE` on page 637

Single Sweep/ RUN SINGLE

After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only 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 on the front panel 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 chapter 3.5.1, "The Sequencer Concept", on page 26.

SCPI command:
`INITiate[:IMMediate]` on page 510

Continuous Sweep/RUN CONT
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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

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

For details on the Sequencer, see chapter 3.5.1, "The Sequencer Concept", on page 26.

SCPI command:
`INITiate:CONTinuous` on page 509

Continue Single Sweep
After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

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

SCPI command:
`INITiate:CONMeas` on page 509

Spectrogram Frames
These settings are only available if spectrogram display is active (see chapter 6.3.3.2, "How to Display and Configure a Spectrogram", on page 306).

Select frame ← Spectrogram Frames
Selects a specific frame and loads the corresponding trace from the memory.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is available in single sweep mode or if the sweep is stopped.

The most recent frame is number 0, all previous frames have a negative number.

For more information see "Time Frames" on page 289.

SCPI command:
`CALCulate:SGRam:FRAMe:SELect` on page 696

Continue Frame ← Spectrogram Frames
Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

- **On**
  When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also taken into account.
- **Off**
  The average or peak values are determined from the results of the newly swept frames only.

SCPI command:
`CALCulate:SGRam:CONT` on page 695

Frame Count ← Spectrogram Frames
Defines the number of frames to be captured in a single sweep.

Thus, the frame count defines the number of traces the R&S FSW plots in the spectrogram result display in a single sweep. The maximum number of possible frames depends on the history depth (see "History Depth" on page 302).

The sweep count, on the other hand, determines how many sweeps are combined in one frame in the spectrogram, i.e. how many sweeps the R&S FSW performs to plot one trace in the spectrogram result display (see "Sweep/Average Count" on page 247).

This softkey is available in single sweep mode.

For more details see "Time Frames" on page 289.

SCPI command:
`CALCulate:SGRam:FRAMe:COUNt` on page 696

Clear Spectrogram ← Spectrogram Frames
Resets the spectrogram result display and clears the history buffer.

SCPI command:
`CALCulate:SGRam:CLEar[:IMMediate]` on page 695

5.5.3 Reference: List of Available RRC and Channel Filters

For power measurement a number of especially steep-edged channel filters are available (see the following table). The indicated filter bandwidth is the 3 dB bandwidth. For RRC filters, the fixed roll-off factor (a) is also indicated.

The available Gaussian 3dB sweep filters are listed in the R&S FSW data sheet.

Table 5-2: Filter types

Filter Bandwidth	Filter Type	Application
100 Hz	CFILter	
200 Hz	CFILter	A0
300 Hz	CFILter	
500 Hz	CFILter	
1 kHz	CFILter	
1.5 kHz	CFILter	
2 kHz	CFILter	
2.4 kHz	CFILter	SSB
2.7 kHz	CFILter	
3 kHz	CFILter	
3.4 kHz	CFILter	
4 kHz	CFILter	DAB, Satellite
4.5 kHz	CFILter	
5 kHz	CFILter	
6 kHz	CFILter	
6 kHz, a=0.2	RRC	APCO
8.5 kHz	CFILter	ETS300 113 (12.5 kHz channels)
9 kHz	CFILter	AM Radio
10 kHz	CFILter	
12.5 kHz	CFILter	CDMAone
14 kHz	CFILter	ETS300 113 (20 kHz channels)
15 kHz	CFILter	
16 kHz	CFILter	ETS300 113 (25 kHz channels)
18 kHz, a=0.35	RRC	TETRA
20 kHz	CFILter	
21 kHz	CFILter	PDC
24.3 kHz, a=0.35	RRC	IS 136
25 kHz	CFILter	
30 kHz	CFILter	CDPD, CDMAone
50 kHz	CFILter	

Filter Bandwidth	Filter Type	Application
100 kHz	CFILter	
150 kHz	CFILter	FM Radio
192 kHz	CFILter	PHS
200 kHz	CFILter	
300 kHz	CFILter	
500 kHz	CFILter	J.83 (8-VSB DVB, USA)
1 MHz	CFILter	CDMAone
1.228 MHz	CFILter	CDMAone
1.28 MHz, a=0.22	RRC	
1.5 MHz	CFILter	DAB
2 MHz	CFILter	
3 MHz	CFILter	
3.75 MHz	CFILter	
3.84 MHz, a=0.22	RRC	W-CDMA 3GPP
4.096 MHz, a=0.22	RRC	W-CDMA NTT DOCoMo
5 MHz	CFILter	
10 MHz ***)**	CFILter	
20 MHz ***)**	CFILter	
28 MHz ***)**	CFILter	
40 MHz ***)**	CFILter	
80 MHz ***)**	CFILter	
***)** These filters are only available with option R&S FSW-B8 (Resolution Bandwidths > 10 MHz).		

5.6 Trigger and Gate Configuration

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

Gating allows you to restrict measurement analysis to the important part or parts of the signal, for example bursts.

5.6.1 Basics of Triggering and Gated Measurements

Some background knowledge on triggering and gated measurements is provided here for a better understanding of the required configuration settings.

5.6.1.1 Triggered measurements

In a basic sweep measurement with default settings, the sweep is started immediately when you start the measurement, for example by pressing the RUN SINGLE key. However, sometimes you want the measurement to start only when a specific condition is fulfilled, for example a signal level is exceeded, or in certain time intervals. For these cases you can define a trigger for the measurement. In FFT sweep mode, the trigger defines when the data acquisition starts for the FFT conversion.

An "Offset" can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

For complex tasks, advanced trigger settings are available:

- Hysteresis to avoid unwanted trigger events caused by noise
- Holdoff to define exactly which trigger event will cause the trigger in a jittering signal

Trigger Source

The trigger source defines which source must fulfill the condition that triggers the measurement. Basically, this can be:

- Time: the measurement is repeated in a regular interval
- Power: an input signal is checked for a defined power level
  The trigger signal can be an internal one (the input signal at one of various stages in the signal analysis process - before or after the input mixer, after the video filter etc.) or it may come from an external device via one of the TRIGGER INPUT connectors on the front or rear panel of the instrument.
  A power sensor can also provide an external trigger, see "Using a Power Sensor as an External Power Trigger" on page 189.

For details on the available trigger sources see "Trigger Source" on page 260.

Trigger Offset

An offset can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

Pre-trigger offsets are possible because the R&S FSW captures data continuously in the time domain, even before the trigger occurs.

See "Trigger Offset" on page 264.

Trigger Hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level that the signal must fall below on a rising slope or rise above on a falling slope before another trigger event occurs.

Example:

In the following example, the second possible trigger event is ignored as the signal does not exceed the hysteresis (threshold) before it reaches the trigger level again on the rising edge. On the falling edge, however, two trigger events occur as the signal exceeds the hysteresis before it falls to the trigger level the second time.

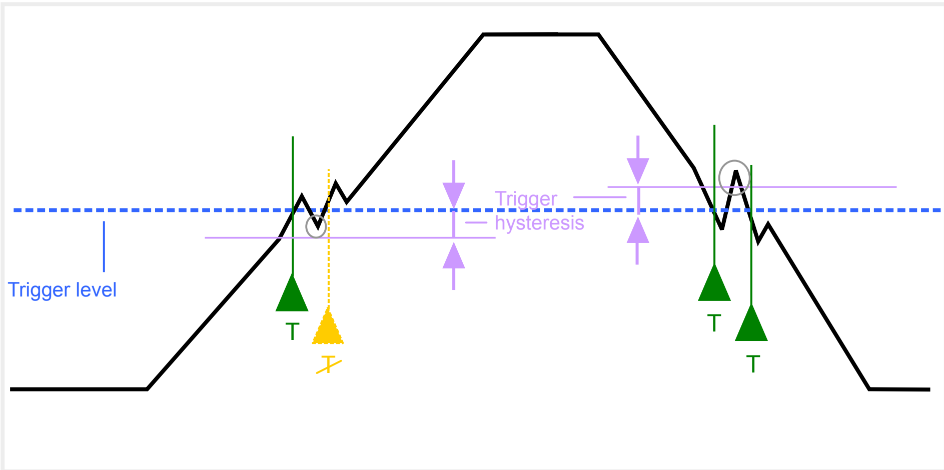


Fig. 5-11: Effects of the trigger hysteresis

See "Hysteresis" on page 264

Trigger Drop-Out Time

If a modulated signal is instable and produces occassional "drop-outs" during a burst, you can define a minimum duration that the input signal must stay below the trigger level before triggering again. This is called the "drop-out" time. Defining a dropout time helps you stabilize triggering when the analyzer is triggering on undesired events.

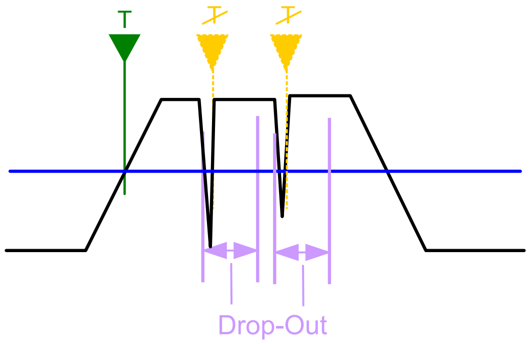


Fig. 5-12: Effect of the trigger drop-out time

See "Drop-Out Time" on page 263.

Trigger Holdoff

The trigger holdoff defines a waiting period before the next trigger after the current one will be recognized.

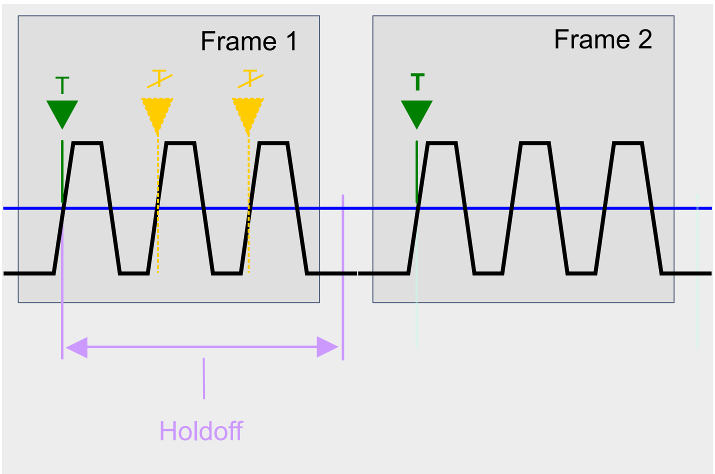


Fig. 5-13: Effect of the trigger holdoff

See "Trigger Holdoff" on page 264.

5.6.1.2 Gated Measurements

Like a gate provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source. Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Gate Level". Using a pulsed gate signal in level mode, the following behaviour can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.

- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.

The "Gate Mode" *Level* is not supported for R&S power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on power sensors see "Using a Power Sensor as an External Power Trigger" on page 189.

Additionally, a delay time can be defined so that the first few measurement points after the gate opening are ignored.

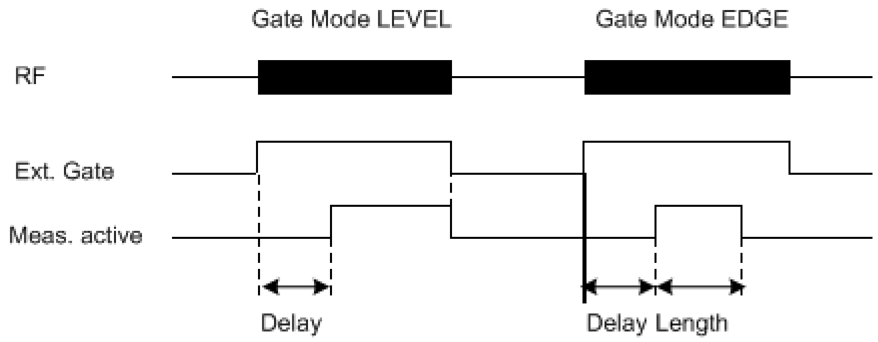


Fig. 5-14: Effects of Gate mode, Gate delay and Gate length

Example:

By using a gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed RF carriers can be displayed without the superposition of frequency components generated during switching. Similarly, the spectrum can also be analyzed for an inactive carrier. The sweep can be controlled by an external gate or by the internal power trigger.

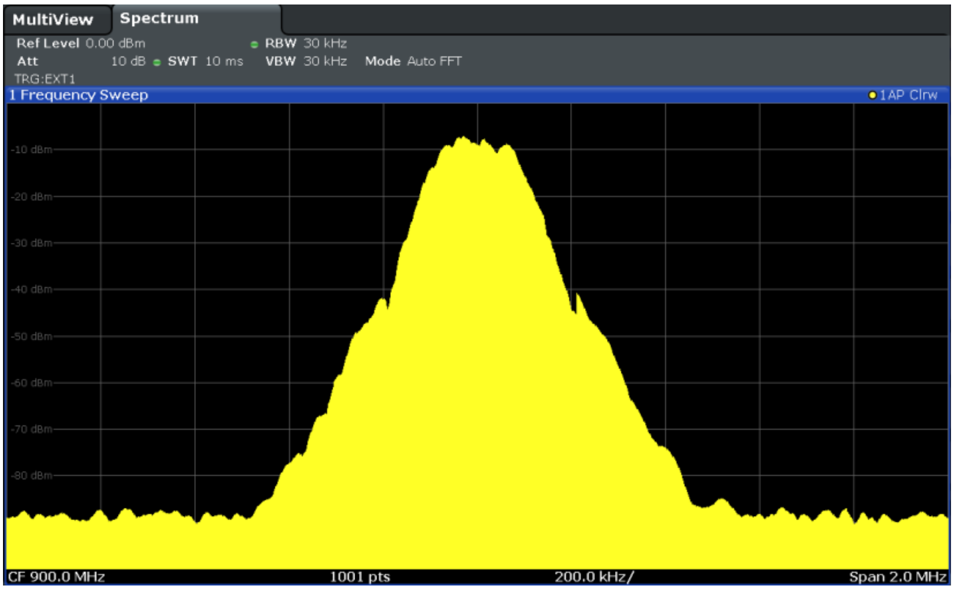


Fig. 5-15: GSM signal with GATE OFF

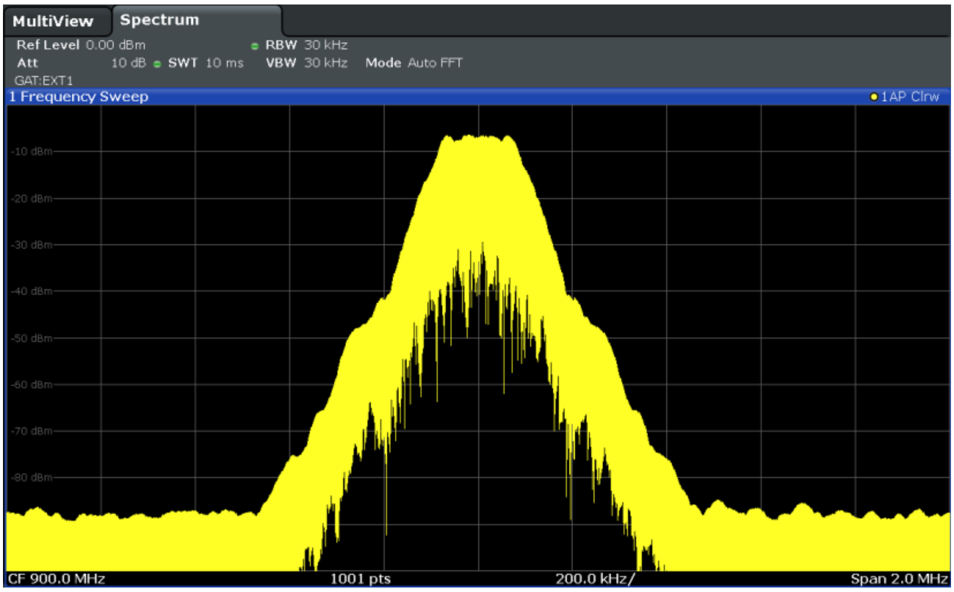


Fig. 5-16: GSM signal with GATE ON

Gated sweep operation is also possible for zero span measurements. This allows you to display level variations of individual slots, for instance in burst signals, versus time.

To indicate that a gate is used for the sweep, "GAT" and the gate source is displayed in the channel bar.

5.6.1.3 Determining the Parameters in Preview Mode

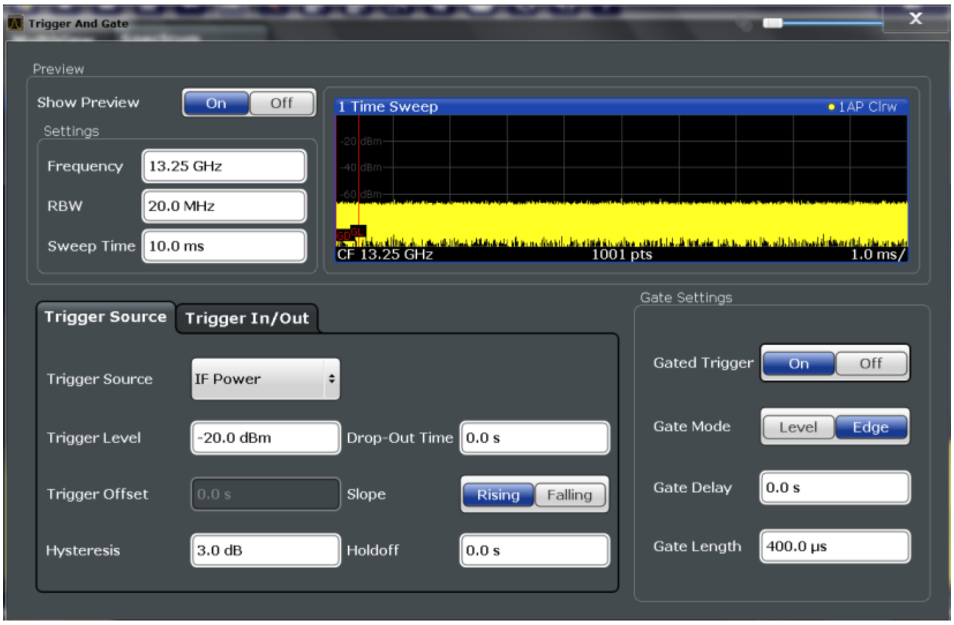
The preview mode allows you to try out trigger and gate settings before actually applying them to the current measurement. When the preview diagram shows the correct results, you can "Update the Main Diagram" and check the results in the background before closing the dialog box.

If preview mode is switched off, changes to the trigger and gate settings are applied to the measurement diagram directly.

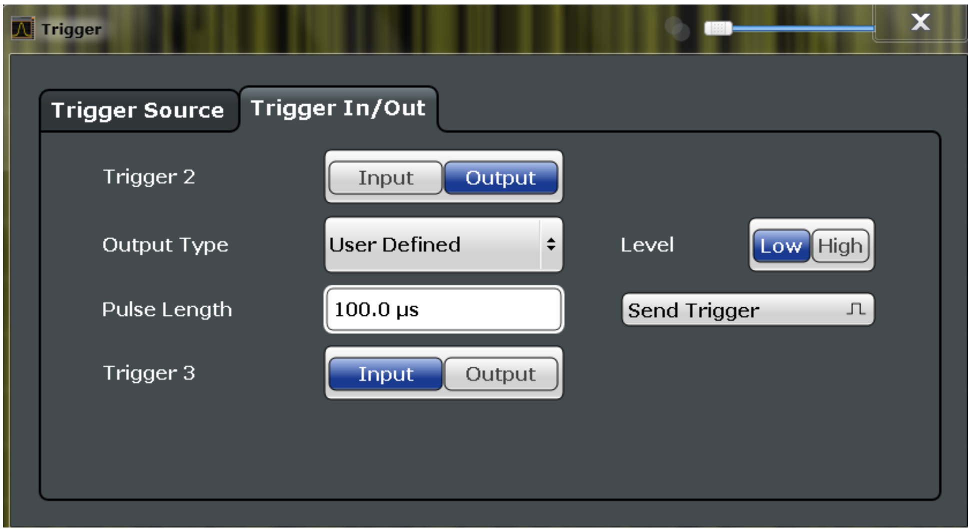
The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time. This is useful to analyze bursts, for example, to determine the required gate settings. The main diagram remains unchanged concerning the zero span settings. Only the trigger and gate settings are applied to the measurement.

5.6.2 Trigger and Gate Settings

Trigger and gate settings can be configured via the TRIG key or in the "Trigger and Gate" dialog box, which is displayed when you select the "Trigger/Gate" button in the "Overview".



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



For step-by-step instructions on configuring triggered and gated measurements, see chapter 5.6.3, "How to Configure a Triggered and Gated Measurement", on page 267.

Preview

The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time.

For details see chapter 5.6.1.3, "Determining the Parameters in Preview Mode", on page 258.

Note: The zero span settings refer only to the preview diagram. The main diagram remains unchanged.

The trigger and gate settings are applied to the measurement when the dialog box is closed or "Update Main Diagram" is selected.

If preview mode is switched off, any changes to the settings in this dialog box are applied to the measurement diagram directly. In this case, the zero span settings for the preview diagram are not displayed.

For information on the zero span settings see:

- "Center" on page 225
- "RBW" on page 245
- "Sweep Time" on page 246

Frequency ← Preview

Defines the center frequency.

SCPI command:

`[SENSe:]FREQuency:CENTer` on page 627

RBW ← Preview

Defines the bandwidth value. The available resolution bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.

SCPI command:

`[SENSe:]BANDwidth|BWIDth[:RESolution]` on page 632

Sweep Time ← Preview

Defines the sweep time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

SCPI command:

`[SENSe:]SWEep:TIME` on page 636

Trigger Settings

The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Settings

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

For gated measurements, this setting also defines the gating source.

For more information see "Trigger Source" on page 253.

Note: When triggering or gating is activated, the squelch function is automatically disabled.

(See "Demodulating Marker Values and Providing Audio Output" on page 320).

SCPI command:

`TRIGger[:SEQuence]:SOURce` on page 649

`[SENSe:]SWEep:EGATe:SOURce` on page 652

Free Run ← Trigger Source ← Trigger Settings

No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitely.

In the Spectrum application, this is the default setting.

SCPI command:

`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 649

External Trigger 1/2/3 ← Trigger Source ← Trigger Settings

Data acquisition starts when the TTL signal fed into the specified input connector (on the front or rear panel) meets or exceeds the specified trigger level.

(See "Trigger Level" on page 263).

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

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

"External Trigger 1"
: Trigger signal from the TRIGGER INPUT connector on the front panel.

"External Trigger 2"
: Trigger signal from the TRIGGER INPUT/OUTPUT connector on the front panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 220).

"External Trigger 3"
: Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector on the rear panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 220).

SCPI command:

`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`, `TRIG:SOUR EXT3`

See `TRIGger[:SEQuence]:SOURce` on page 649

`SWE:EGAT:SOUR EXT` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 652

Video ← Trigger Source ← Trigger Settings

Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

Video mode is only available in the time domain, and not for I/Q-based data.

SCPI command:

`TRIG:SOUR VID`, see `TRIGger[:SEQuence]:SOURce` on page 649

`SWE:EGAT:SOUR VID` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 652

IF Power ← Trigger Source ← Trigger Settings

The R&S FSW starts capturing data as soon as the trigger threshold 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.

The trigger threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. For details on available trigger levels and trigger bandwidths see the data sheet.

This trigger source is only available for RF input.

Note: Be aware that in auto sweep type mode, due to a possible change in sweep types, the trigger bandwidth may vary considerably for the same RBW setting.

SCPI command:

`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 649

`SWE:EGAT:SOUR IFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 652

RF Power ← Trigger Source ← Trigger Settings

Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose the instrument uses a level detector at the first intermediate frequency. The input signal must be in the frequency range between 500 MHz and 8 GHz. The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels see the data sheet.

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

SCPI command:

`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 649

`SWE:EGAT:SOUR RFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 652

Power Sensor ← Trigger Source ← Trigger Settings

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

(See chapter 5.2.3.3, "How to Work With a Power Sensor", on page 194.)

If a power sensor is selected as the trigger mode, the following softkeys are not available; these settings are configured in the "Power Sensor Configuration" dialog box (seechapter 5.2.3.2, "Power Sensor Settings", on page 190).

- "Trigger Level" on page 263
- "Slope" on page 264
- "Hysteresis" on page 264
- "Trigger Holdoff" on page 264

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

SCPI command:

`TRIG:SOUR PSE`, see `TRIGger[:SEQuence]:SOURce` on page 649

`SWE:EGAT:SOUR PSE` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 652

Time ← Trigger Source ← Trigger Settings

Triggers in a specified repetition interval.

SCPI command:

`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 649

Trigger Level ← Trigger Settings

Defines the trigger level for the specified trigger source.

For gated measurements, this setting also defines the gate level.

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

SCPI command:

`TRIGger[:SEQuence]:LEVel:IFPower` on page 647

`TRIGger[:SEQuence]:LEVel:IQPower` on page 647

`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 647

`TRIGger[:SEQuence]:LEVel:VIDeo` on page 648

`TRIGger[:SEQuence]:LEVel:RFPower` on page 648

Repetition Interval ← Trigger Settings

Defines the repetition interval for a time trigger. The shortest interval is 2 ms.

The repetition interval should be set to the exact pulse period, burst length, frame length or other repetitive signal characteristic.

SCPI command:

`TRIGger[:SEQuence]:TIME:RINTerval` on page 650

Drop-Out Time ← Trigger Settings

Defines the time the input signal must stay below the trigger level before triggering again.

For more information on the drop-out time see "Trigger Drop-Out Time" on page 254.

SCPI command:

`TRIGger[:SEQuence]:DTIMe` on page 645

Trigger Offset ← Trigger Settings
Defines the time offset between the trigger event and the start of the sweep.

For more information see "Trigger Offset" on page 253.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pre-trigger) Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off Maximum allowed range limited by the sweep time: $pretrigger_{max}$ = sweep time

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger delay ("Trigger Offset") as well.

For the "Time" trigger source, this function is not available.

SCPI command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 646

Hysteresis ← Trigger Settings
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.

For more information see "Trigger Hysteresis" on page 254.

SCPI command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 646

Trigger Holdoff ← Trigger Settings
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

For more information see "Trigger Holdoff" on page 255.

SCPI command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 646

Slope ← Trigger Settings
For all trigger sources except time you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

SCPI command:
`TRIGger[:SEQuence]:SLOPe` on page 648
`[SENSe:]SWEep:EGATe:POLarity` on page 651

Trigger 2/3
Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

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

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

(Trigger 1 is INPUT only.)

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

"Input"	The signal at the connector is used as an external trigger source by the R&S FSW. No further trigger parameters are available for the connector.
"Output"	The R&S FSW sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

SCPI command:

OUTPut:TRIGger<port>:LEVel on page 654

OUTPut:TRIGger<port>:DIRection on page 653

Output Type ← Trigger 2/3

Type of signal to be sent to the output

"Device Triggered"	(Default) Sends a trigger when the R&S FSW triggers.
"Trigger Armed"	Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state. This state is indicated by a status bit in the STATus:OPERation register (bit 5), as well as by a low level signal at the AUX port (pin 9). For details see "STATus:OPERation Register" on page 451 and the R&S FSW Getting Started manual.
"User Defined"	Sends a trigger when user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

SCPI command:

OUTPut:TRIGger<port>:OTYPe on page 654

Level ← Output Type ← Trigger 2/3

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

SCPI command:

OUTPut:TRIGger<port>:LEVel on page 654

Pulse Length ← Output Type ← Trigger 2/3

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

SCPI command:

OUTPut:TRIGger<port>:PULSe:LENGth on page 655

Send Trigger ← Output Type ← Trigger 2/3

Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, 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.

SCPI command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 654

Gate Settings
Gate settings define one or more extracts of the signal to be measured.

Note: Gating is not available for measurements on I/Q-based data.

Gated Trigger ← Gate Settings
Switches gated triggering on or off.

If the gate is switched on, a gate signal applied to one of the "TRIGGER INPUT" connectors or the internal IF power detector controls the sweep of the analyzer.

Gate Mode ← Gate Settings
Sets the gate mode.

For more information see chapter 5.6.1.2, "Gated Measurements", on page 255

"Edge"	The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.
"Lvl"	The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Trigger Level". This mode is not supported when using R&S Power Sensors as power triggers ("Trg/Gate Source" = *Power Sensor* or *External*).

SCPI command:
`[SENSe:]SWEep:EGATe:TYPE` on page 652

Gate Delay ← Gate Settings
Defines the delay time between the gate signal and the continuation of the measurement. The delay position on the time axis in relation to the sweep is indicated by a line labeled "GD".

As a common input signal is used for both trigger and gate when selecting the "External" or "IF Power" trigger source, changes to the gate delay will affect the trigger delay ("Trigger Offset") as well.

For more information see chapter 5.6.1.2, "Gated Measurements", on page 255

SCPI command:
`[SENSe:]SWEep:EGATe:HOLDoff` on page 651

Gate Length ← Gate Settings
Defines how long the gate is open when it is triggered. The gate length can only be set in the edge-triggered gate mode. In the level-triggered mode the gate length depends on the level of the gate signal.

The gate length in relation to the sweep is indicated by a line labeled "GL".

For more information see chapter 5.6.1.2, "Gated Measurements", on page 255

SCPI command:

`[SENSe:]SWEep:EGATe:LENGth` on page 651

5.6.3 How to Configure a Triggered and Gated Measurement

The following step-by-step instructions demonstrate how to configure a triggered and gated measurement manually. For remote operation see chapter 10.5.4, "Configuring Triggered and Gated Measurements", on page 645.

Trigger and gate settings are configured in the "Trigger and Gate" dialog box.

To display the "Trigger and Gate" dialog box, do one of the following:

- Select "Trigger/Gate" from the "Overview".
- Select the TRIG key and then the "Trigger/Gate Config" softkey.

The following tasks are described:

5.6.3.1 How to Determine the Required Trigger/Gate Parameters

1. In the "Trigger and Gate" dialog box, switch on "Show Preview".

   A zero span measurement for the currently defined center frequency is displayed.

2. Set the "Frequency", "RBW" and "Sweep Time" such that the relevant part of the signal is displayed, for example a complete burst.

3. Determine the parameters you want to use to define the trigger and gate conditions from the preview diagram, for example:
   - the length of a burst or slot
   - the upper or lower power level of a pulse
   - the maximum noise level
   - the power level or time at which a certain incident occurs

4. Try out different trigger and gate settings as described in How to Configure a Triggered Measurement and How to Configure a Gated Measurement, then select "Update Main Diagram" to see the effect of the current settings on the main measurement in the background.

5. If the results are as expected, close the dialog box to keep the changes permanently. Otherwise, correct the settings as necessary.

5.6.3.2 How to Configure a Triggered Measurement

To define a time trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "Time".
2. Define the "Repetition Interval": the time after which a new measurement is started.

To define an external trigger:

1. Connect an external device that will provide the trigger signal to one of the TRIGGER INPUT connectors on the front or rear panel (for details see the R&S FSW "Getting Started" manual).
2. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "External".
3. If you are using one of the variable TRIGGER INPUT/OUTPUT connectors, you must define their use as input connectors. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the corresponding trigger to "Input". (Note: Trigger 2 is on the front panel, Trigger 3 is on the rear panel.)
4. Configure the external trigger as described for the other power triggers.

To define a power trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "IF Power" or "Video". Note that the video signal corresponds to the envelope of the IF signal: it has been processed by the resolution and video filters and the selected detector.
2. Define the "Trigger Level": the power level at which the measurement will start.
   For a "Video" trigger source you can move the level line graphically to define the level. If you define the value numerically, you must enter a percentage of the full diagram height as the level.
3. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
4. To start the measurement with a time delay, define a "Trigger Offset".
5. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. The holdoff time should be slightly larger than the burst.

5.6.3.3 How to Configure a Gated Measurement

1. Determine the required parameters as described in chapter 5.6.3.1, "How to Determine the Required Trigger/Gate Parameters", on page 267.

2. The gate is opened by a trigger event, which must be based on a power source. Define the trigger as described in chapter 5.6.3.2, "How to Configure a Triggered Measurement", on page 268. As the "Trigger Source", use "IF Power", "Video" or "External".
3. Define how long the gate is to remain open:
   To measure the signal as long as the trigger level is exceeded, for example for one or more pulses, define "Gate Mode" = "Level".
   To measure the signal for a certain time after a level is exceeded, for example during a burst:
   a) Define "Gate Mode" = "Edge".
   b) Define the time to measure for each gate: "Gate Length".
4. To open the gate with a time delay, for example to ignore an overshoot, define a "Gate Delay".
5. Select "Gated Trigger" = "On".

5.6.4 How to Output a Trigger Signal

Using one of the variable TRIGGER INPUT/OUTPUT connectors of the R&S FSW, the internal trigger signal can be output for use by other connected devices. For details on the connectors see the R&S FSW "Getting Started" manual.

To output a trigger to a connected device

1. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the trigger to be used to "Output". (Note: Trigger 2 is output to the front panel connector, Trigger 3 is output to the rear panel connector.)
2. Define whether the trigger signal is to be output automatically ("Output Type" = "Device triggered" or "Trigger Armed") or whether you want to start output manually ("Output Type" = "User-defined").
3. For manual output: Specify the constant signal level and the length of the trigger pulse to be output. Note that the level of the trigger pulse is opposite to the constant output "Level" setting (compare the graphic on the "Send Trigger" button).
4. Connect a device that will receive the trigger signal to the configured TRIGGER INPUT/OUTPUT connector.
5. Start a measurement and wait for an internal trigger, or select the "Send Trigger" button.

   The configured trigger is output to the connector.

5.7 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings. In order to do so, a measurement is performed. The duration of this measurement can be defined automatically or manually.

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.

MSRA operating mode

In MSRA operating mode, settings related to data acquisition can only be adjusted automatically for the MSRA Master, not the applications.

Adjusting settings automatically during triggered measurements

When you select an auto adjust function a measurement is performed to determine the optimal settings. If you select an auto adjust funtion for a triggered measurement, you are asked how the R&S FSW should behave:

- (default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows:
  - For IF Power and RF Power triggers:
    Trigger Level = Reference Level - 15 dB
  - For Video trigger:
    Trigger Level = 85 %

SCPI command:

`[SENSe:]ADJust:CONFigure:TRIG` on page 657

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level

SCPI command:

`[SENSe:]ADJust:ALL` on page 656

Adjusting the Center Frequency Automatically (Auto Freq)

This function adjusts the center frequency automatically.

The optimum center frequency can be determined as the highest frequency level in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

SCPI command:

`[SENSe:]ADJust:FREQuency` on page 658

Setting the Reference Level Automatically (Auto Level)

Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 271).

SCPI command:

`[SENSe:]ADJust:LEVel` on page 658

Resetting the Automatic Measurement Time (Meastime Auto)

Resets the measurement duration for automatic settings to the default value.

(Spectrum application: 1 ms)

SCPI command:

`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 656

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.

SCPI command:

`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 656

`[SENSe:]ADJust:CONFigure:DURation` on page 656

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 an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

SCPI command:

`[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer` on page 657

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.

SCPI command:

`[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer` on page 657

6 Common Analysis and Display Functions

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

The analysis settings and functions are available via the "Analysis" dialog box, which is displayed when you select the "Analysis" button in the "Overview". Additional measurement-specific analysis functions may be available in separate tabs in the "Analysis" dialog box. These are described with the individual measurements.

See chapter 4, "Measurements", on page 31.

6.1 Result Display Configuration

Measurement results can be evaluated in many different ways, for example graphically, as spectrograms, as summary tables, statistical evaluations etc. Thus, the result display is highly configurable to suit your specific requirements and optimize analysis. Here you can find out how to optimize the display for your measurement results.

Basic operations concerning the R&S FSW display, for example how to use the Smart-Grid, are described in the R&S FSW Getting Started manual.

General display settings that are usually configured during initial instrument setup, independantly of the current measurement, e.g. which items or colors are displayed on the screen, are described in chapter 8.4, "Display Settings", on page 410.

6.1.1 Basic Evaluation Methods

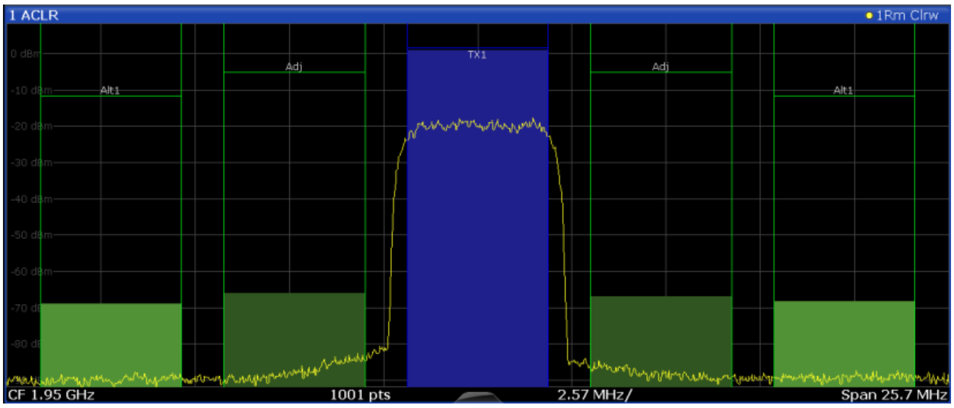
Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the Spectrum application.

Diagram

Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the "Trace" settings. Scaling for the y-axis can be configured.

See chapter 6.3, "Trace Configuration", on page 281 and chapter 5.4.3, "Scaling the Y-Axis", on page 235.



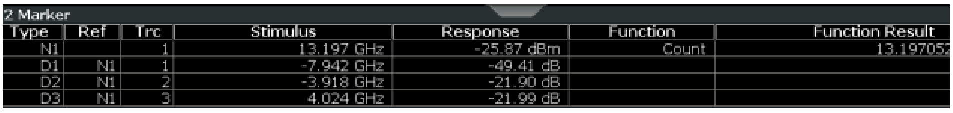
SCPI command:

`LAY:ADD? '1',RIGH, DIAG`, see `LAYout:ADD[:WINDow]?` on page 621

Marker Table

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

This table may be displayed automatically if configured accordingly (see "Marker Table Display" on page 325).



2 Marker

Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.197052
D1	N1	1	-7.942 GHz	-49.41 dB		
D2	N1	2	-3.918 GHz	-21.90 dB		
D3	N1	3	4.024 GHz	-21.99 dB		

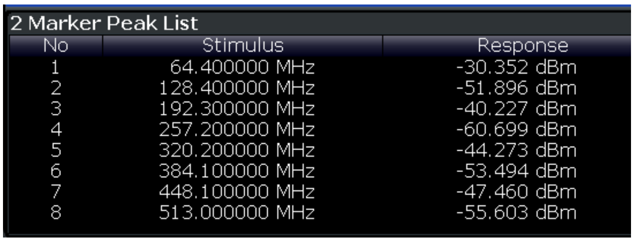
SCPI command:

`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 621

Marker Peak List

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

You can define search and sort criteria to influence the results of the analysis (see "Marker Search Settings" on page 326).



2 Marker Peak List

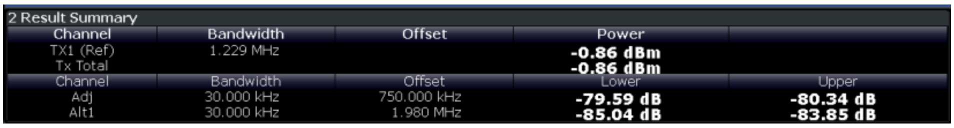
No	Stimulus	Response
1	64.400000 MHz	-30.352 dBm
2	128.400000 MHz	-51.896 dBm
3	192.300000 MHz	-40.227 dBm
4	257.200000 MHz	-60.699 dBm
5	320.200000 MHz	-44.273 dBm
6	384.100000 MHz	-53.494 dBm
7	448.100000 MHz	-47.460 dBm
8	513.000000 MHz	-55.603 dBm

SCPI command:

`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 621

Result Summary

Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.



2 Result Summary

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	1.229 MHz		-0.86 dBm	
Tx Total			-0.86 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	30.000 kHz	750.000 kHz	-79.59 dB	-80.34 dB
Alt1	30.000 kHz	1.980 MHz	-85.04 dB	-83.85 dB

SCPI command:

`LAY:ADD? '1',RIGH, RSUM`, see `LAYout:ADD[:WINDow]?` on page 621

Spectrogram

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency or sweep time, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

The spectrogram display consists of two diagrams: the standard spectrum result display (upper diagram) and the spectrogram result display (lower diagram).

For details see chapter 6.3.1.6, "Spectrograms", on page 287.

SCPI command:

`LAY:ADD? '1',RIGH, SGR`, see `LAYout:ADD[:WINDow]?` on page 621

6.1.2 How to Select an Evaluation Method

All evaluation methods available for the currently selected measurement are displayed in the evaluation bar in SmartGrid mode. The same evaluation method can be displayed in several windows simultaneously.

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

► To activate SmartGrid mode, do one of the following:

- Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the configuration "Overview".

- Select the "Display Config" softkey from the MEAS CONFIG menu.

The Smartgrid functions and the evaluation bar are displayed.

To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the righthand corner of the toolbar, or press any key on the front panel.

6.2 Zoomed Displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touch screen or a mouse pointer you can easily define the area to be enlarged.

Zoom and the number of sweep points

Note that zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points!

You should increase the number of sweep points before zooming, as otherwise the function has no real effect (see chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242).

6.2.1 Single Zoom Versus Multiple Zoom

Two different zoom modes are available: single zoom and multiple zoom. A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible. In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom areas can be moved and resized any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Fig. 6-1: Single zoom

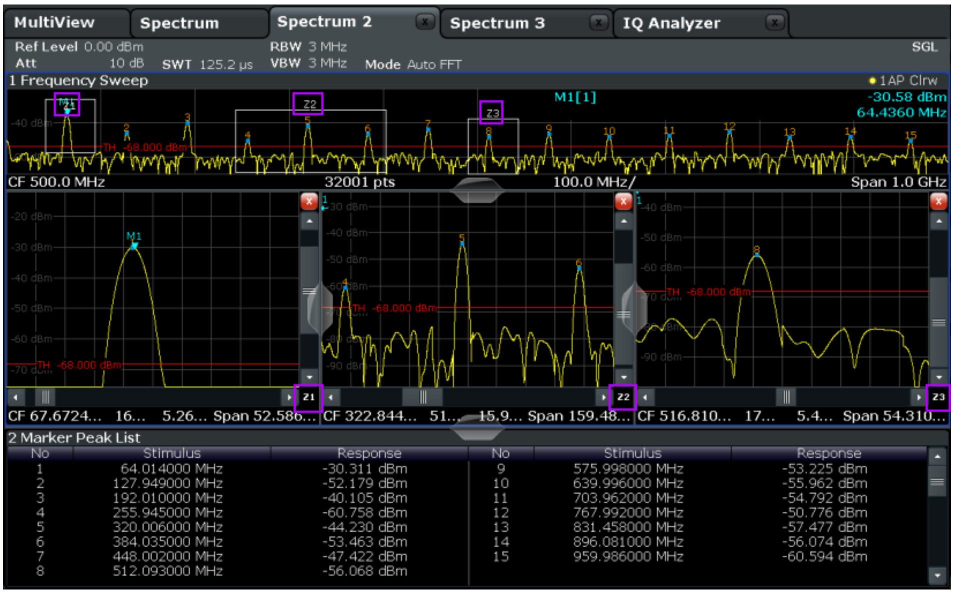


Fig. 6-2: Multiple zoom

Using the zoom area to restrict a peak search

The selected zoom area can be used to restrict the search range for a peak search, but only in single zoom mode (see "Using Zoom Limits" on page 329).

6.2.2 Zoom Functions

The zoom functions are only available from the toolbar.

Single Zoom

A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

SCPI command:

DISPlay[:WINDow<n>]:ZOOM:STATe on page 689

DISPlay[:WINDow<n>]:ZOOM:AREA on page 688

Multiple Zoom

In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

SCPI command:

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe on page 690

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA on page 689

Restore Original Display

Restores the original display and closes all zoom windows.

SCPI command:

DISPlay[:WINDow<n>]:ZOOM:STATe on page 689 (single zoom)

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe on page 690 (for each multiple zoom window)

Deactivating Zoom (Selection mode)

Deactivates zoom mode; tapping the screen no longer invokes a zoom, but selects an object.

SCPI command:

DISPlay[:WINDow<n>]:ZOOM:STATe on page 689 (single zoom)

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe on page 690 (for each multiple zoom window)

6.2.3 How to Zoom Into a Diagram

The remote commands required to zoom into a display are described in chapter 10.6.1, "Zooming into the Display", on page 688.

The following tasks are described here:

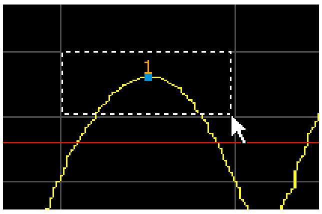
- "To zoom into the diagram at one position" on page 279
- "To return to selection mode in the diagram" on page 280
- "To return to original display" on page 280
- "To zoom into multiple positions in the diagram" on page 280

To zoom into the diagram at one position

1. 

   Click on the "Single Zoom" icon in the toolbar.

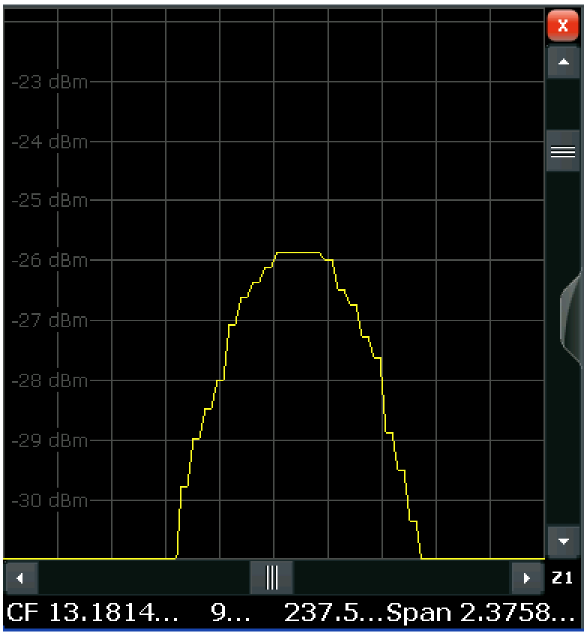
   Zoom mode is activated.
2. Select the area in the diagram to be enlarged on the touch screen. The selected area is indicated by a dotted rectangle.

   When you leave the touch screen, the diagram is replaced by the zoomed trace area.
3. Repeat these steps, if necessary, to enlarge the diagram further.

Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



To return to selection mode in the diagram

While you are in zoom mode, touching the screen changes the zoom area. In order to select or move a trace or marker, you must switch back to selection mode:

► 

Select the "Selection mode" icon in the toolbar.

To return to original display

► 

Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.
To switch off zoom mode and return to selection mode, select the "Selection mode" icon in the toolbar.

To zoom into multiple positions in the diagram

1. 

Click on the "Multiple Zoom" icon in the toolbar.

Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged on the touch screen. The selected area is indicated by a dotted rectangle.

   When you have completed your selection, the original trace is shown in an overview diagram with the selected area indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see figure 6-2.

3. In the overview diagram, select the next area to be enlarged.

   The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

4. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

1. If necessary, switch off zoom mode and return to selection mode by selecting the "Selection mode" icon in the toolbar.

2. To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
   To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

   The contents of the zoom windows are adapted accordingly.

6.3 Trace Configuration

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

6.3.1 Basics on Setting up Traces

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

Each trace represents an analysis of the measured data. Up to 6 traces can be displayed in each window, and up to 16 windows can be displayed on the screen. So, in theory, you can analyze the data measured by the R&S FSW in almost 100 different ways simultaneously!

Trace settings are stored on the instrument for each window. So when you switch to a different window, the trace settings previously configured for that window are restored.

6.3.1.1 Mapping Samples to Sweep Points with the Trace Detector

A trace displays the power values measured at the sweep points. During a frequency sweep, the R&S FSW increments the first local oscillator in steps that are smaller than approximately 1/10 of the bandwidth. This ensures that the oscillator step speed is conform to the hardware settling times and does not affect the precision of the measured power. The number of samples taken during a sweep is independent of the number of oscillator steps and is much larger than the number of sweep points that are displayed in the measurement trace.

Example:

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- Sweep points: 1000
- Sweep time: 100 ms
- Span: 5 GHz

During a single sweep, 3.2 * 10^6 samples are collected and distributed to 1000 sweep points, i.e. 3200 samples are collected per sweep point. For each sweep point, the measured data for a frequency span of 1.6 MHz is analyzed.

Note that if you increase the number of sweep points, the frequency span analyzed for each point in the trace decreases, making the result more stable. See also chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242.

Obviously, a data reduction must be performed to determine which of the samples are displayed for each sweep point. This is the trace detector's task.

The trace detector can analyze the measured data using various methods:

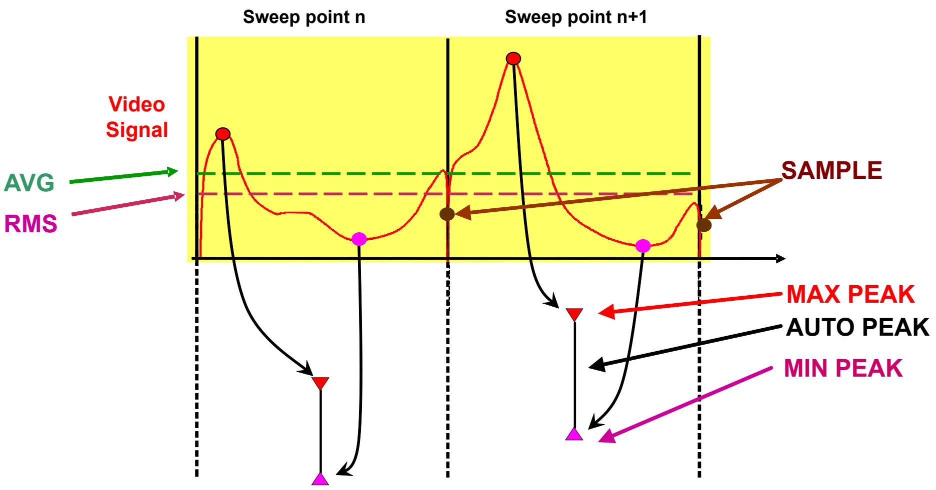
The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation.

Table 6-1: Detector types

Detector	Abbrev.	Description
Positive Peak	Pk	Determines the largest of all positive peak values of the levels measured at the individual frequencies which are displayed in one sample point
Negative Peak	Mi	Determines the smallest of all negative peak values of the levels measured at the individual frequencies which are displayed in one sample point

Detector	Abbrev.	Description
Auto Peak	Ap	Combines the peak detectors; determines the maximum and the minimum value of the levels measured at the individual frequencies which are displayed in one sample point (not available for SEM)
RMS	Rm	Calculates the root mean square of all samples contained in a sweep point. To this effect, R&S FSW uses the linear voltage after envelope detection. The sampled linear values are squared, summed and the sum is divided by the number of samples (= root mean square). For logarithmic display the logarithm is formed from the square sum. For linear display the root mean square value is displayed. Each sweep point thus corresponds to the power of the measured values summed up in the sweep point. The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.
Average	Av	Calculates the linear average of all samples contained in a sweep point. To this effect, R&S FSW uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For logarithmic display the logarithm is formed from the average value. For linear display the average value is displayed. Each sweep point thus corresponds to the average of the measured values summed up in the sweep point. The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).
Sample	Sa	Selects the last measured value of the levels measured at the individual frequencies which are displayed in one sample point; all other measured values for the frequency range are ignored

The result obtained from the selected detector for a sweep point is displayed as the power value at this frequency point in the trace.



The trace detector for the individual traces can be selected manually by the user or set automatically by the R&S FSW.

The detectors of the R&S FSW are implemented as pure digital devices. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

RMS detector and VBW

If the RMS detector is selected, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used the sweep time should be increased to get more stable traces.

Auto detector

If the R&S FSW is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode:

Trace mode	Detector
Clear Write	Auto Peak
Max Hold	Positive Peak
Min Hold	Negative Peak
Average	Sample Peak
View	–
Blank	–

6.3.1.2 Analyzing Several Traces - Trace Mode

If several sweeps are performed one after the other, or continuous sweeps are performed, the trace mode determines how the data for subsequent traces is processed. After each sweep, the trace mode determines whether:

- the data is frozen (View)
- the data is hidden (Blank)
- the data is replaced by new values (Clear Write)
- the data is replaced selectively (Max Hold, Min Hold, Average)

Each time the trace mode is changed, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282.

The R&S FSW offers the following trace modes:

Table 6-2: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.

Trace Mode	Description
Max Hold	The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one. This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope. This mode is not available for statistics measurements.
Min Hold	The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one. This mode is useful e.g. for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level. This mode is not available for statistics measurements.
Average	The average is formed over several sweeps. The Sweep/Average Count determines the number of averaging procedures. This mode is not available for statistics measurements.
View	The current contents of the trace memory are frozen and displayed.

If a trace is frozen ("View" mode), the instrument settings, apart from level range and reference level (see below), can be changed without impact on the displayed trace. The fact that the displayed trace no longer matches the current instrument setting is indicated by the icon on the tab label.

If the level range or reference level is changed, the R&S FSW automatically adapts the trace data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

6.3.1.3 How Many Traces are Averaged - Sweep Count + Sweep Mode

In "Average" trace mode, the sweep count and sweep mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the sweep mode and sweep count.

- **sweep count = 0** (default)
  - In **"Continuous Sweep"** mode, a continuous average is calculated for 10 sweeps, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Fig. 6-3: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about ten sweeps. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

– In **"Single Sweep"** mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first sweep but the measured value is stored in the trace memory. The next time a sweep is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **sweep count = 1**
  The currently measured trace is displayed and stored in the trace memory. No averaging is performed.
- **sweep count > 1**
  For both **"Single Sweep"** mode and **"Continuous Sweep"** mode, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[\sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

Fig. 6-4: Equation 2

where n is the number of the current sweep (n = 2 ... Sweep Count).
No averaging is carried out for the first sweep but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more individual sweeps for averaging.
After the selected number of sweeps the average trace is saved in the trace memory. Until this number of sweeps is reached, a preliminary average is displayed. When the averaging length defined by the "Sweep Count" is attained, averaging is continued in continuous sweep mode or for "Continue Single Sweep" according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

where N is the sweep count

6.3.1.4 How Trace Data is Averaged - the Averaging Mode

When the trace is averaged over several sweeps (Trace mode: "Average"), different methods are available to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or substracted from each other with trace mathematical functions.

With linear averaging, the level values in dB are converted into linear voltages or powers prior to averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved and the negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S FSW offers the selection of linear averaging. The trace data is linearized prior to averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

6.3.1.5 Combining Several Trace Results - Trace Math Evaluation

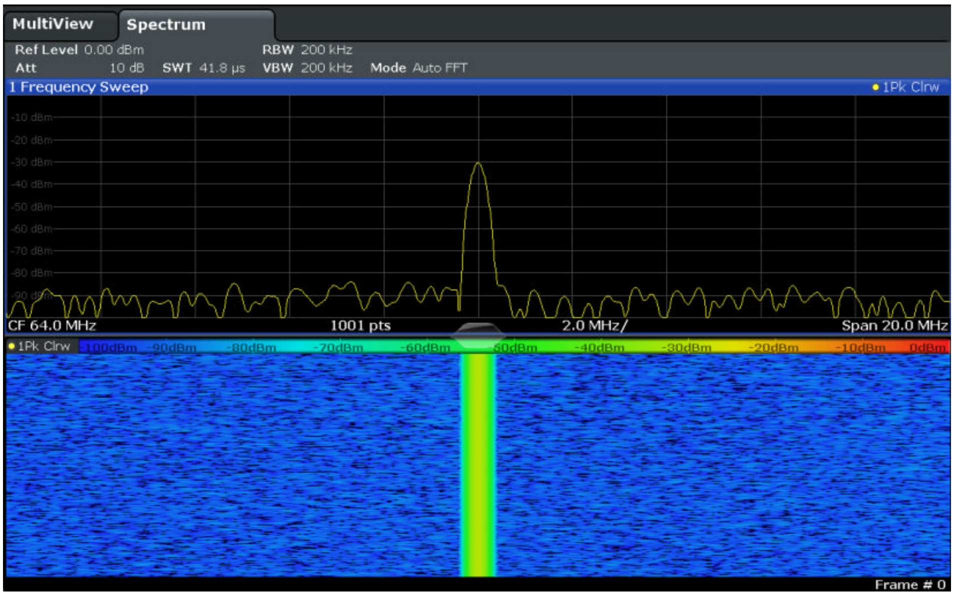
If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, mathematical functions on trace results are provided.

6.3.1.6 Spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the R&S FSW also provides a spectrogram display of the measured data.

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

Example: Spectrogram for the calibration signal



In this example you see the spectrogram for the calibration signal of the R&S FSW, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels the colors represent.

Result display

The spectrogram result can consist of the following elements:

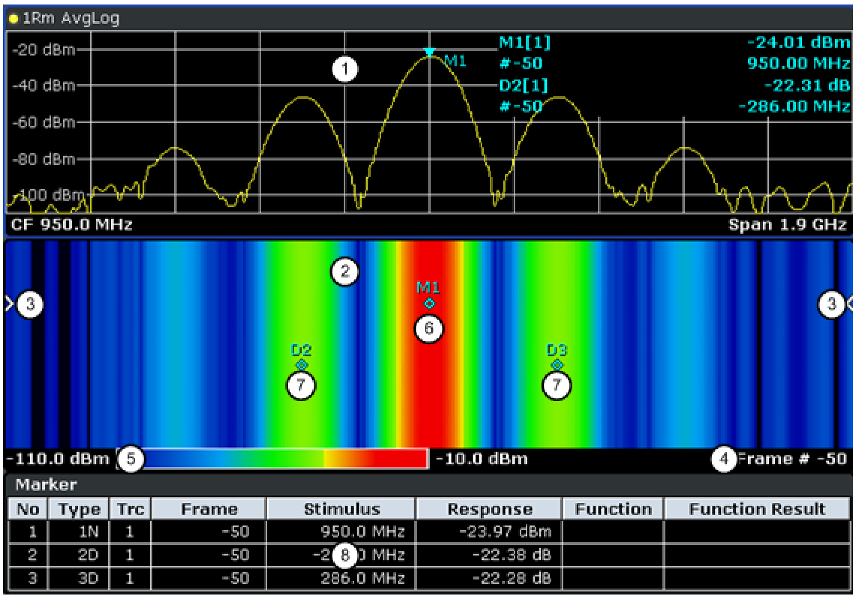


Fig. 6-5: Screen layout of the spectrogram result display

1 = Spectrum result display
2 = Spectrogram result display
3 = Current frame indicator
4 = Time stamp / frame number

5 = Color map
6 = Marker
7 = Delta marker
8 = Marker list

Time Frames

The time information in the spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents one or more captured sweeps and is called a **time frame** or simply "frame". As with standard spectrum traces, several measured values are combined in one sweep point using the selected detector (see chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282).

Frames are sorted in chronological order, beginning with the most recently recorded frame at the top of the diagram (frame number 0). With the next sweep, the previous frame is moved further down in the diagram, until the maximum number of captured frames is reached. The display is updated continuously during the measurement, and the measured trace data is stored. Spectrogram displays are continued even after single sweep measurements unless they are cleared manually.

The maximum number of frames that you can capture is summarized in table 6-3.

Table 6-3: Correlation between number of sweep points and number of frames stored in the history buffer

Sweep Points	Max. History Depth
≤1250	20000
2001	12488
4001	6247
8.001	3124
16.001	1562
32.001	781

Frame analysis - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps are analyzed to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that 10 sweeps are averaged to create a single trace, or frame.

The frame count, on the other hand, determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). For a frame count of 2, for example, 2 frames will be plotted during each single sweep. For continuous sweep mode, the frame count is irrelevant; one frame is plotted per sweep until the measurement is stopped.

If you combine the two settings, 20 sweeps will be performed for each single sweep measurement. The first 10 will be averaged to create the first frame, the next 10 will be averaged to create the second frame.

As you can see, increasing the sweep count increases the accuracy of the individual traces, while increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min hold" and "Max hold" trace modes, the number of sweeps that are analyzed to create a single trace has an effect on the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue frame").

Displaying individual frames

The spectrogram diagram includes all stored frames since it was last cleared. Arrows on the left and right border of the spectrogram indicate the currently selected frame. The spectrum diagram always displays the spectrum for the currently selected frame. The current frame number is indicated in the diagram footer, or alternatively a time stamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g."-10". You can display the spectrum diagram of a previous frame by changing the current frame number.

Color Maps

Spectrograms assign power levels to different colors in order to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e where the focus of the visualization lies (shape of the color curve

The individual colors are assigned to the power levels automatically by the R&S FSW.

The Color Scheme

You can select which colors are assigned to the measured values. Four different color ranges or "schemes" are available:

- **Hot**

  Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.
- **Cold**

  Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.
  The "Cold" color scheme is the inverse "Hot" color scheme.
- **Radar**

  Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**

Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

The Value Range of the Color Map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range so it becomes easier to distinguish between values that are close together, and only parts of interest are displayed at all.

The Shape and Focus of the Color Curve

The color mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, if a certain area of the value range is to be visualized in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large amount of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

Fig. 6-6: Linear color curve shape = 0; colors are distributed evenly over the complete result range

In the color map based on the linear color curve, the range from -105.5 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

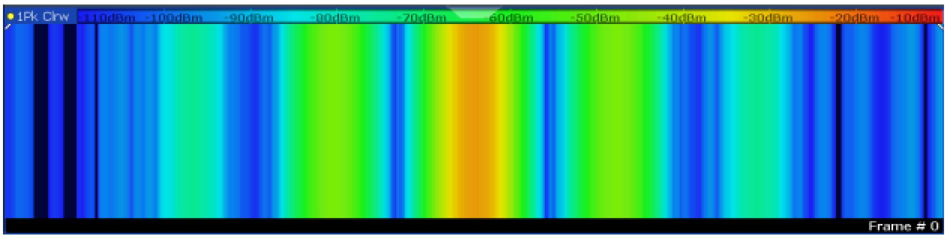


Fig. 6-7: Spectrogram with default color curve

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -105.5 dBm to -60 dBm (blue, green and yellow), which occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

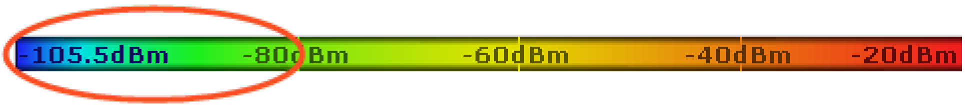


Fig. 6-8: Non-linear color curve shape = -0.5

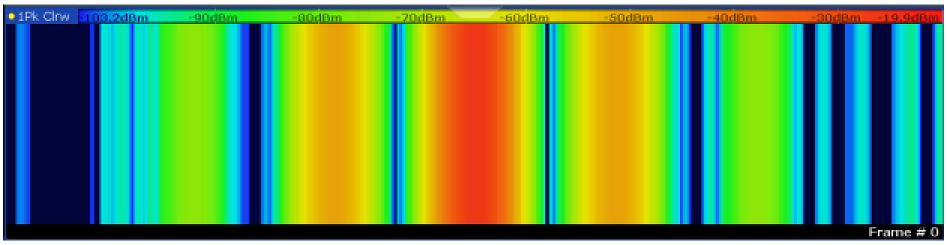


Fig. 6-9: Spectrogram with shifted color curve

Markers in the Spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).

In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

6.3.2 Trace Configuration

Trace configuration includes the following settings and functions:

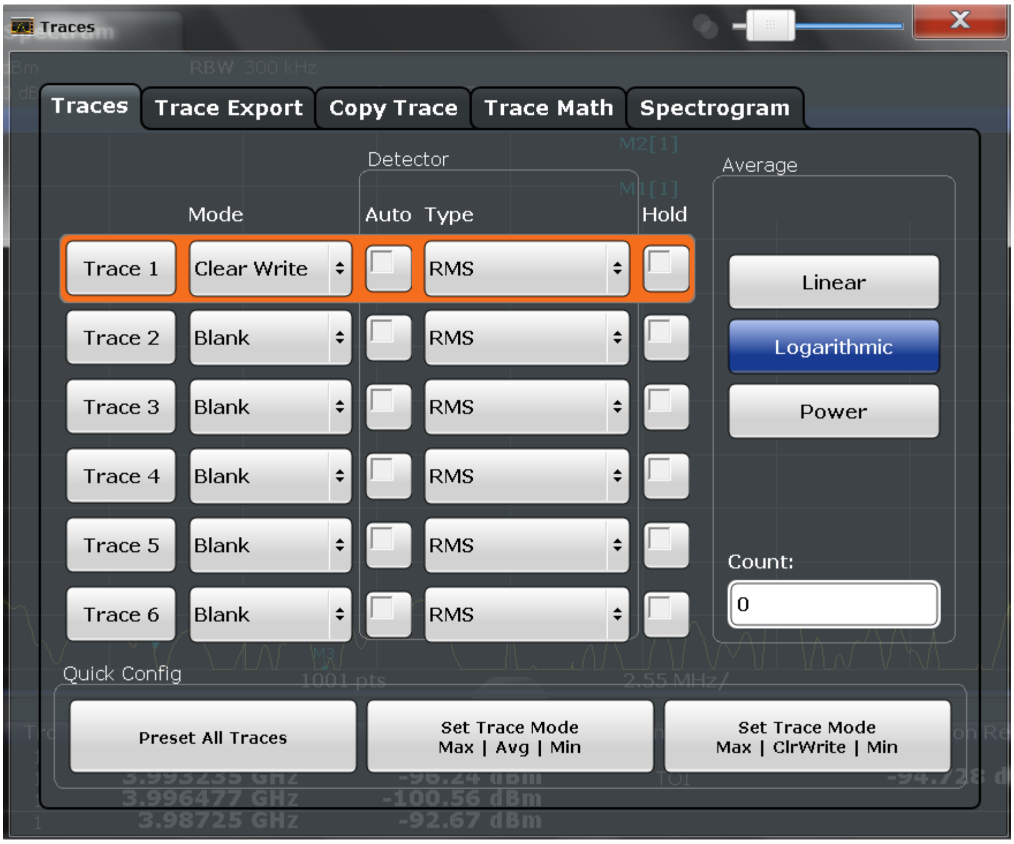
6.3.2.1 Trace Settings

You can configure the settings for up to 6 individual traces.

Trace settings can be configured via the TRACE key, in the "Traces" dialog box, or in the vertical "Traces" tab of the "Analysis" dialog box.

For settings on spectrograms, see chapter 6.3.2.4, "Spectrogram Settings", on page 301.

Trace data can also be exported to an ASCII file for further analysis. For details see chapter 6.3.2.3, "Trace Export Settings", on page 299.



Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6

Selects the corresponding trace for configuration. The currently selected trace is high-lighted orange.

For details see chapter 6.3.3.1, "How to Configure a Standard Trace", on page 305.

SCPI command:
Selected via numeric suffix of:`TRACe<1...6>` commands

Trace Mode

Defines the update mode for subsequent traces.

For details see chapter 6.3.1.2, "Analyzing Several Traces - Trace Mode", on page 284.

"Clear Write" Overwrite mode: the trace is overwritten by each sweep. This is the default setting.
The "Detector" is automatically set to "Auto Peak".

"Max Hold" The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.
The "Detector" is automatically set to "Positive Peak".
This mode is not available for statistics measurements.

"Min Hold" The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.
The "Detector" is automatically set to "Negative Peak".
This mode is not available for statistics measurements.

"Average" The average is formed over several sweeps.
The Sweep/Average Count determines the number of averaging procedures.
The "Detector" is automatically set to "Sample".
This mode is not available for statistics measurements.

"View" The current contents of the trace memory are frozen and displayed.

"Blank" Removes the selected trace from the display.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 691

Detector

Defines the trace detector to be used for trace analysis.

For details see chapter 6.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 282.

"Auto" Selects the optimum detector for the selected trace and filter mode. This is the default setting.

"Type" Defines the selected detector type.

SCPI command:
`[SENSe:][WINDow:]DETector<trace>[:FUNCtion]` on page 694
`[SENSe:][WINDow:]DETector<trace>[:FUNCtion]:AUTO` on page 694

Hold

If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started anew after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous` on page 692

Average Mode

Defines the mode with which the trace is averaged over several sweeps. A different averaging mode can be defined for each trace.

This setting is only applicable if trace mode "Average" is selected.

How many sweeps are averaged is defined by the "Sweep/Average Count" on page 247.

For details see chapter 6.3.1.4, "How Trace Data is Averaged - the Averaging Mode", on page 286.

"Linear" The power level values are converted into linear units prior to averaging. After the averaging, the data is converted back into its original unit.

"Logarithmic" For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.

"Power" Activates linear power averaging.
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.
Use this mode to average power values in Volts or Amperes correctly.

SCPI command:
[SENSe:]AVERage<n>:TYPE on page 693

Average Count
Determines the number of averaging or maximum search procedures If the trace modes "Average", "Max Hold" or "Min Hold" are set.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweeps. For sweep count =1, no averaging, maxhold or minhold operations are performed.

This value is identical to the Sweep/Average Count setting in the "Sweep" configuration.

SCPI command:
[SENSe:]AVERage:COUNt on page 692

Predefined Trace Settings - Quick Config
Commonly required trace settings have been predefined and can be applied very quickly by selecting the appropriate button.

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write Auto Detector (Auto Peak)
	Traces 2-6:	Blank Auto Detector
Set Trace Mode Max | Avg | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Average Auto Detector (Sample)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector

Function	Trace Settings	
Set Trace Mode Max | ClrWrite | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Clear Write Auto Detector (Auto Peak)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)

Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

For details see chapter 6.3.3.1, "How to Configure a Standard Trace", on page 305.

SCPI command:

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] on page 692

Copy Trace

The "Copy Trace" softkey opens the "Copy Trace" tab of the "Trace Configuration" dialog box.

The "Copy Trace" tab contains functionality to copy trace data to another trace.

The first group of buttons (labelled "Trace 1" to "Trace 6") select the source trace. The second group of buttons (labelled "Copy to Trace 1" to "Copy to Trace 6") select the destination.

SCPI command:

TRACe<n>:COPY on page 694

6.3.2.2 Trace Math

Trace math settings can be configured via the TRACE key, in the "Trace Math" tab of the "Traces" dialog box.

Trace Math Function

Defines which trace is subtracted from trace 1. The result is displayed in trace 1 and refers to the zero point defined with the Trace Math Position setting. The following subtractions can be performed:

"T1-T2 -> T1"	Subtracts trace 2 from trace 1.
"T1-T3 -> T1"	Subtracts trace 3 from trace 1
"T1-T4 -> T1"	Subtracts trace 4 from trace 1
"T1-T5 -> T1"	Subtracts trace 5 from trace 1
"T1-T6 -> T1"	Subtracts trace 6 from trace 1

To switch off the trace math, use the Trace Math Off button.

SCPI command:

`CALCulate<n>:MATH[:EXPression][:DEFine]` on page 700

`CALCulate<n>:MATH:STATe` on page 701

Trace Math Off

Deactivates any previously selected trace math functions.

SCPI command:

`CALC:MATH:STAT OFF`, see `CALCulate<n>:MATH:STATe` on page 701

Trace Math Position
Defines the zero point on the y-axis of the resulting trace in % of the diagram height. The range of values extends from -100 % to +200 %.

SCPI command:
`CALCulate<n>:MATH:POSition` on page 701

Trace Math Mode
Defines the mode for the trace math calculations.

"Lin" Activates linear subtraction, which means that the power level values are converted into linear units prior to subtraction. After the subtraction, the data is converted back into its original unit.
This setting takes effect if the grid is set to a linear scale. In this case, subtraction is done in two ways (depending on the set unit):

- The unit is set to either W or dBm: the data is converted into W prior to subtraction, i.e. averaging is done in W.
- The unit is set to either V, A, dBmV, dBµV, dBµA or dBpW: the data is converted into V prior to subtraction, i.e. subtraction is done in V.

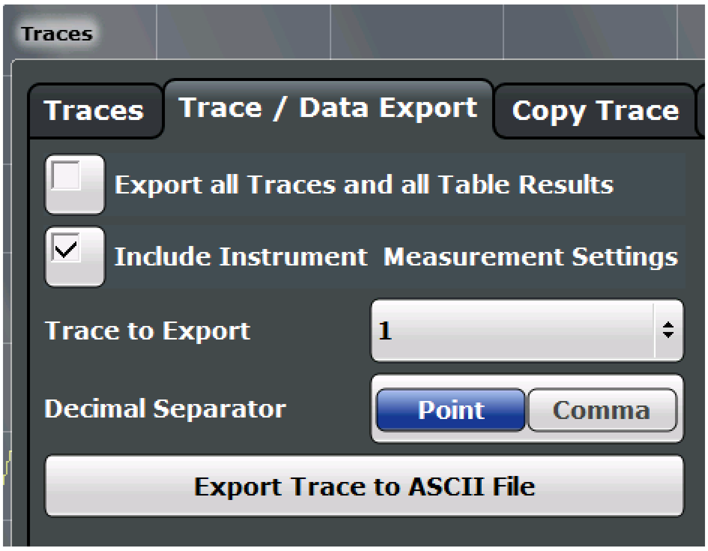
"Log" Activates logarithmic subtraction.
This subtraction method only takes effect if the grid is set to a logarithmic scale, i.e. the unit of the data is dBm. In this case the values are subtracted in dBm. Otherwise (i.e. with linear scaling) the behavior is the same as with linear subtraction.

"Power" Activates linear power subtraction.
The power level values are converted into unit Watt prior to subtraction. After the subtraction, the data is converted back into its original unit. Unlike the linear mode, the subtraction is always done in W.

SCPI command:
`CALCulate<n>:MATH:MODE` on page 700

6.3.2.3 Trace Export Settings

Trace settings can be configured in the "Traces" dialog box or in the vertical "Traces" tab of the "Analysis" dialog box. Switch to the "Trace/Data Export" tab.



Export all Traces and all Table Results

Selects all displayed traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

SCPI command:

`FORMat:DEXPort:TRACes` on page 775

Include Instrument Measurement Settings

Includes additional instrument and measurement settings in the header of the export file for result data.

See chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378 for details.

SCPI command:

`FORMat:DEXPort:HEADer` on page 774

Trace to Export

Defines an individual trace that will be exported to a file.

This setting is not available if Export all Traces and all Table Results is selected.

Decimal Separator

Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

SCPI command:

`FORMat:DEXPort:DSEParator` on page 756

Export Trace to ASCII File

Opens a file selection dialog box and saves the selected trace in ASCII format (`.dat`) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation may take some time.

For details on the file format see chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378.

SCPI command:

`MMEMory:STORe<n>:TRACe` on page 776

`MMEMory:STORe:SGRam` on page 776

6.3.2.4 Spectrogram Settings

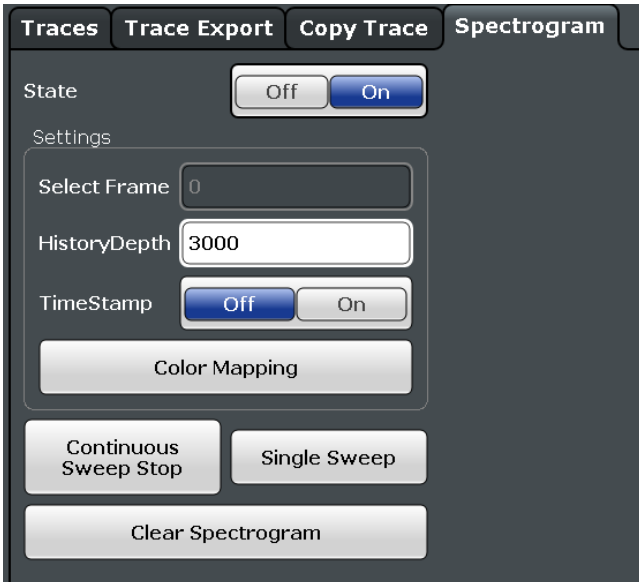
The individual settings available for spectrogram display are described here. For settings on color mapping, see "Color Map Settings" on page 304.

Settings concerning the frames and how they are handled during a sweep are provided as additional sweep settings for spectrogram display, see "Spectrogram Frames" on page 249.

Search functions for spectrogram markers are described in "Marker Search Settings for Spectrograms" on page 329.

General Spectrogram Settings

This section describes general settings for spectrogram display. They are available when you press the TRACE key and then select the "Spectrogram Config" softkey.



State

Activates and deactivates the spectrogram result display

SCPI command:

`CALCulate:SGRam[:STATe]` on page 698

`CALCulate:SGRam:CONT` on page 695

Select frame

Selects a specific frame and loads the corresponding trace from the memory.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is available in single sweep mode or if the sweep is stopped.

The most recent frame is number 0, all previous frames have a negative number.

For more information see "Time Frames" on page 289.

SCPI command:

`CALCulate:SGRam:FRAMe:SELect` on page 696

History Depth

Sets the number of frames that the R&S FSW stores in its memory. The maximum number of frames depends on the Sweep Points.

If the memory is full, the R&S FSW deletes the oldest frames stored in the memory and replaces them with the new data.

For an overview of the maximum number of frames depending on the number of sweep points, see table 6-3.

SCPI command:
CALCulate:SGRam:HDEPth on page 696

Time Stamp
Activates and deactivates the time stamp. The time stamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the time stamp shows the time and date of the end of the sweep.

When active, the time stamp replaces the display of the frame number.

SCPI command:
CALCulate:SGRam:TSTamp[:STATe] on page 697
CALCulate:SGRam:TSTamp:DATA? on page 697

Color Mapping
Opens the "Color Map" dialog.

For details see "Color Maps" on page 290.

Continuous Sweep Stop
Stops a continuous sweep measurement, e.g. in order to display the spectrum display for a previous frame.

Single Sweep/ RUN SINGLE
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only 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 on the front panel 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 chapter 3.5.1, "The Sequencer Concept", on page 26.

SCPI command:
INITiate[:IMMediate] on page 510

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

SCPI command:
CALCulate:SGRam:CLEar[:IMMediate] on page 695

Color Map Settings

The settings for color mapping are displayed in the "Color Mapping" dialog box that is displayed when you press the "Color Mapping" softkey in the "Spectrogram" menu, or tap the color map in the spectrogram display.

For more information on color maps see "Color Maps" on page 290.

For details on changing color mapping settings see "How to Configure the Color Mapping" on page 308.

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

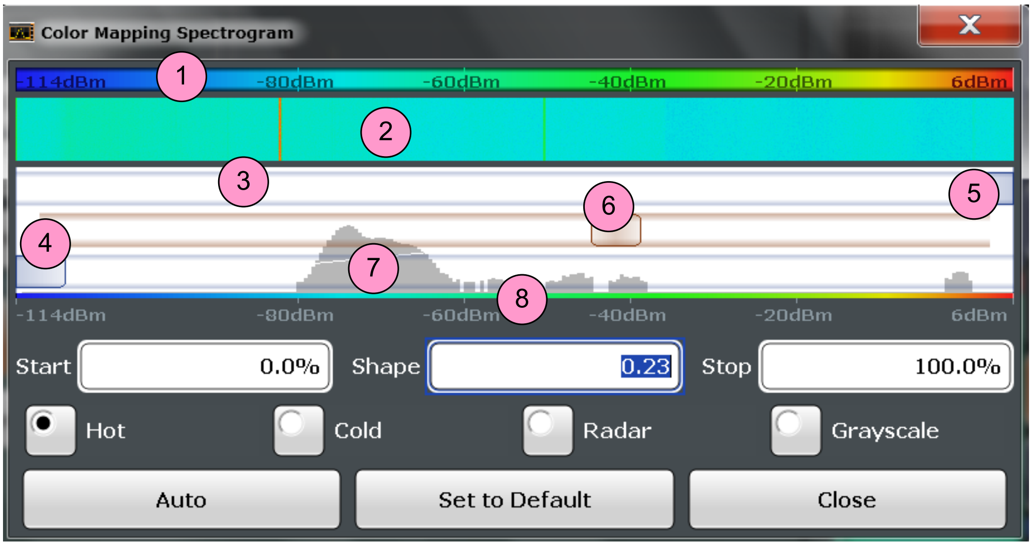


Fig. 6-10: Color Mapping dialog box

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop

Defines the lower and upper boundaries of the value range of the spectrogram.

SCPI command:

DISPlay:WINDow:SGRam:COLor:LOWer on page 698

DISPlay:WINDow:SGRam:COLor:UPPer on page 699

Shape

Defines the shape and focus of the color curve for the spectrogram result display.

"-1 to <0"	More colors are distributed amoung the lower values
"0"	Colors are distributed linearly amoung the values

">0 to 1" More colors are distributed amoung the higher values

SCPI command:
DISPlay:WINDow:SGRam:COLor:SHAPe on page 699

Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

SCPI command:
DISPlay:WINDow:SGRam:COLor[:STYLe] on page 699

Auto

Defines the color range automatically according to the existing measured values for optimized display.

Set to Default

Sets the color mapping to the default settings.

SCPI command:
DISPlay:WINDow:SGRam:COLor:DEFault on page 698

6.3.3 How to Configure Traces

The following step-by-step procedures describe the following tasks:

6.3.3.1 How to Configure a Standard Trace

Step-by-step instructions on configuring the trace settings are provided here. For details on individual functions and settings see chapter 6.3.2.1, "Trace Settings", on page 293.

The remote commands required to perform these tasks are described in chapter 10.6.2, "Configuring the Trace Display and Retrieving Trace Data", on page 690.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press the TRACE key and then select the "Trace Config" softkey.
- Select "Analysis" from the "Overview", then select the "Traces" tab.

1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.
2. To configure several traces to predefined display modes in one step, press the button for the required function:
   - "Preset All Traces"
   - "Set Trace Mode Avg | Max | Min"
   - "Set Trace Mode Max | ClrWrite | Min"

For details see chapter 6.3.2.1, "Trace Settings", on page 293.

3. For "Average" trace mode, define the number of sweeps to be averaged in the "Sweep/Average Count" field of the "Sweep Config" dialog box.
(Press the SWEEP key and then select the "Sweep Config" softkey to display the "Sweep Config" dialog box.)
4. If linear scaling is used, select the "Average Mode: Linear".
5. To improve the trace stability, increase the number of "Sweep Points" or the "Sweep Time".

   All configured traces (not set to "Blank") are displayed after the next sweep.

How to Copy Traces

1. A trace copy function is provided in a separate tab of the "Traces" dialog box. To display this tab do one of the following:
   - Select the TRACE key and then the "Trace Copy" softkey.
   - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.
2. Select the "Source" trace to be copied.
3. Select the "Copy to trace..." button for the trace to which the settings are to be applied.

   The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

6.3.3.2 How to Display and Configure a Spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see chapter 6.3.2.4, "Spectrogram Settings", on page 301.

The remote commands required to perform these tasks are described in chapter 10.6.2.2, "Configuring Spectrograms", on page 694.

The following tasks are described here:

- "To display a spectrogram" on page 307
- "To remove the spectrogram display" on page 307
- "To set a marker in the spectrogram" on page 307
- "To configure a spectrogram" on page 307
- "To select a color scheme" on page 308
- "To set the value range graphically using the color range sliders" on page 308
- "To set the value range numerically" on page 309
- "To set the color curve shape graphically using the slider" on page 310
- "To set the color curve shape numerically" on page 310

To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.
   Alternatively:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Toggle "Spectrogram" to "ON".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using RUN SINGLE or RUN CONT.
   The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:
   a) Stop the continuous measurement or wait until the single sweep is completed.
   b) Select the frame number in the diagram footer.
   c) Enter the required frame number in the edit dialog box.
      Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select the TRACE key and then the "Spectrogram Config" softkey.
2. Toggle "Spectrogram" to "OFF".
   The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select the MARKER key.
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example *0* for the current frame, or *-2* for the second to last frame. Note that the frame number is always 0 or a negative value!
   The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
   a) Select the SWEEP key.
   b) Select the "Sweep Config" softkey.
   c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.
   d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.

e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "ON".

2. Define how many frames are to be stored in total:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Select the "History Depth" softkey.
   c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling the "Timestamp" softkey to "On".
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in "How to Configure the Color Mapping" on page 308.

How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrograms to your needs.

The settings for color mapping are defined in the "Color Mapping" dialog box. To display this dialog box, do one of the following:

- Tap the color map in the spectrogram display.
- Press the "Color Mapping" softkey in the "Spectrogram" menu.

To select a color scheme

You can select which colors are assigned to the measured values.

► In the "Color Mapping" dialog box, select the option for the color scheme to be used.

Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box (see "Color Map Settings" on page 304). To cover the entire measurement value range, make sure the first and last bar of the histogram are included. To remove noise from the display, exclude the bottom 10 or 20 dB of the histogram.

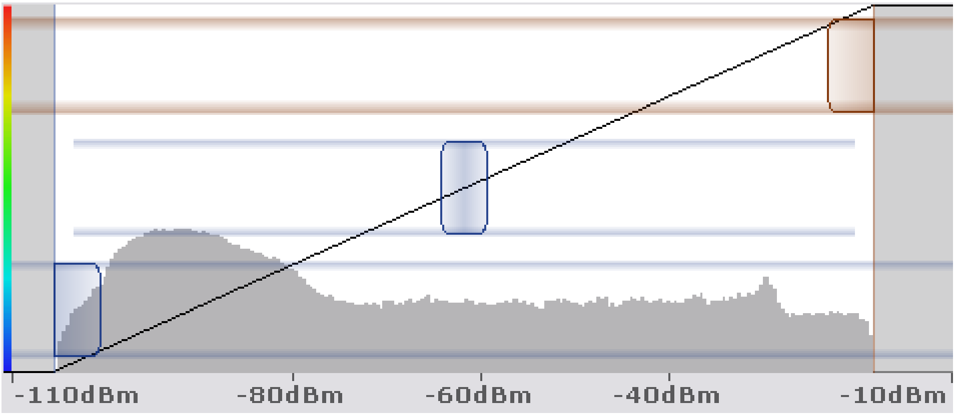
The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram.

The value range can be set numerically or graphically.

To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider (indicated by a gray box at the left of the color curve pane) to the lowest value you want to include in the color mapping.

2. Select and drag the top color curve slider (indicated by a gray box at the right of the color curve pane) to the highest value you want to include in the color mapping.



To set the value range numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

Example:

The color map starts at -100 dBm and ends at 0 dBm (i.e. a range of 100 dB). In order to suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter *10%* in the "Start" field. The R&S FSW shifts the start point 10% to the right, to -90 dBm.

Adjusting the reference level and level range

Note that changing the reference level and level range of the measurement also affects the color mapping in the spectrogram.

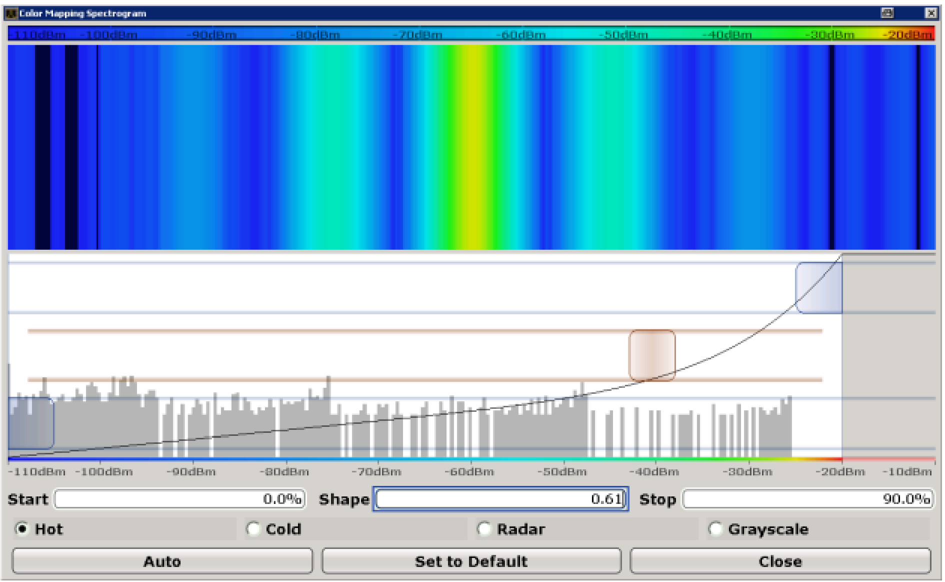
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large amount of results, while the other end distributes several colors over a relatively small result range.

The color curve shape can be set numerically or graphically.

To set the color curve shape graphically using the slider

► Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The area beneath the slider is focussed, i.e. more colors are distributed there.



To set the color curve shape numerically

► In the "Shape" field, enter a value to change the shape of the curve:

- A negative value (-1 to <0) focusses the lower values
- 0 defines a linear distribution
- A positive value (>0 to 1) focusses the higher values

6.3.3.3 How to Copy Traces

You can copy the trace settings from one trace to another in the "Copy Trace" tab of the "Traces" dialog box.

► Select the "Source" trace and then the button for the "Copy to" trace.

SCPI command:

TRACe<n>:COPY on page 694

6.4 Marker Usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

Markers in Spectrogram Displays

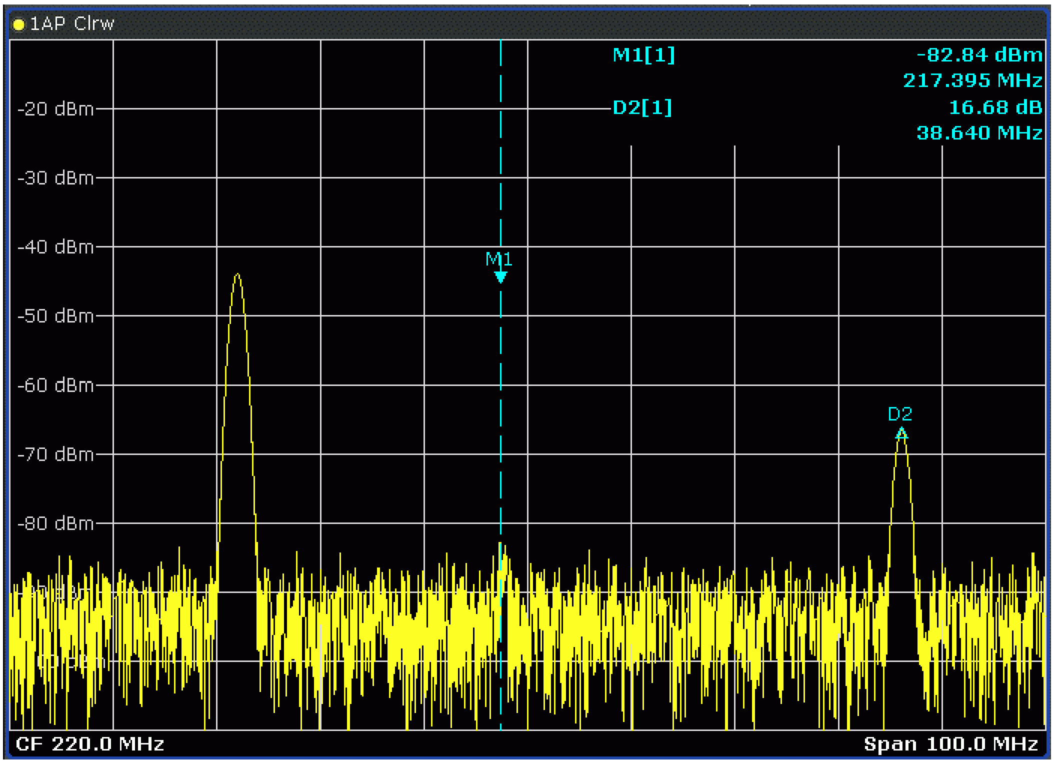
In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame.

6.4.1 Basics on Markers and Marker Functions

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S FSW provides 16 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- The easiest way to work with markers is using the touch screen. Simply drag the marker and drop it at the required position. When a marker label is selected, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold your finger for about 2 seconds until the context menu is opened, then select the required entry.
- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.

6.4.1.1 Marker Types

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default marker 1).

In addition, special functions can be assigned to the individual markers. The availability of special marker functions depends on whether the measurement is performed in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

6.4.1.2 Activating Markers

Only active markers are displayed in the diagram and in the marker table. Active markers are indicated by a highlighted softkey.

By default, marker 1 is active and positioned on the maximum value (peak) of trace 1 as a normal marker. If several traces are displayed, the marker is set to the maximum value of the trace which has the lowest number and is not frozen (View mode). The next marker to be activated is set to the frequency of the next lower level (next peak) as a delta marker; its value is indicated as an offset to marker 1.

A marker can only be activated when at least one trace in the corresponding window is visible. If a trace is switched off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again, the markers along with coupled functions are restored to their original positions, provided the markers have not been used on another trace.

6.4.1.3 Marker Results

Normal markers point to a sweep point on the time or frequency axis and display the associated numeric value for that sweep point. delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB. Signal count markers determine the frequency of a signal at the marker position very accurately.

The results can be displayed directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If more markers are activated, the results are displayed in a marker table.

Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number (1 to 16)
- The assigned trace number in square brackets [ ]
- The marker value (response) on the y-axis, or the result of the marker function
- The marker position (stimulus) on the x-axis

For n dB down markers, additional information is displayed, see "Measuring Characteristic Bandwidths (n dB Down Marker)" on page 319.

Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed beneath the diagram. This table provides the following information for all active markers:

Type	Marker type: N (normal), D (delta), T (temporary, internal) and number
Dgr	Diagram number
Ref	Reference marker for delta markers
Trc	Trace to which the marker is assigned
Stimulus	x-value of the marker
Response	y-value of the marker
Function	Activated marker or measurement function
Function Result	Result of the active marker or measurement function

6.4.1.4 Searching for Signal Peaks

A common task in spectrum analysis is determining peak values, i.e. maximum or minimum signal levels. The R&S FSW provides various peak search functions and applications:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area (Search Limits)
- Creating a marker table with all or a defined number of peak values for one sweep (Marker Peak List)
- Updating the marker position to the current peak value automatically after each sweep (Auto Peak Search)
- Creating a fixed reference marker at the current peak value of a trace (Peak Search)

Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

When is a peak a peak? - Peak excursion

During a peak search, for example when a marker peak table is displayed, noise values may be detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

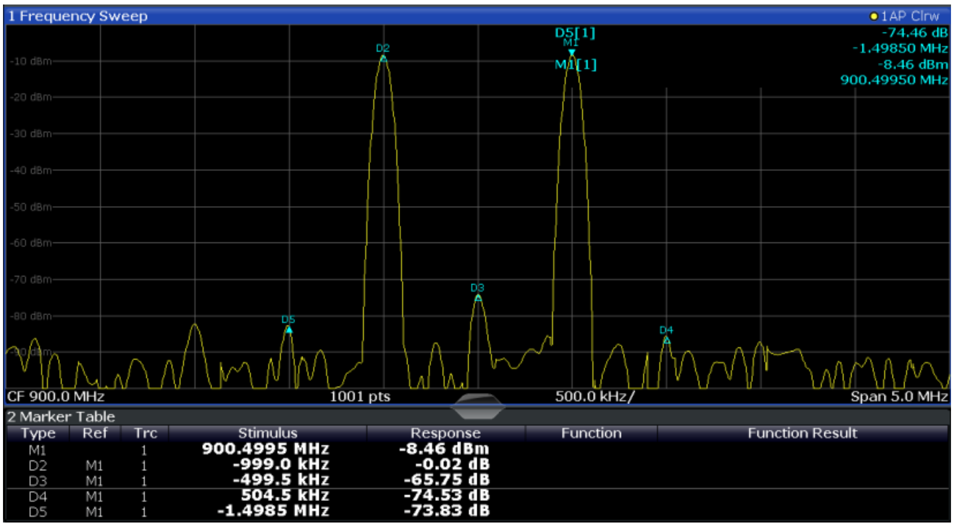


Fig. 6-11: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	30 dB
2	29.85 dB
3	20 dB
4	10 dB
5	18 dB

In order to eliminate the smaller peaks M3,M4 and M5 in the example above, a peak excursion of at least 20 dB is required. In this case, the amplitude must rise at least 20 dB before falling again before a peak is detected.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each sweep in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.

6.4.1.5 Special Marker Functions

In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

Performing a Highly Accurate Frequency Measurement (Signal Count)

A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point may contain many measurement values. Thus, the frequency resolution of each trace point is limited (see also chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242). Frequency resolution is further restricted by the RBW and sweep time settings.

In order to determine the frequency of a signal point accurately without changing the sweep settings, the R&S FSW is equipped with a signal counter. The signal counter sets the RF to the current marker position, then counts the zero crossings of the IF (thus the term signal *counter*) and derives the precise frequency value.

Signal counting can be performed explicitely at the current marker position ("Signal Count" marker function), or implicitely by the R&S FSW for certain functions.

Signal counting is only possible while the instrument is not sweeping. Thus, to perform a signal count for a marker, the sweep is stopped at the marker position. The frequency is determined with the desired resolution and then the sweep is allowed to continue.

Measuring Noise Density

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, two points to the right and left of the marker are used for the measurement to obtain a stable result.

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBmμV, dBμA), the noise power density is output in dBm/Hz, i.e. as level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in μV/Hz, the noise current density in μA/Hz or the noise power density in μW/Hz. The result is indicated as the noise marker value.

Prerequisite settings

The following settings have to be made to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
  ≤ 0.1 resolution bandwidth with sample detector
  ≥ 3 x resolution bandwidth with RMS detector
- Trace averaging:
  In the default setting, the R&S FSW uses the sample detector for the noise function. With the sample detector, the trace can additionally be set to "Average" mode to stabilize the measured values. When the RMS detector is used, trace averaging should not be used since in this case it produces too low noise levels which cannot be corrected. Instead, the sweep time can be increased to obtain stable measurement results.

Correction factors

The R&S FSW uses the following correction factors to analyze the noise density from the marker level:

- Since the noise power is indicated with reference to 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. It is 10 x lg (1 Hz/BWNoise), where BWNoise is the noise or power bandwidth of the set resolution filter (RBW).
- RMS detector: With the exception of bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, 1.45 dB is added additionally. Logarithmic averaging is thus fully taken into account which yields a value that is 1.45 dB lower than that of linear averaging.

- To allow a more stable noise display the adjacent (symmetric to the measurement frequency) points of the trace are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).

The R&S FSW noise figure can be calculated from the measured power density level. It is calculated by deducting the set RF attenuation (RF Att) from the displayed noise level and adding 174 to the result.

Measuring Phase Noise

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, a peak search can be started to use the current signal peak as the reference point, or a reference point can be defined manually.

Since the reference point is fixed, the reference level or the center frequency can be set so that the carrier is outside the displayed frequency range after phase noise measurement is started. Or a notch filter can be switched on to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. This function can be used to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker.

The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are taken into account in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement. The procedure for determining the noise power is identical to the method used for the noise power measurement (see "Measuring Noise Density" on page 317).

Using logarithmic scaling for the frequency axis allows for a large frequency range with fine resolution close to the carrier.

Defining a Fixed Reference Marker

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

Measuring Characteristic Bandwidths (n dB Down Marker)

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. In order to measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

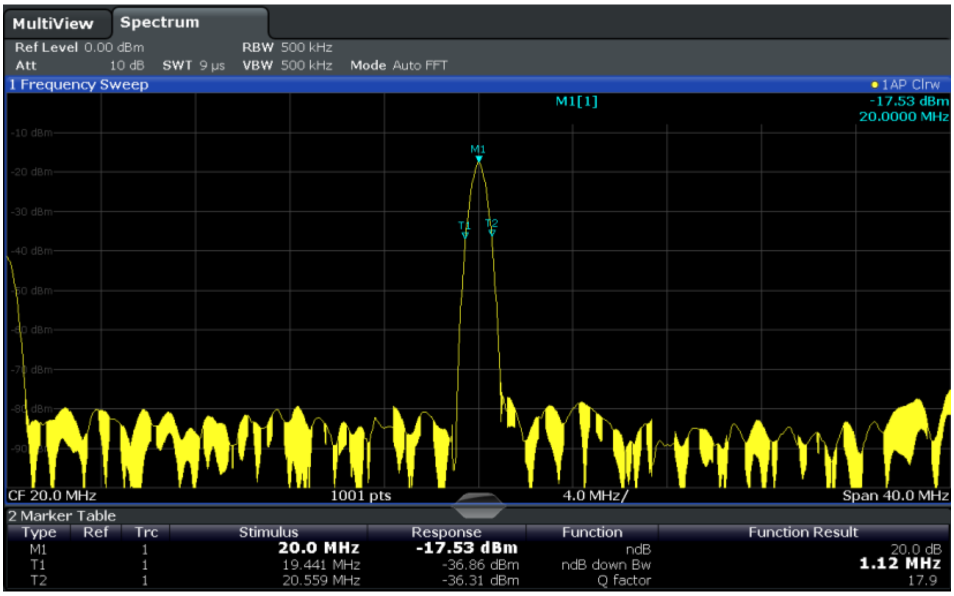


Fig. 6-12: n dB down marker function

The following marker function results are displayed:

Table 6-4: n dB down marker function results

Label	Description
M1	Current position and level of marker 1
ndB	Offset value (n dB down)
ndB down Bw / PWid	Determined bandwidth or pulse width (zero span) at the offset
Q-factor	Quality factor of the determined bandwidth (characteristic of damping or resonance)
T1, T2	Current position and level of the temporary markers

If the required position for the temporary markers cannot be determined uniquely, for example due to noise, dashes are displayed as a result.

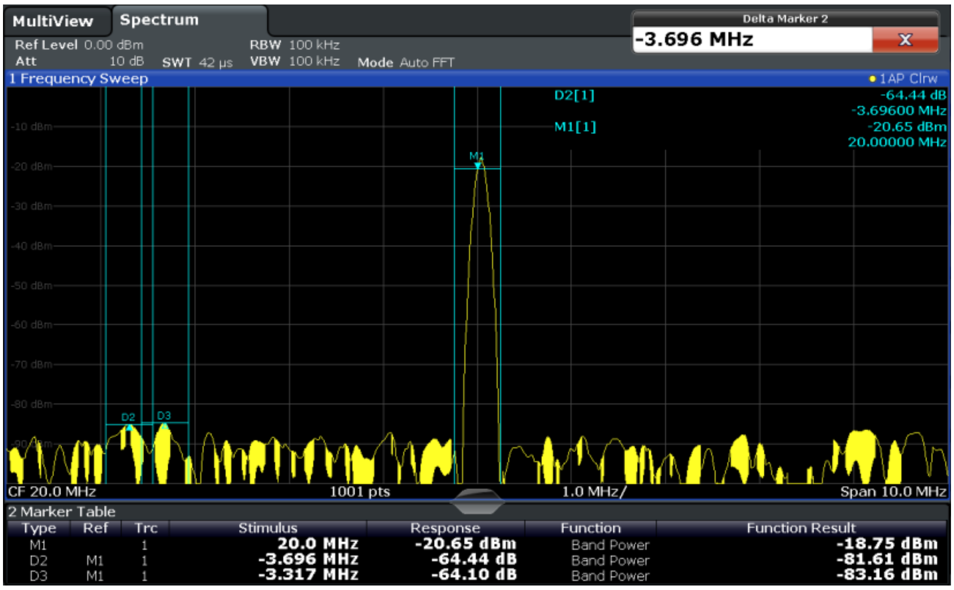
Measuring the Power in a Channel (Band)

When you want to determine the noise power in a transmission channel, you could use a noise marker and multiply the result with the channel bandwidth. However, the results would only be accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

Demodulating Marker Values and Providing Audio Output

The R&S FSW provides demodulators for AM, FM and PM signals. The demodulation marker function sends the demodulated data at the current marker frequency to the audio output. Thus, a displayed signal can be identified acoustically through the use of the internal loudspeaker or with headphones.

This function is not available for Spectrum Emission Mask measurements.

The sweep stops at the frequency determined by marker 1 for the selected time and the RF signal is demodulated in a bandwidth that corresponds to the RBW. Alternatively, demodulation can be activated continuously, i.e. audio output occurs regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), demodulation is always continuous.

Optionally, a mimumum level ("Squelch level") can be defined so that the signal is only demodulated when it exceeds the set level. This is useful during continuous demodulation to avoid listening to noise.

The squelch function activates the video trigger function (see "Video" on page 261) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value. The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

6.4.2 Marker Configuration

When working with markers, the following configuration settings and functions are available:

6.4.2.1 Marker Settings

Marker settings can be configured via the MARKER key or in the "Marker" dialog box. To display the "Marker" dialog box, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab.

The remote commands required to define these settings are described in chapter 10.6.3.1, "Setting Up Individual Markers", on page 705.

Individual Marker Setup

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.

The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

Selected Marker

Marker name. The marker which is currently selected for editing is highlighted orange.

SCPI command:

Marker selected via suffix <m> in remote commands.

Marker State

Activates or deactivates the marker in the diagram.

SCPI command:

`CALCulate<n>:MARKer<m>[:STATe]` on page 709

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 707

Marker Position (Stimulus)

Defines the position (x-value) of the marker in the diagram.

SCPI command:

`CALCulate<n>:MARKer<m>:X` on page 709

`CALCulate<n>:DELTamarker<m>:X` on page 708

Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

SCPI command:

`CALCulate:MARKer<m>:SGRam:FRAMe` on page 722

Marker Type

Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

SCPI command:

`CALCulate<n>:MARKer<m>[:STATe]` on page 709

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 707

Reference Marker

Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If a fixed reference point is configured (see "Defining a Fixed Reference" on page 325), the reference point ("FXD") can also be selected instead of another marker.

SCPI command:

`CALCulate<n>:DELTamarker<m>:MREF` on page 707

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the inital marker is changed, the linked marker follows on the same x-position. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

SCPI command:

`CALCulate<n>:MARKer<m1>:LINK:TO:MARKer<m2>` on page 709

`CALCulate<n>:DELTamarker<m1>:LINK:TO:MARKer<m2>` on page 706

`CALCulate<n>:DELTamarker<m>:LINK` on page 706

Assigning the Marker to a Trace
The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

The marker can also be assigned to the currently active trace using the "Marker to Trace" softkey.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

SCPI command:
`CALCulate<n>:MARKer<m>:TRACe` on page 709

Select Marker
Opens a dialog box to select and activate or deactivate one or more markers quickly.

SCPI command:
Marker selected via suffix <m> in remote commands.

All Markers Off
Deactivates all markers in one step.

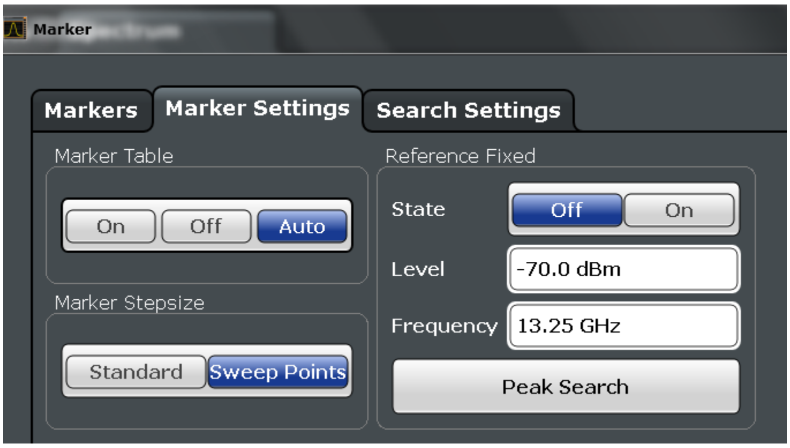
SCPI command:
`CALCulate<n>:MARKer<m>:AOFF` on page 708

General Marker Settings

Some general marker settings allow you to influence the marker behavior for all markers.

These settings are located in the "Marker Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab. Then select the horizontal "Marker Settings" tab.



Marker Table Display

Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area.

"Auto" (Default) Up to two markers are displayed in the diagram area. If more markers are active, the marker table is displayed automatically.

SCPI command:

`DISPlay:MTABle` on page 710

Marker Stepsize

Defines the size of the steps that the marker position is moved using the rotary knob.

"Standard" The marker position is moved from pixel to pixel on the display. This is the default and most suitable to move the marker over a larger distance.

"Sweep Points" The marker position is moved from one sweep point to the next. This setting is required for a very precise positioning if more sweep points are collected than the number of pixels that can be displayed on the screen.

SCPI command:

`CALCulate:MARKer:X:SSIZe` on page 710

Defining a Fixed Reference

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis.

When you set the "State" to "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

If activated, the fixed reference marker ("FXD") can also be selected as a "Reference Marker" instead of another marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker.

Alternatively, a **Peak Search** can be performed to set the current maximum value of the trace assigned to marker 1 as the fixed reference marker.

SCPI command:

`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 729
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 729
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]` on page 729

6.4.2.2 Marker Search Settings and Positioning Functions

Several functions are available to set the marker to a specific position very quickly and easily, or to use the current marker position to define another characteristic value. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

Most marker positioning functions and the search settings are available in the MKR -> menu.

Search settings are also available via the MARKER key or in the vertical "Marker Config" tab of the "Analysis" dialog box (horizontal "Search Settings" tab).

For more information on searching for signal peaks see chapter 6.4.1.4, "Searching for Signal Peaks", on page 314.

The remote commands required to define these settings are described in chapter 10.6.3.4, "Positioning the Marker", on page 714.

Marker Search Settings

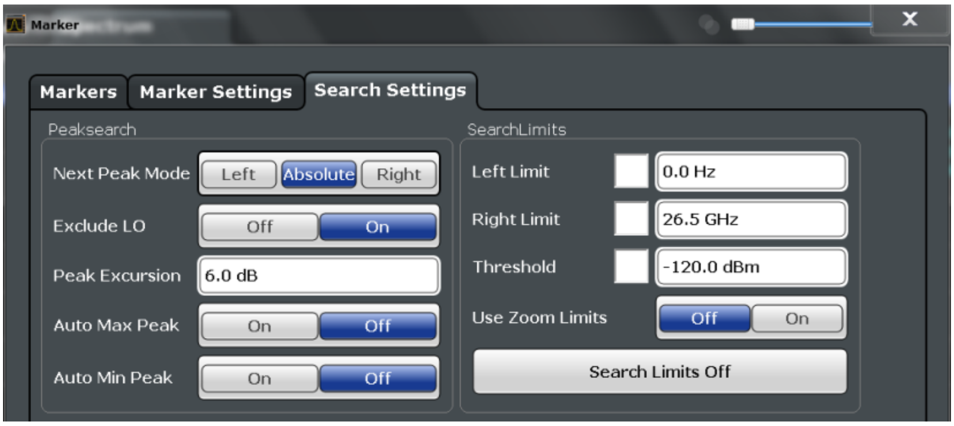
Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Configuration settings allow you to influence the peak search results.

For Spectrograms, special marker settings are available, see "Marker Search Settings for Spectrograms" on page 329.

These settings are are available as softkeys in the "Marker To" menu, or in the "Search Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

● Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.

- In the "Overview", select "Analysis", and switch to the vertical "Marker Config" tab. Then select the horizontal "Search Settings" tab.



Search Mode for Next Peak

Selects the search mode for the next peak search.

"Left"	Determines the next maximum/minimum to the left of the current peak.
"Absolute"	Determines the next maximum/minimum to either side of the current peak.
"Right"	Determines the next maximum/minimum to the right of the current peak.

SCPI command:

`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 717
`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 715
`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 717
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 715
`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 718
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 715
`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 718
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 716
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 718
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 716
`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 719
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 717

Exclude LO

If activated, restricts the frequency range for the marker search functions.

"ON" The minimum frequency included in the peak search range is ≥ 5 × resolution bandwidth (RBW).
Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"OFF" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

SCPI command:
CALCulate:MARKer:LOEXclude on page 711

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 6.4.1.4, "Searching for Signal Peaks", on page 314.

SCPI command:
CALCulate<n>:MARKer:PEXCursion on page 711

Automatic Peak Search

If activated, a peak search is performed automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

SCPI command:
CALCulate<n>:MARKer<m>:MAXimum:AUTO on page 714
CALCulate<n>:MARKer<m>:MINimum:AUTO on page 716

Search Limits

The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits

If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 315.

SCPI command:
CALCulate:MARKer:X:SLIMits[:STATe] on page 712
CALCulate:MARKer:X:SLIMits:LEFT on page 712
CALCulate:MARKer:X:SLIMits:RIGHT on page 713

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

SCPI command:
CALCulate:THReshold on page 713

Using Zoom Limits ← Search Limits

If activated, the peak search is restricted to the active zoom area defined for a single zoom (see "Single Zoom" on page 278).

SCPI command:

CALCulate:MARKer:X:SLIMits:ZOOM[:STATe] on page 713

Deactivating All Search Limits ← Search Limits

Deactivates the search range limits.

SCPI command:

CALCulate:MARKer:X:SLIMits[:STATe] on page 712

CALCulate:THReshold:STATe on page 714

Marker Search Settings for Spectrograms

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

These settings are are available in the "Search Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Config" tab. Then select the horizontal "Search Settings" tab.

Search Mode for Next Peak in X Direction

Selects the search mode for the next peak search within the currently selected frame.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

SCPI command:

`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 715
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 715
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 715
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 716
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 716
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 717

Search Mode for Next Peak in Y Direction

Selects the search mode for the next peak search within all frames at the current marker position.

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

SCPI command:

`CALCulate:MARKer<m>:SGRam:Y:MAXimum:ABOVe` on page 723
`CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe` on page 727
`CALCulate:MARKer<m>:SGRam:Y:MAXimum:BELow` on page 723
`CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:BELow` on page 727
`CALCulate:MARKer<m>:SGRam:Y:MAXimum:NEXT` on page 724
`CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:NEXT` on page 727
`CALCulate:MARKer<m>:SGRam:Y:MINimum:ABOVe` on page 724
`CALCulate:DELTamarker<m>:SGRam:Y:MINimum:ABOVe` on page 728
`CALCulate:MARKer<m>:SGRam:Y:MINimum:BELow` on page 724
`CALCulate:DELTamarker<m>:SGRam:Y:MINimum:BELow` on page 728
`CALCulate:MARKer<m>:SGRam:Y:MINimum:NEXT` on page 724
`CALCulate:DELTamarker<m>:SGRam:Y:MINimum:NEXT` on page 728

Marker Search Type

Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current marker position.

"XY-Search" Searches in all frames at all positions.

SCPI command:
CALCulate:MARKer<m>:SGRam:XY:MAXimum[:PEAK] on page 723
CALCulate:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK] on page 726
CALCulate:MARKer<m>:SGRam:XY:MINimum[:PEAK] on page 723
CALCulate:DELTamarker<m>:SGRam:XY:MINimum[:PEAK] on page 726
CALCulate:MARKer<m>:SGRam:Y:MAXimum[:PEAK] on page 724
CALCulate:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK] on page 727
CALCulate:MARKer<m>:SGRam:Y:MINimum[:PEAK] on page 725
CALCulate:DELTamarker<m>:SGRam:Y:MINimum[:PEAK] on page 728
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 715
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 718
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 716
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 718

Marker Search Area

Defines which frames the search is performed in.

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

SCPI command:
CALCulate:MARKer:SGRam:SARea on page 722
CALCulate:DELTamarker<m>:SGRam:SARea on page 726

Exclude LO

If activated, restricts the frequency range for the marker search functions.

"ON" The minimum frequency included in the peak search range is ≥ 5 × resolution bandwidth (RBW).
Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"OFF" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

SCPI command:
CALCulate:MARKer:LOEXclude on page 711

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 6.4.1.4, "Searching for Signal Peaks", on page 314.

SCPI command:
`CALCulate<n>:MARKer:PEXCursion` on page 711

Automatic Peak Search
If activated, a peak search is performed automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

SCPI command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 714
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 716

Search Limits
The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 315.

SCPI command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 712
`CALCulate:MARKer:X:SLIMits:LEFT` on page 712
`CALCulate:MARKer:X:SLIMits:RIGHT` on page 713

Search Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

SCPI command:
`CALCulate:THReshold` on page 713

Using Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom (see "Single Zoom" on page 278).

SCPI command:
`CALCulate:MARKer:X:SLIMits:ZOOM[:STATe]` on page 713

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

SCPI command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 712
`CALCulate:THReshold:STATe` on page 714

Positioning Functions

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value. These functions are available as softkeys in the "Marker To" menu, which is displayed when you press the MKR -> key.

Peak Search

Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the peak is to be searched in.

SCPI command:

`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 715

`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 718

Search Next Peak

Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next peak is to be searched in.

SCPI command:

`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 715

`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 717

Search Minimum

Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the minimum is to be searched in.

SCPI command:

`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 716

`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 718

Search Next Minimum

Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next minimum is to be searched in.

SCPI command:

`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 716

`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 718

Center Frequency = Marker Frequency

Sets the center frequency to the selected marker or delta marker frequency. A peak can thus be set as center frequency, for example to analyze it in detail with a smaller span.

This function is not available for zero span measurements.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 627

Reference Level = Marker Level
Sets the reference level to the selected marker level.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:REFerence` on page 638

6.4.2.3 Marker Function Configuration

Special marker functions can be selected via the "Marker Function" dialog box.

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

- Press the MKR FUNC key, then select the "Select Marker Function" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab.

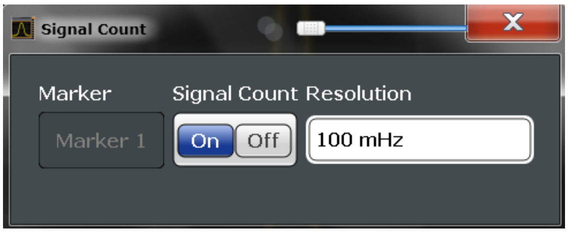
The remote commands required to define these settings are described in chapter 10.6.3, "Working with Markers", on page 705.

Precise Frequency (Signal Count) Marker

A special marker can be used to determine a particular frequency or time in a measured signal very accurately. Signal counters are configured in the "Signal Count Config" dialog box.

To display the "Signal Count Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.



For details see "Performing a Highly Accurate Frequency Measurement (Signal Count)" on page 316

Signal counters are not available for measurements on I/Q-based data.

Signal Count Marker State

Activates or deactivates the special signal count marker function.

When activated, the sweep stops at the reference marker until the signal counter has delivered a result.

SCPI command:

CALCulate<n>:MARKer<m>:COUNt on page 740

CALCulate<n>:MARKer<m>:COUNt:FREQuency? on page 740

Resolution

Defines the resolution with which the signal is analyzed around the reference marker 1.

SCPI command:

CALCulate<n>:MARKer<m>:COUNt:RESolution on page 741

Noise Measurement Marker

For each of the 16 markers noise measurement can be activated. Noise measurement markers are configured in the "Noise Measurement Config" dialog box, using the "Noise Measurement" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see "Individual Marker Setup" on page 321). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Noise Measurement Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.

For details see "Measuring Noise Density" on page 317.

Marker State

Activates or deactivates the marker in the diagram.

SCPI command:

`CALCulate<n>:MARKer<m>[:STATe]` on page 709

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 707

Marker Type

Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

SCPI command:
CALCulate<n>:MARKer<m>[:STATe] on page 709
CALCulate<n>:DELTamarker<m>[:STATe] on page 707

Noise Measurement State

Activates or deactivates noise measurement for the marker in the diagram.

This function is only available for normal markers.

If activated, the marker displays the noise power density measured at the position of the marker.

For details see "Measuring Noise Density" on page 317.

SCPI command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 733
CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? on page 733

Switching All Noise Measurements Off

Deactivates noise measurement for all markers.

SCPI command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 733

Phase Noise Measurement Marker

For each of the 16 markers phase noise measurement can be activated. Phase noise measurement markers are configured in the "Phase Noise Config" dialog box, using the "Phase Noise" function.

The individual marker settings correspond to those defined in the "Marker" dialog box. Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Phase Noise Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Phase Noise" button. Select the "Phase Noise Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Phase Noise" button. Select the "Phase Noise Config" softkey.

For more information see "Measuring Phase Noise" on page 318.

Phase Noise Measurement State

Activates or deactivates phase noise measurement for the reference point in the diagram.

This function is only available for delta markers.

If activated, the delta markers display the phase noise measured at defined offsets from the reference position.

SCPI command:

`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 734
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?` on page 734

Defining a Reference Point

Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

SCPI command:

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y on page 729
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X on page 729
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK] on page 729
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO on page 734

Switching All Phase Noise Measurements Off
Deactivates phase noise measurement for all markers.

SCPI command:

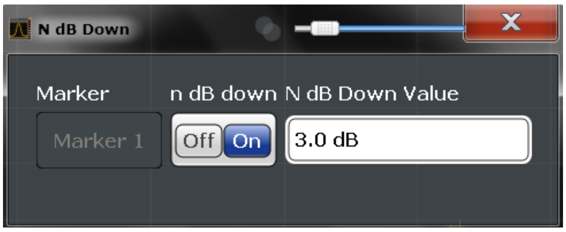
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] on page 734

n dB Down Marker

A special marker can be defined to determine a characteristic bandwidth or time span in a measured signal. n dB down markers are configured in the "N dB Down Config" dialog box, using the "n dB down" function.

To display the "N dB Down Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "n dB down" button. Select the "N dB Down Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "n dB down" button. Select the "N dB Down Config" softkey.



For details see "Measuring Characteristic Bandwidths (n dB Down Marker)" on page 319

n dB down Marker State
Activates or deactivates the special n dB down marker function.

SCPI command:

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe on page 739
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? on page 738

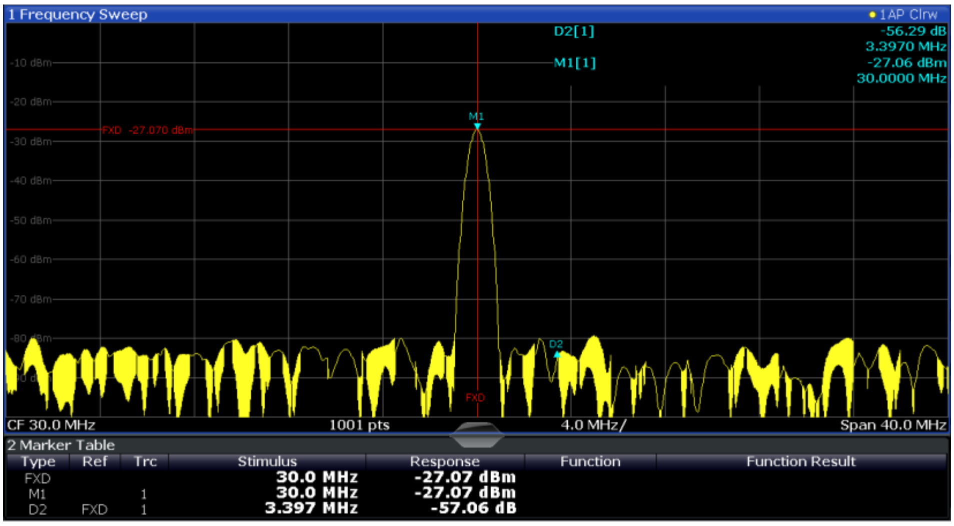
n dB down Delta Value
Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?` on page 738
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME` on page 739

Reference Fixed

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

When you select this marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is activated and set to the peak value and a delta marker to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.



You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

For more information see chapter 6.4.3.2, "How to Use a Fixed Reference Marker", on page 346.

Band Power Marker

For each of the 16 markers band power measurement can be activated. Band power measurement markers are configured in the "Band Power Config" dialog box, using the "Band Power" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see "Individual Marker Setup" on page 321). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Band Power Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Band Power" button. Select the "Band Power Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Band Power" button. Select the "Band Power Config" softkey.

For more information see "Measuring the Power in a Channel (Band)" on page 320.

Band Power Measurement State

Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see "Measuring the Power in a Channel (Band)" on page 320.

SCPI command:

`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 736

Span
Defines the span (band) around the marker for which the power is measured. The span is indicated by lines in the diagram.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN` on page 736

Power Mode
Defines the mode of the power measurement result.

"Power" The result is an absolute power level displayed in dBm.

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE` on page 735

Switching All Band Power Measurements Off
Deactivates band power measurement for all markers.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 736

Marker Demodulation

A special marker can be used to demodulate the signal at a particular position and send the result to the audio output. Marker Demodulation is configured in the "Marker Demod Config" dialog box, using the "Marker Demodulation" function.

To display the "Marker Demod Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.

This function is not available for Spectrum Emission Mask measurements or measurements on I/Q-based data.

For details see "Demodulating Marker Values and Providing Audio Output" on page 320.

Marker Demodulation State
Activates or deactivates the demodulation output.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe]` on page 742

Continuous Demodulation
If activated, the signal is demodulated continuously (not only at the marker position) and sent to the audio output. This allows you to monitor the frequency range acoustically (assuming the sweep time is long enough).

For zero span measurements, demodulation is always active continuously.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous` on page 741

Marker Stop Time
Defines how long the sweep is stopped at the marker position to output the demodulated signal.

For zero span measurements, demodulation is always active continuously, regardless of the marker stop time.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff` on page 742

Modulation
Defines the demodulation mode for output (AM/FM). The default setting is AM.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect` on page 742

Squelch
Activates or deactivates the squelch function. If activated, the audible AF is cut off below a defined threshold level. Thus, you avoid hearing noise at the audio output when no signal is available.

The squelch function activates the video trigger function (see "Video" on page 261) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value.

The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

SCPI command:

`[SENSe:]DEMod:SQUelch[:STATe]` on page 743

Squelch level

Defines the level threshold below which the audible AF is cut off if squelching is enabled. The video trigger level is set to the same value.

The squelch level is indicated by a red line in the diagram.

SCPI command:

`[SENSe:]DEMod:SQUelch:LEVel` on page 743

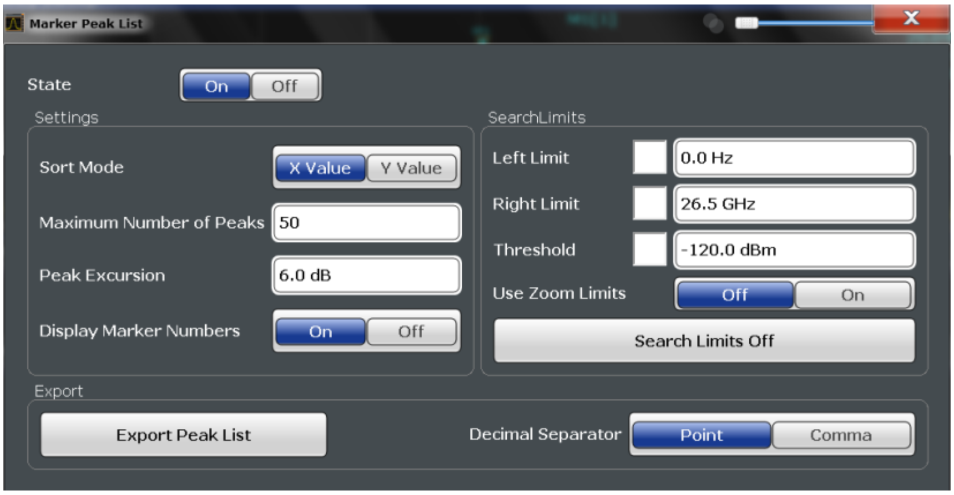
Marker Peak List Configuration

The marker peak list provides an overview of all marker peaks in the measurement. You can define search and sort criteria to influence the results of the analysis. The general marker search settings also apply to the marker peak list (see "Marker Search Settings" on page 326).

For more information see chapter 6.4.1.4, "Searching for Signal Peaks", on page 314.

To display the "Marker Peak List" dialog, do one of the following:

- Press the MKR FUNC key, then select the "Marker Peak List" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Peak List" tab.



Peak List State

Activates/deactivates the marker peak list. If activated, the peak list is displayed and the peaks are indicated in the trace display.

For each listed peak the frequency/time ("Stimulus") and level ("Response") values are given.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STAT` on page 732

Sort Mode
Defines whether the peak list is sorted according to the x-values or y-values. In either case the values are sorted in ascending order.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT` on page 731

Maximum Number of Peaks
Defines the maximum number of peaks to be determined and displayed.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE` on page 731

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 6.4.1.4, "Searching for Signal Peaks", on page 314.

SCPI command:
`CALCulate<n>:MARKer:PEXCursion` on page 711

Displaying Marker Numbers
By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks the marker numbers may decrease readability; in this case, deactivate the marker number display.

SCPI command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe]`
on page 730

Exporting the Peak List
The peak list can be exported to an ASCII file (`.DAT`) for analysis in an external application.

SCPI command:
`MMEMory:STORe:LIST` on page 775
`FORMat:DEXPort:DSEParator` on page 756

Deactivating All Marker Functions

All special marker functions can be deactivated in one step.

Use the "All Functions Off" button in the "Marker Functions" dialog box.

6.4.3 How to Work With Markers

The following step-by-step instructions demonstrate in detail how to work with markers.

6.4.3.1 How to Analyze a Signal Point in Detail

Step-by-step instructions on working with markers are provided here. For details on individual functions and settings see chapter 6.4.2.1, "Marker Settings", on page 321.

The remote commands required to perform these tasks are described in chapter 10.6.3, "Working with Markers", on page 705.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing the PEAK SEARCH key.
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
   a) Press the MKR -> key.
   b) Select the "Next Peak" or "Next Min" key.
   c) If necessary, change the search settings by selecting the "Search Config" softkey.
3. Center the display around the determined signal point by setting the marker value to the center frequency. Select the "Center = Mkr Freq" softkey.
4. Determine the precise frequency of the signal point:
   a) Select the "Select Marker Function" softkey.
   b) Select the "Signal Count" button.
   c) Select the "Signal Count Resolution" softkey.
   d) Select the resolution depending on how precise the result needs to be.

6.4.3.2 How to Use a Fixed Reference Marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

How to Define and Move a Fixed Reference Marker

1. To display a fixed reference marker, do one of the following:
   - Press the MKR FUNC key, then select the "Reference Fixed" marker function.
   - In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.

2. To move the fixed reference marker, do one of the following:
   - Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
   - Set the fixed reference marker to the current peak value by selecting the "Peak Search" button in the "Marker Config" tab of the "Marker" dialog box.
   - Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Ref. Marker" list.

   The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

6.4.3.3 How to Output the Demodulated Signal Accoustically

For long sweep times you may wish to monitor a measurement accoustically rather than visually to determine when a certain signal level is reached.

CAUTION

Risk of hearing damage

To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.

1. Set marker 1 to the signal level you want to monitor.
2. Press the MKR FUNCT key.
3. Select the "Select Marker Function" softkey.
4. Select the "Marker Demodulation" button.
5. Select the "Marker Demod Config" softkey.

   The marker function results are determined immediately according to the default settings.
6. Define how long you want to hear the output signal when the marker value is reached by entering the duration in the "Marker Stop Time" field.

Alternatively, the audio signal can be output continuously, regardless of the marker value; in this case, set "Continuous Demodulation" to "On".

7. Select the modulation type (AM/FM/PM) of the signal.
8. To avoid listening to noise during continuous output, set "Squelch" to "On" and define the signal level below which the signal is ignored ("Squelch level").
9. Set "Marker Demodulation" to "On".
10. Plug your headphones into the PHONES connector on the front panel of the R&S FSW.
11. Adjust the volume using the rotary knob next to the PHONES connector.

    During the next or currently running measurement, when the sweep reaches the marker position, the demodulated signal is output as an audio signal via the headphones for the given duration. Or, depending on the configuration, the demodulated signal is continuously output via the headphones, if the signal level exceeds the squelch level.

6.4.4 Measurement Example: Measuring Harmonics Using Marker Functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that this task can be performed much simpler using the Harmonic Distortion measurement (see chapter 4.9, "Harmonic Distortion Measurement", on page 158).

Signal generator settings (e.g. R&S FSW SMU):

Frequency:	128 MHz
Level:	- 25 dBm

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.

   The R&S FSW displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.
4. Switch on the marker by pressing the MKR key.
   The marker is positioned on the trace maximum.
5. Set the measured signal frequency and the measured level as reference values:
   a) Press the MKR FUNC key
   b) Press the "Reference Fixed" softkey.

The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.

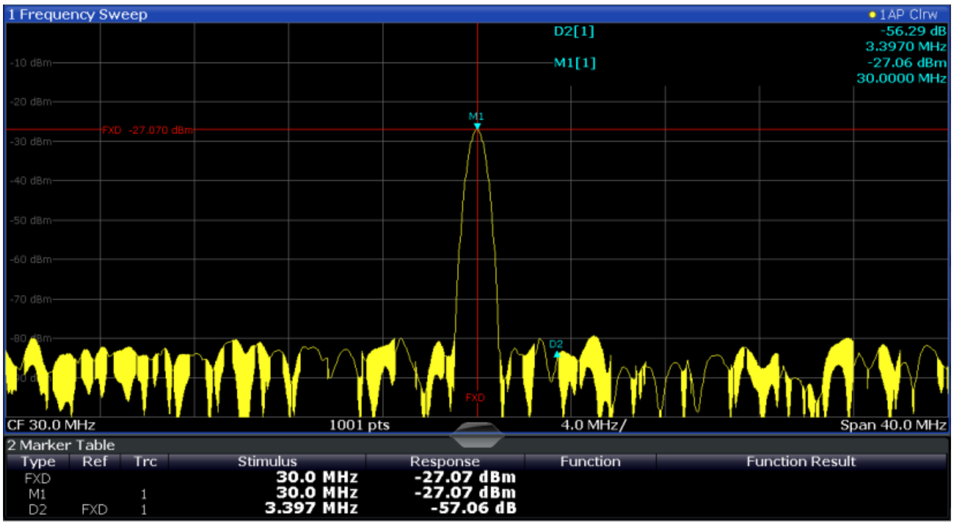


Fig. 6-13: Fundamental wave and the frequency and level reference point

6. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize = Marker".

   The step size for the center frequency is now equal to the marker frequency.

7. Move the center frequency to the 2nd harmonic of the signal by pressing the UP (⇧) key on the front panel.

   The center frequency is set to the 2nd harmonic.

8. Place the delta marker on the 2nd harmonic: in the "Marker To" menu, select the "Peak" softkey.

   The delta marker moves to the maximum of the 2nd harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).

The other harmonics are measured by repeating steps step 7 and step 8, with the center frequency being incremented or decremented in steps of 128 MHz using the UP or DOWN keys.

6.5 Display and Limit Lines

Display and limit lines help you analyze a measurement trace.

6.5.1 Basics on Display Lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see chapter 6.5.2, "Basics on Limit Lines", on page 350).

Two different types of display lines are provided:

- Two horizontal level lines for marking levels – Display Line 1 and 2
  The level lines are continuous horizontal lines across the entire width of a diagram and can be shifted in y direction.
- Two vertical frequency or time lines for marking frequencies or points in time – Frequency/Time Line 1 and 2
  The frequency or time lines are continuous vertical lines across the entire height of the diagram and can be shifted in x direction.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- D1: Display Line 1
- D2: Display Line 2
- F1: Frequency Line 1
- F2: Frequency Line 2
- T1: Time Line 1
- T2: Time Line 2

6.5.2 Basics on Limit Lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S FSW supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the instrument is only limited by the capacity of the storage device used.

Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line has to be identical to the current setting.

- The y unit of the limit line has to be identical to the current setting with the exception of dB based units; all dB based units are compatible with each other.

Validity

Only limit lines that fulfill the following conditions can be activated:

- Each limit line must consist of a minimum of 2 and a maximum of 200 data points.
- The frequencies/times for each data point must be defined in ascending order; however, for any single frequency or time, two data points may be entered (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies or times need not necessarily be selectable in R&S FSW. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.

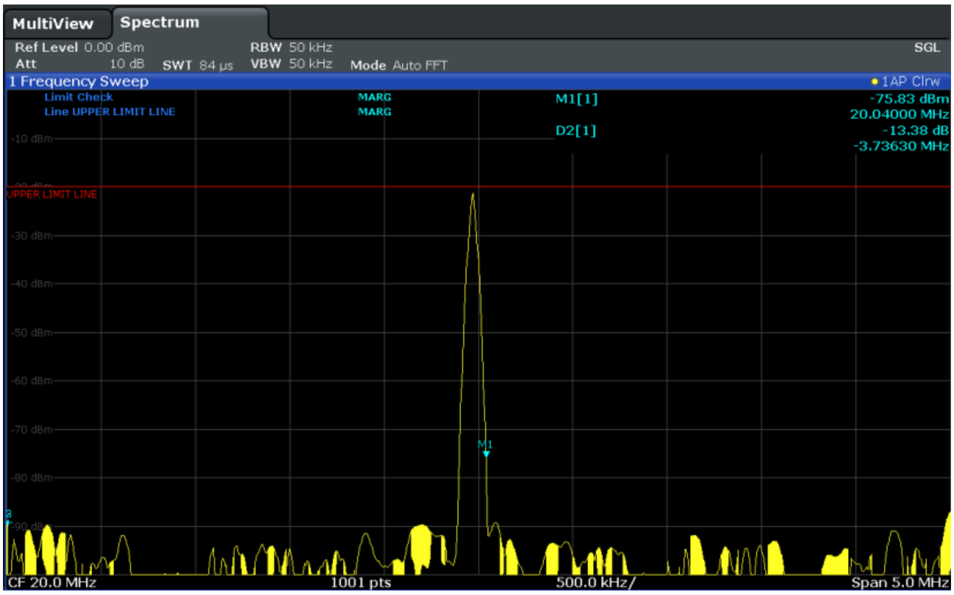


Fig. 6-14: Example for an upper limit line

Limits and Margins

Limit lines define strict values that must not be exceeded by the measured signal. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. It can be used as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display, but if it is violated, a warning is displayed. Margins are defined as lines with a fixed distance to the limit line.

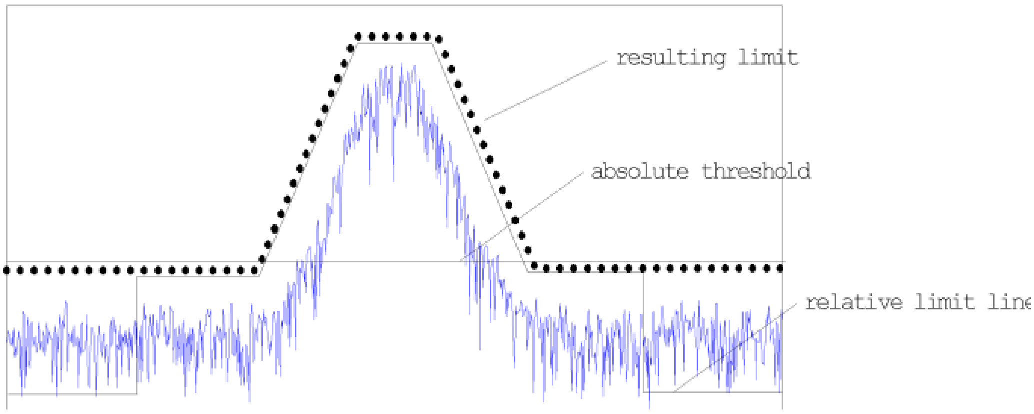
To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

Limits can be defined relative to the reference level, the beginning of the time scale, or the center frequency, or as absolute values.

Relative scaling is suitable, for example, if masks for bursts are to be defined in zero span, or if masks for modulated signals are required in the frequency domain.

Thresholds

If the y-axis for the limit line data points uses relative scaling, an additional absolute **threshold** can be defined for the limit check. In this case, both the threshold value and the relative limit line must be exceeded before a violation occurs.



Offsets and Shifting

A configured limit line can easily be moved vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if relative scaling is used.
  Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit Check Results

A limit check is automatically performed as soon as any of the limit lines is activated ("Visibility" setting). Only the specified "Traces to be Checked" are compared with the active limit lines. The status of the limit check for each limit line is indicated in the diagram. If a violation occurs, the limit check status is set to "MARG" for a margin violation, or to"FAIL" for a limit violation.

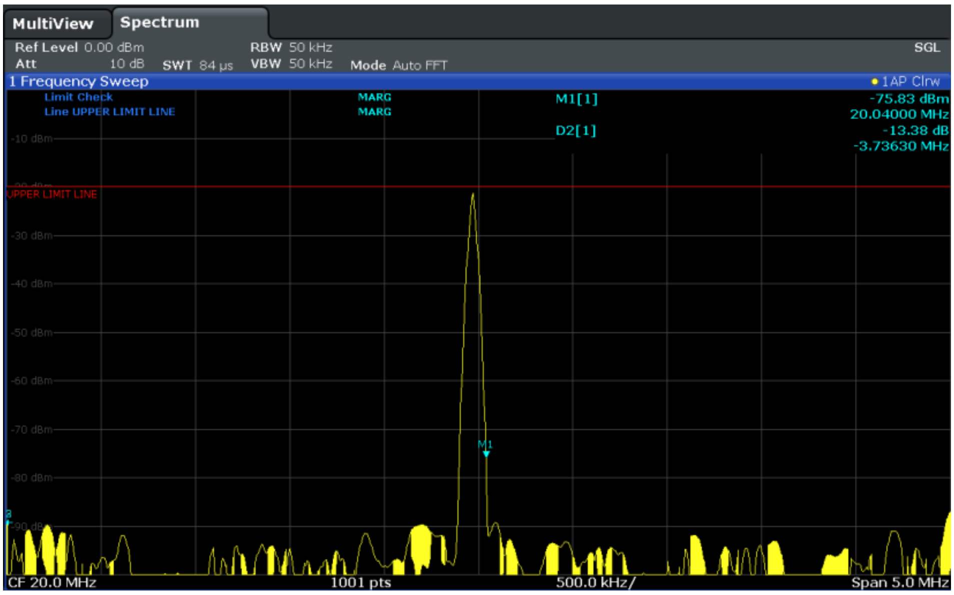


Fig. 6-15: Margin violation for limit check

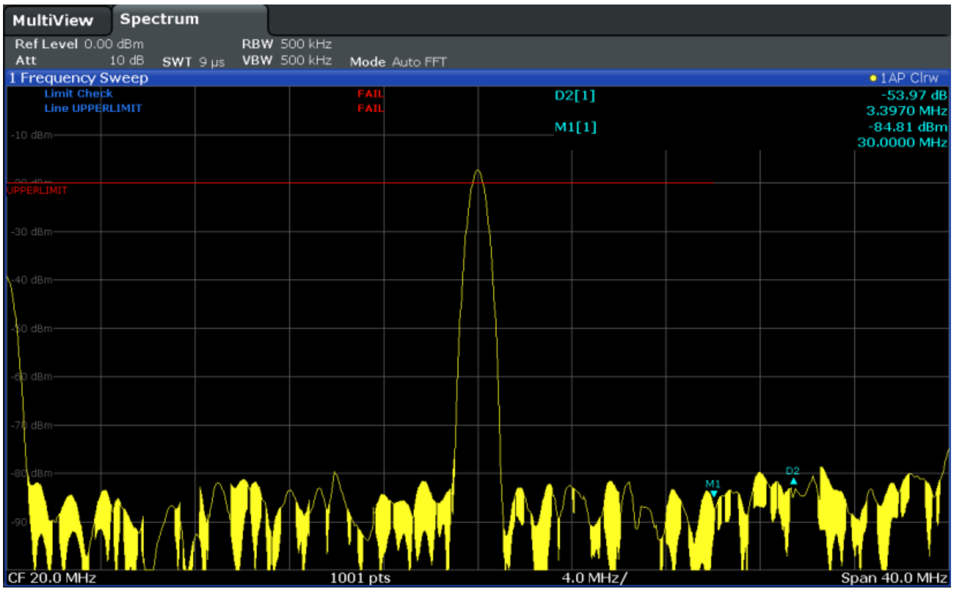


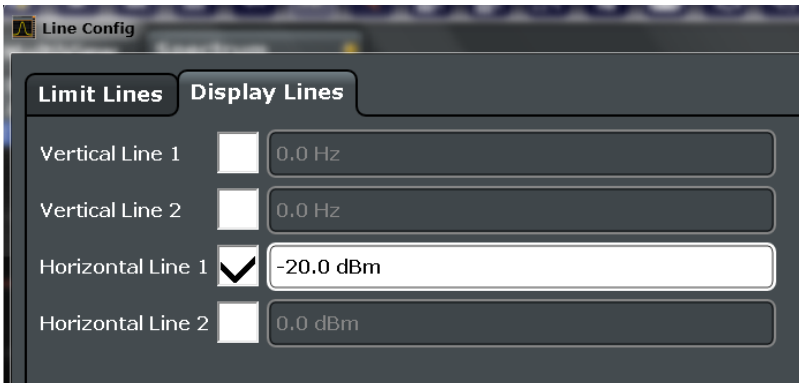
Fig. 6-16: Limit violation for limit check

6.5.3 Settings and Functions for Display and Limit Lines

For remote operation, see chapter 10.6.4, "Configuring Display and Limit Lines", on page 743.

6.5.3.1 Display Line Settings

Two vertical and two horizontal lines can be defined in the display.



Vertical Line 1/2

Activates a vertical display line (F1/F2 or T1/T2) in the diagram at the specified frequency or point in time, depending on the frequency span.

SCPI command:

`CALCulate<n>:FLINe<k>` on page 744
`CALCulate<n>:FLINe<k>` on page 744
`CALCulate<n>:TLINe<Line>` on page 745
`CALCulate<n>:TLINe<Line>` on page 745

Horizontal Line 1/2

Activates a horizontal display line (D1/D2) in the diagram at the specified level.

SCPI command:

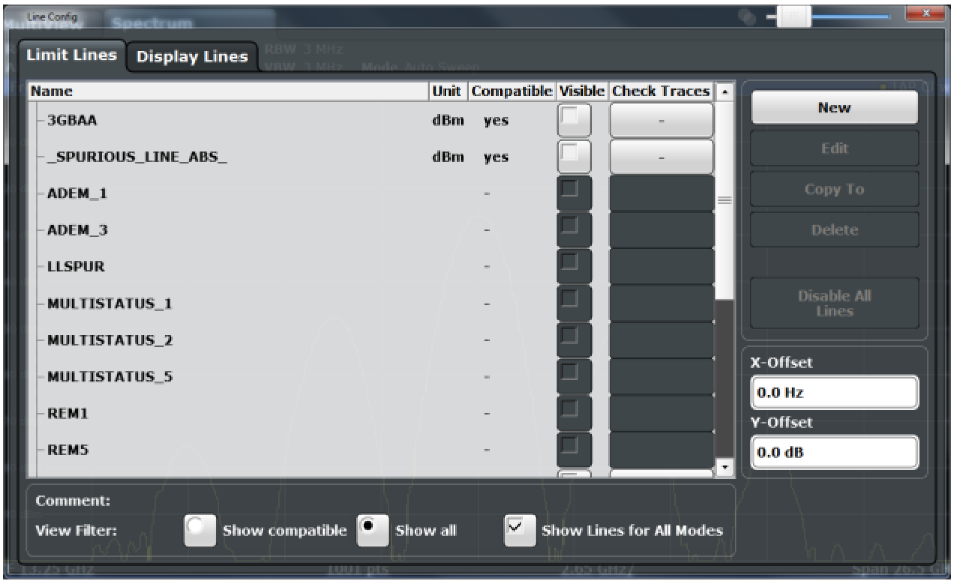
`CALCulate<n>:DLINe<k>` on page 744
`CALCulate<n>:DLINe<k>` on page 744

6.5.3.2 Limit Line Settings and Functions

Up to 8 limit lines can be displayed simultaneously in the R&S FSW. Many more can be stored on the instrument.

Limit Line Management

Limit lines are managed in the "Line Config" dialog box which is displayed when you press the LINES key and then "Lines Config" softkey.



For the limit line overview, the R&S FSW searches for all stored limit lines with the file extension `.LIM` in the `limits` subfolder of the main installation folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

For details on settings for individual lines see "Limit Line Details" on page 357.

For more basic information on limit lines see chapter 6.5.2, "Basics on Limit Lines", on page 350.

Name

The name of the stored limit line.

Unit
The unit in which the y-values of the data points of the limit line are defined.

Compatibility
Indicates whether the limit line definition is compatible with the current measurement settings.

For more information on which conditions a limit line must fulfill to be compatible, see chapter 6.5.2, "Basics on Limit Lines", on page 350.

Visibility
Displays or hides the limit line in the diagram. Up to 8 limit lines can be visible at the same time. Inactive limit lines can also be displayed in the diagram.

SCPI command:
`CALCulate:LIMit<k>:LOWer:STATe` on page 749
`CALCulate:LIMit<k>:UPPer:STATe` on page 752
`CALCulate:LIMit:ACTive?` on page 753

Traces to be Checked
Defines which traces are automatically checked for conformance with the limit lines. As soon as a trace to be checked is defined, the assigned limit line is active. One limit line can be activated for several traces simultaneously. If any of the "Traces to be Checked" violate any of the active limit lines, a message is indicated in the diagram.

SCPI command:
`CALCulate:LIMit<k>:TRACe` on page 753

Comment
An optional description of the limit line.

Included Lines in Overview (View Filter)
Defines which of the stored lines are included in the overview.

"Show compatible"	Only compatible lines Whether a line is compatible or not is indicated in the Compatibility setting.
"Show all"	All stored limit lines with the file extension `.LIM` in the `limits` subfolder of the main installation folder (if not restricted by "Show lines for all modes" setting).

Show lines for all modes
If activated (default), limit lines from all applications are displayed. Otherwise, only lines that were created in the Spectrum application are displayed.

Note that limit lines from some applications may include additional properties that are lost when the limit lines are edited in the Spectrum application. In this case a warning is displayed when you try to store the limit line.

X-Offset
Shifts a limit line that has been specified for relative frequencies or times (x-axis) horizontally.

This setting does not have any effect on limit lines that are defined by absolute values for the x-axis.

SCPI command:
CALCulate:LIMit<k>:CONTrol:OFFSet on page 747

Y-Offset
Shifts a limit line that has relative values for the y-axis (levels or linear units such as volt) vertically.

This setting does not have any effect on limit lines that are defined by absolute values for the y-axis.

SCPI command:
CALCulate:LIMit<k>:LOWer:OFFSet on page 748
CALCulate:LIMit<k>:UPPer:OFFSet on page 751

Create New Line
Creates a new limit line.

Edit Line
Edit an existing limit line configuration.

Copy Line
Copy the selected limit line configuration to create a new line.

SCPI command:
CALCulate:LIMit<k>:COPY on page 753

Delete Line
Delete the selected limit line configuration.

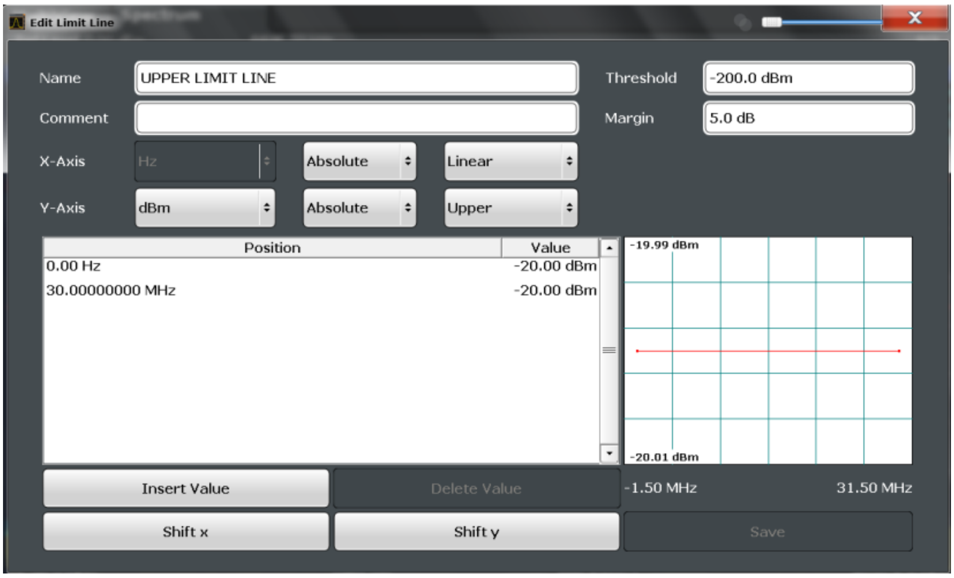
SCPI command:
CALCulate:LIMit<k>:DELete on page 753

Disable All Lines
Disable all limit lines in one step.

SCPI command:
CALCulate:LIMit<k>:STATe on page 754

Limit Line Details

Limit lines details are configured in the "Edit Line Line" dialog box which is displayed when you select the "New", "Edit" or "Copy To" buttons in the "Line Config" dialog box.



Name

Defines the limit line name. All names must be compatible with Windows conventions for file names. The limit line data is stored under this name (with a `.LIM` extension).

SCPI command:

`CALCulate:LIMit<k>:NAME` on page 750

Comment

Defines an optional comment for the limit line. The text may contain up to 40 characters.

SCPI command:

`CALCulate:LIMit:COMMent` on page 746

Threshold

Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see chapter 6.5.2, "Basics on Limit Lines", on page 350.

SCPI command:

`CALCulate:LIMit<k>:LOWer:THReshold` on page 749

`CALCulate:LIMit<k>:UPPer:THReshold` on page 752

Margin

Defines a margin for the limit line. The default setting is 0 dB (i.e. no margin).

For details on margins see chapter 6.5.2, "Basics on Limit Lines", on page 350.

SCPI command:

`CALCulate:LIMit<k>:LOWer:MARGin` on page 748

`CALCulate:LIMit<k>:UPPer:MARGin` on page 751

X-Axis

Describes the horizontal axis on which the data points of the limit line are defined. Includes the following settings:

- Domain:
  - "Hz": for frequency domain
  - "s": for time domain
- Scaling mode: absolute or relative (Hz/s/%) values
  For relative values, the frequencies are referred to the currently set center frequency. In the zero span mode, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

SCPI command:

`CALCulate:LIMit<k>:LOWer:SPACing` on page 749

`CALCulate:LIMit<k>:UPPer:SPACing` on page 752

`CALCulate:LIMit<k>:LOWer:MODE` on page 748

`CALCulate:LIMit<k>:UPPer:MODE` on page 751

`CALCulate:LIMit<k>:CONTrol:DOMain` on page 746

Y-Axis

Describes the vertical axis on which the data points of the limit line are defined. Includes the following settings:

- Level unit
- Scaling mode: absolute or relative (dB/%) values
  Relative limit values refer to the reference level.
- Limit type: upper or lower limit; values must stay above the lower limit and below the upper limit to pass the limit check

SCPI command:

`CALCulate:LIMit<k>:UNIT` on page 750

`CALCulate:LIMit<k>:LOWer:SPACing` on page 749

`CALCulate:LIMit<k>:UPPer:SPACing` on page 752

Data points

Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-value). Data points must be defined in ascending order. The same position can have two different values.

SCPI command:

`CALCulate:LIMit<k>:CONTrol[:DATA]` on page 746

`CALCulate:LIMit<k>:LOWer[:DATA]` on page 748

`CALCulate:LIMit<k>:UPPer[:DATA]` on page 750

Insert Value
Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog box.

Delete Value
Deletes the selected data point in the "Edit Limit Line" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "X-Offset" on page 356).

SCPI command:
`CALCulate:LIMit<k>:CONTrol:SHIFt` on page 747

Shift y
Shifts the y-value of each data point vertically by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "Y-Offset" on page 357).

SCPI command:
`CALCulate:LIMit<k>:LOWer:SHIFt` on page 749
`CALCulate:LIMit<k>:UPPer:SHIFt` on page 751

Save
Saves the currently edited limit line under the name defined in the "Name" field.

6.5.4 How to Work with Display and Limit Lines

Step-by-step instructions on configuring display and limit lines are provided here. For details on individual functions and settings see chapter 6.5.3, "Settings and Functions for Display and Limit Lines ", on page 353.

The remote commands required to perform these tasks are described in chapter 10.6.4, "Configuring Display and Limit Lines", on page 743.

6.5.4.1 Defining Display Lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press the LINES key and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line, select "Vertical Line 1" or 2 and enter the x-value at which the line is to be displayed.
   To define a horizontal line, select "Horizontal Line 1" or 2 and enter the y-value at which the line is to be displayed.

6.5.4.2 Defining Limit Lines

Limit lines are configured in the "Lines Config" dialog box. To display this dialog box, do one of the following:

- Press the LINES key and then the "Lines Config" softkey, then select the "Lines Config" tab.
- In the "Overview", select "Analysis" and then the vertical "Limit Lines Config" tab.

Limit lines for spurious and SEM measurements

Note that for spurious and SEM measurements, special limit lines can be defined for each frequency range, see chapter 4.5.4.2, "Limit Lines in SEM Measurements", on page 100 and chapter 4.6.3.2, "Limit Lines in Spurious Measurements", on page 129. It is strongly recommended that you define limits only via the "Sweep list" dialog for these measurements, not using the LINES key.

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

- "How to find compatible limit lines" on page 361
- "How to activate and deactivate a limit check" on page 361
- "How to edit existing limit lines" on page 362
- "How to copy an existing limit line" on page 362
- "How to delete an existing limit line" on page 362
- "How to configure a new limit line" on page 362
- "How to move the limit line vertically or horizontally" on page 363

How to find compatible limit lines

► In the "Line Config" dialog box, select the "View filter" option: "Show compatible".

All stored limit lines with the file extension `.LIM` in the `limits` subfolder of the main installation folder of the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a limit check

A limit check is automatically performed as soon as any of the limit lines is activated.

1. To activate a limit check:
   Select the "Check Traces" setting for a limit line in the overview and select the trace numbers to be included in the limit check. One limit line can be assigned to several traces.

   The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.

2. To deactivate a limit line, deactivate all "Traces to check" for it.
   To deactivate all limit lines at once, select the "Disable All Lines" button.

The limit checks for the deactivated limit lines are stopped and the results are removed form the display.

How to edit existing limit lines

Existing limit line configurations can be edited.

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Edit" button.
3. Edit the line configuration as described in "How to configure a new limit line" on page 362.
4. Save the new configuration by selecting the "Save" button.

   If the limit line is active, the edited limit line is displayed in the diagram.

How to copy an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Copy To" button.
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new limit line" on page 362.
5. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Delete" button.
3. Confirm the message.

   The limit line and the results of the limit check are deleted.

How to configure a new limit line

1. In the "Line Config" dialog box, select the "New" button.

   The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
   - Time domain or frequency domain
   - Absolute or relative limits
   - Linear or logarithmic scaling

4. Define the y-axis configuration:
   - Level unit
   - Absolute or relative limits
   - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.
   d) Repeat this to insert all other data points.
   To insert a data point before an existing one, select the data point and then "Insert Value".
   To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
   To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
   If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
7. Optionally, define a "Margin" at a fixed distance to the limit line.
   The margin must be within the valid value range and is not displayed in the diagram or preview area.
8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
9. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select the "X-Offset" button and enter an offset value.
   To shift the complete limit line parallel in the vertical direction, select the "Y-Offset" button and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):
   a) Select the "Edit" button.
   b) In the "Edit Limit Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
   c) Save the shifted data points by selecting the "Save" button.

   If activated, the limit line is shifted in the diagram.

7 Data Management

The R&S FSW allows you to store and load instrument settings, as well as import and export measurement data for analysis at a later time. Finally, you can store or print the measurement results displayed on the screen.

General storage and import/export functions are available via the toolbar. Some special storage functions are (also) available via softkeys or dialog boxes in the corresponding menus, e.g. trace data or marker peak lists.

7.1 Restoring the Default Instrument Configuration (Preset)

When delivered, the R&S FSW has a default configuration. You can restore this defined initial state at any time as a known starting point for measurements. This is often recommendable as a first step in troubleshooting when unusual measurement results arise.

To restore the default instrument configuration for all channels at once

► Press the PRESET key.

Alternatively to the factory default settings, you can define user-specific recall settings to be restored after a preset or reboot, see "To recall settings automatically after preset or reboot" on page 375.

After you use the PRESET function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

SCPI command:

`*RST` or `SYSTem:PRESet`

To restore the default configuration for a single channel

The default measurement settings can also be reset for an individual channel only, rather than resetting the entire instrument.

► In the "Overview", select the "Preset Channel" button.

The factory default settings are restored to the current channel. Note that a user-defined recall settings file is **NOT** restored.

SCPI command:

SYSTem:PRESet:CHANnel[:EXECute] on page 768

7.1.1 Factory Default Configuration

The factory default configuration is selected such that the RF input is always protected against overload, provided that the applied signal levels are in the allowed range for the instrument.

Table 7-1: Factory default configuration

Parameter	Setting
mode	Spectrum
sweep mode	auto
center frequency	$f_{max}/2$
center frequency step size	0.1 * span
span	R&S FSW8: 8 GHz R&S FSW13: 13 GHz R&S FSW26: 26.5 GHz
RF attenuation	10 dB
reference level	0 dBm
level range	100 dB log
level unit	dBm
sweep time	auto
resolution bandwidth	auto (3 MHz)
video bandwidth	auto (3 MHz)
FFT filters	off
span/RBW	100
RBW/VBW	1
sweep	cont
trigger	free run
trace mode	1: clr write; 2/3/4/5/6: blank
detector	auto peak
frequency offset	0 Hz
reference level offset	0 dB
reference level position	100 %
grid	abs
cal correction	on

Parameter	Setting
noise source	off
input	RF

7.2 Storing and Recalling Instrument Settings and Measurement Data

Possibly you would like to restore or repeat a measurement you performed under specific conditions on the instrument. Or you want to evaluate imported data in another application on the R&S FSW and would like to restore the measurement settings applied during measurement. In these cases, you can store and recall instrument and measurement settings, and possibly other related measurement data.

Two different methods are available for managing instrument settings:

- Quick Save/Quick Recall - a defined set of instrument or channel settings are stored or recalled quickly in just one step
- Configurable Save/Recall - a user-defined set of instrument or channel settings are stored to a definable storage location

7.2.1 Quick Save/Quick Recall

The Quick Save and Quick Recall functions allow you to store instrument or channel settings very easily and quickly in one step. Up to 10 different sets of settings can be stored to or recalled from "save sets". Each save set is identified by its storage date and type (instrument or specific channel) in the display. The save sets are stored in the `C:\r_s\instr\user\QuickSave` directory, in files named `QuickSave1.dfl` to `QuickSave10.dfl`. The storage file names and locations cannot be changed.

During recall, save sets of type "Instrument" replace the settings of the entire instrument. All other save sets start a new measurement channel with the stored settings.

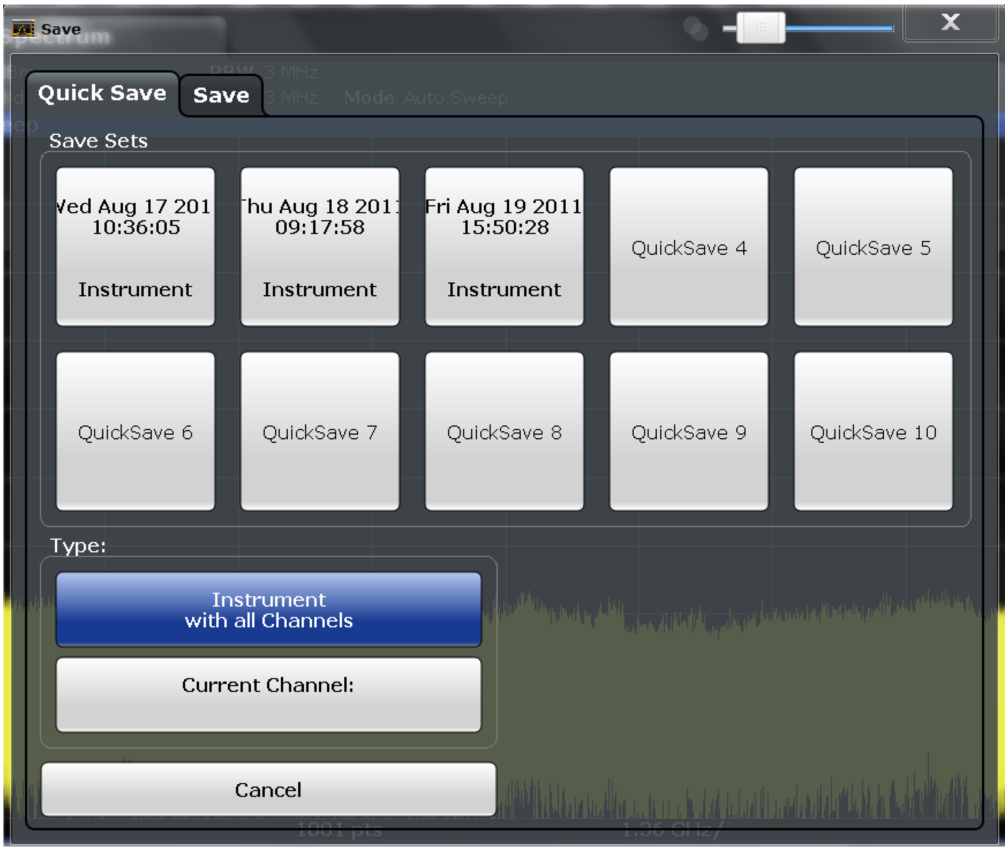
If a measurement channel with the same name as the channel to be restored is already active, the channel name for the new channel is extended by a consecutive number:

7.2.1.1 Quick Save / Quick Recall Dialog Boxes

The "QuickSave" dialog box is displayed when you select the "Save" icon in the toolbar.

The "Quick Recall" dialog box is displayed when you select the "Open" icon in the toolbar, or select the "Quick Recall" tab in the "Recall" dialog box.

Both dialog boxes are very similar and closely related.



QuickSave 1 / ... / QuickSave 10

Selects one of the save sets to store the current settings in or to be recalled. At the time of storage, the "QuickSave 1 / ... / QuickSave 10" placeholder is replaced by a label indicating the storage date and time and the storage type.

During recall, save sets of type "Instrument" replace the settings of the entire instrument. All other save sets start a new measurement channel with the stored settings.

Storage Type (Save only)

Defines which type of settings is to be stored in the save set.

"Instrument with all channels" The instrument settings for all currently active channels are stored.

"Current Channel" Only the instrument settings for the currently selected measurement channel are stored.

Recall

Restores the instrument settings as saved in the selected settings file. If the settings file contains settings for a specific channel only a new channel with the stored settings is activated, otherwise the entire instrument settings are loaded.

Note: After you use the "Recall" function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

Note: If a measurement channel with the same name as the channel to be restored (in a new channel) is already active, the channel name for the new channel is extended by a consecutive number:

In remote commands, you must append this number to the channel name, as well.

SCPI command:

`MMEMory:LOAD:STATe` on page 766

Cancel

Closes the dialog box without saving the settings.

7.2.2 Configurable Storage and Recall

The more sophisticated storage and recall functions allow you to define which settings are stored, and where the settings file is stored to. Any settings file can be selected for recall.

7.2.2.1 Stored Data Types

The following types of data can be stored to and loaded from files via the "Save" dialog box on the R&S FSW:

Table 7-2: Items that can be stored to files

Item	Description
Current Settings	Current instrument and measurement settings
All Transducers	Transducer factors for all active transducers.
All Traces	All active traces; R&S FSW-K30 only: also calibration data

Item	Description
All Limit Lines	All limit lines (Note: information on which limit lines are active is stored with the "Current Settings")
Noise - ENR	Data in "ENR Settings" dialog box (R&S FSW-K30 only)
Noise - Loss Settings	Data in "Loss Settings" dialog box (R&S FSW-K30 only)
Noise - Calibration data	Results from calibration measurement (R&S FSW-K30 only)
K40 Results	All current phase noise trace results (R&S FSW-K40 only)

7.2.2.2 Storage Location and File Name

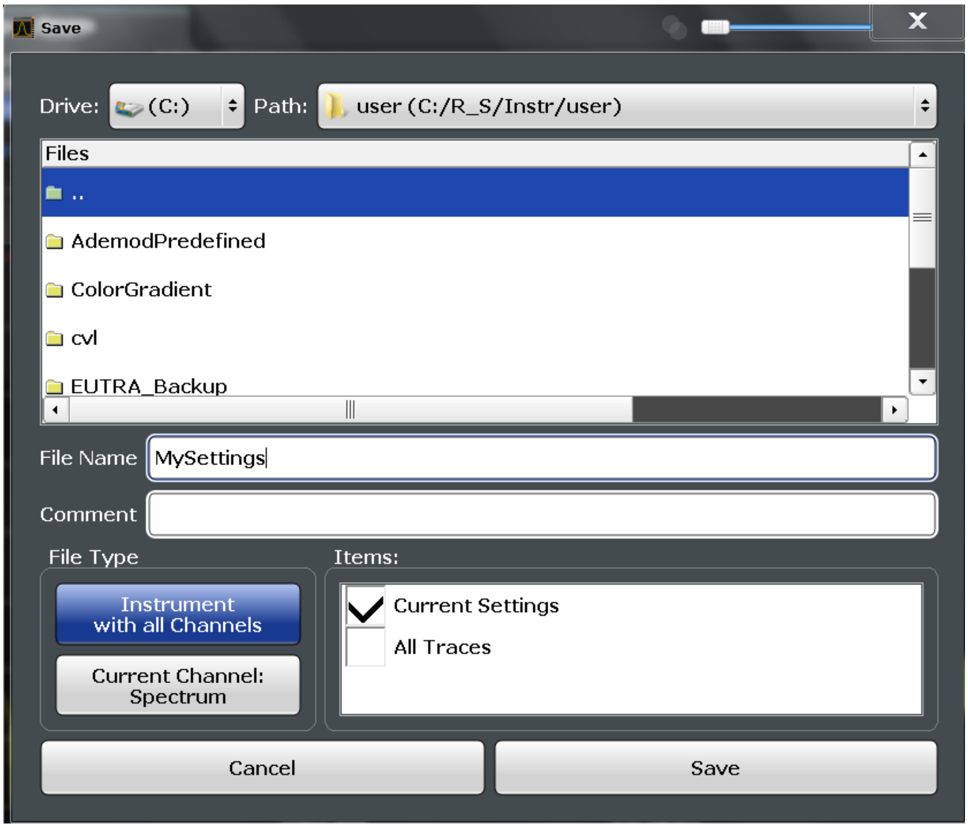
The data is stored on the internal flash disk or, if selected, on a memory stick or network drive. The operating system, firmware and stored instrument settings are located on drive C. All other folders and drives can be used to store measurement data.

The storage location and file name are selected in a file selection dialog box which is displayed when you perform a storage function.

By default, the name of a settings file consists of a base name followed by an underscore and three numbers, e.g. `limit_lines_005`. In the example, the base name is `limit_lines`. The base name can contain characters, numbers and underscores. The file extension `dfl` is added automatically. The default folder for settings files is `C:\r_s\instr\user`.

7.2.2.3 Save and Recall Dialog Boxes


The following dialog boxes are available via softkeys in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar. Both dialog boxes are very similar and closely related.



Selecting the Storage Location - Drive/ Path/ Files

Select the storage location of the settings file on the instrument or an external drive.

The "Drive" indicates the internal (C:) or any connected external drives (e.g. a USB storage device).

The "Path" contains the drive and the complete file path to the currently selected folder.

The "Files" list contains all subfolders and files of the currently selected path.

The default storage location for the SEM settings files is: `C:\R_S\instr\sem_std`.

SCPI command:

`MMEMory:CATalog?` on page 756

File Name

Contain the name of the data file without the path or extension.

By default, the name of a settings file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. `limit_lines_005`.

For details on the file name and location see chapter 7.2.2.2, "Storage Location and File Name", on page 369.

Comment
An optional description for the data file. A maximum of 60 characters can be displayed.

SCPI command:
`MMEMory:COMMent` on page 758

File Type
Determines whether the global instrument settings with all channels will be stored or recalled, or the current channel settings only.

Items
Defines which data and settings are stored or will be recalled. Depending on the "File Type", only channel settings or global settings are available. Which items are available also depends on the installed options (see also chapter 7.2.2.1, "Stored Data Types", on page 368).

SCPI command:
`MMEMory:SELect[:ITEM]:ALL` on page 762
`MMEMory:SELect[:ITEM]:DEFault` on page 762
`MMEMory:SELect[:ITEM]:HWSettings` on page 763
`MMEMory:SELect[:ITEM]:LINes:ALL` on page 763
`MMEMory:SELect[:ITEM]:NONE` on page 763
`MMEMory:SELect[:ITEM]:TRACe[:ACTive]` on page 764
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 764

Save File
Saves the settings file with the defined file name.

SCPI command:
`MMEMory:STORe:STATe` on page 767
`MMEMory:STORe:STATe:NEXT` on page 767

Recall in New Channel / Recall in Current Channel
Restores the instrument settings as saved in the selected settings file. If the settings file contains settings for a specific channel only, select "Recall in New Channel" to activate a new channel with the stored settings, or "Recall in Current Channel" to replace the current channel settings.

Note: After you use the "Recall" function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

Note: If a measurement channel with the same name as the channel to be restored (in a new channel) is already active, the channel name for the new channel is extended by a consecutive number:

In remote commands, you must append this number to the channel name, as well.

SCPI command:

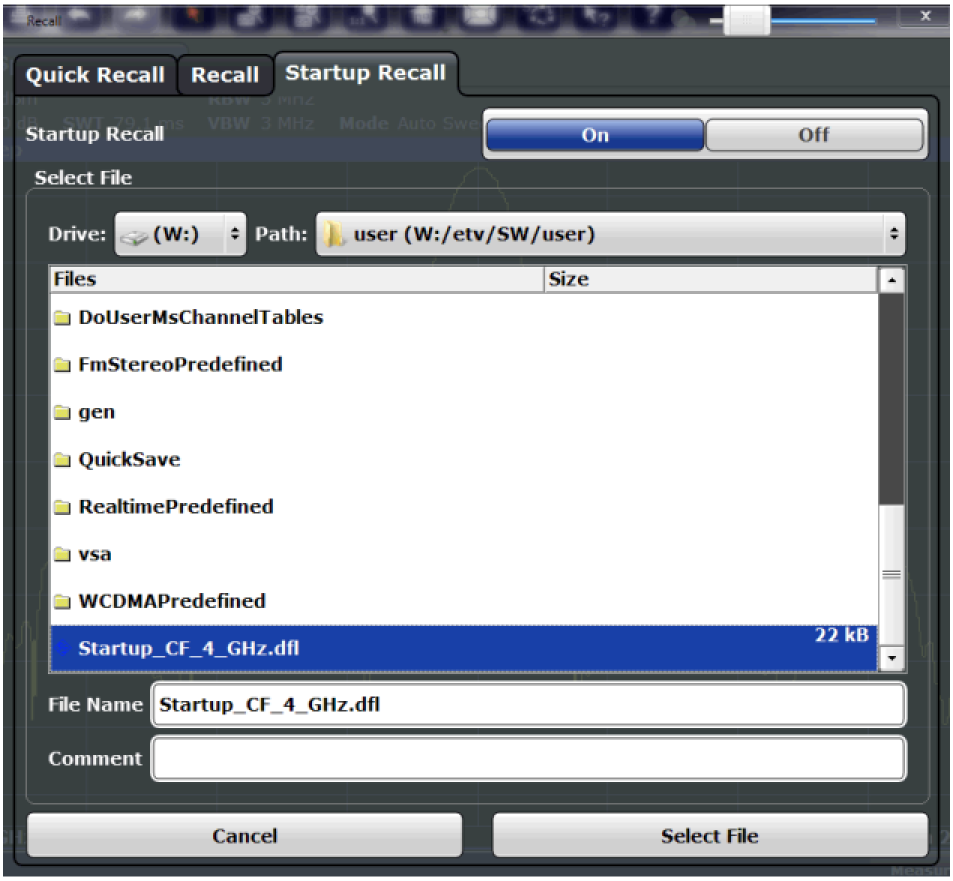
`MMEMory:LOAD:STATe` on page 766

Cancel

Closes the dialog box without saving the settings.

7.2.2.4 Startup Recall Settings

The "Startup Recall" softkey opens the "Startup Recall" tab of the "Recall" dialog box.



Startup Recall
Activates or deactivates the startup recall function. If activated, the settings stored in the selected file are loaded each time the instrument is started or preset. If deactivated, the default settings are loaded.

Note that only *instrument* settings files can be selected for the startup recall function, not channel settings files.

SCPI command:
`MMEMory:LOAD:AUTO` on page 765

Selecting the Storage Location - Drive/ Path/ Files
Select the storage location of the settings file on the instrument or an external drive.

The "Drive" indicates the internal (C:) or any connected external drives (e.g. a USB storage device).

The "Path" contains the drive and the complete file path to the currently selected folder.

The "Files" list contains all subfolders and files of the currently selected path.

The default storage location for the SEM settings files is: `C:\R_S\instr\sem_std`.

SCPI command:
`MMEMory:CATalog?` on page 756

File Name
Contain the name of the data file without the path or extension.

By default, the name of a settings file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. `limit_lines_005`.

For details on the file name and location see chapter 7.2.2.2, "Storage Location and File Name", on page 369.

Comment
An optional description for the data file. A maximum of 60 characters can be displayed.

SCPI command:
`MMEMory:COMMent` on page 758

Cancel
Closes the dialog box without saving the settings.

7.2.3 How to Save and Load Instrument Settings

Instrument settings can be saved to a file and loaded again later, so that you can repeat the measurement with the same settings. Optionally, user-defined measurement settings can automatically be restored each time you start or preset the instrument.

To save and recall instrument settings using the Quick Save function

1. Select the "Save" icon from the toolbar.

2. Select whether the instrument settings for **all** channels are to be stored, or only those for the **current** channel.
3. Select one of the save sets in which the settings are to be stored ("QuickSaveX").

   The selected settings are stored to the file `C:\r_s\instr\user\QuickSave\QuickSaveX.dfl`.
4. To restore the settings, select the "Open" icon from the toolbar.
5. Select the save set in which the settings were stored ("QuickSaveX").

   The selected settings are restored to the instrument or channel.

To save configurable instrument settings

1. Select the "Save" icon from the toolbar.
2. In the "Save" dialog box, switch to the "Save" tab.
3. In the file selection dialog box, select a file name and storage location for the settings file.
4. Optionally, define a comment to describe the stored settings.
5. Select whether the instrument settings for **all** channels are to be stored, or only those for the **current** channel.
6. Select the items to be saved with the settings. Either the settings for the currently selected channel only or for all channels can be stored, and various other items such as lines or traces etc. can be stored as well (see chapter 7.2.2.1, "Stored Data Types", on page 368).
7. Select "Save".

   A file with the defined name and path and the extension `.dfl` is created.

To recall configurable instrument settings

1. Select the "Open" icon from the toolbar.
2. In the "Recall" dialog box, switch to the "Recall" tab.
3. In the file selection dialog box, select the file name and storage location of the settings file.

   Note: The "File Type" indicates whether the file contains instrument settings for **all** channels, or only those for the current channel.
4. If several items were saved, select which items are to be restored.
5. If channel settings were saved, select whether the settings will replace the settings in the current channel, or whether a new channel with the saved settings will be opened.

6. Select "Recall".

   The settings and selected items from the saved measurement are restored and you can repeat the measurement with the same settings.

To recall settings automatically after preset or reboot

You can define the settings that are restored when you preset or reboot the instrument.

1. Configure the settings as required and save them as described in "To save configurable instrument settings" on page 374.
2. In the "Save/Recall" menu, select the "Startup Recall" softkey.
3. If the file selection dialog box is not displayed automatically, select the "Select Dataset" softkey.
4. Select the recall settings that are to be restored.
5. Tap "Select".
6. Toggle the "Startup Recall" softkey to "On".

   Now when you press the PRESET key or reboot the instrument, the defined settings will be restored.
7. To restore the factory preset settings, toggle the "Startup Recall" softkey to "Off".

7.3 Importing and Exporting Measurement Results for Evaluation

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

The following data types can be exported:

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

The following data types can be imported:

- I/Q data

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

See the corresponding user manuals for those applications for details.

7.3.1 Import/Export Functions

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

Some functions for particular data types are (also) available via softkeys or dialog boxes in the corresponding menus, e.g. trace data or marker peak lists.

For a description of the other functions in the "Save/Recall" menu see the R&S FSW User Manual.

Export
Opens a submenu to configure data export.

Export Trace to ASCII File ← Export
Opens a file selection dialog box and saves the selected trace in ASCII format (`.dat`) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation may take some time.

For details on the file format see chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378.

SCPI command:
`MMEMory:STORe<n>:TRACe` on page 776
`MMEMory:STORe:SGRam` on page 776

Trace Export Configuration ← Export
Opens the "Traces" dialog box to configure the trace and data export settings. See chapter 6.3.2.3, "Trace Export Settings", on page 299.

IQ Export ← Export
Opens a file selection dialog box to select an export file to which the IQ data will be stored. This function is only available in single sweep mode, and only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

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

Import
Provides functions to import data.

Currently, only I/Q data can be imported, and only by applications that process I/Q data.

See the R&S FSW I/Q Analyzer User Manual for more information.

7.3.2 How to Export Trace Data and Numerical Results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point the measured trace position and value are output. The file is stored with a `.DAT` extension. For details on the storage format see chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378.

For the results of a Spectrum Emission Mask (SEM) or Spurious Emissions measurement, special file export functions are available, see chapter 4.5.6.2, "How to Save SEM Result Files", on page 119(SEM) and "Saving the Evaluation List" on page 136 (Spurious).

To export trace data and table results

Trace data can be exported either from the "Trace" menu, or from the "Save/Recall" menu.

1. Press the TRACE key, then select the "Trace Config" softkey and switch to the "Trace/Data Export" tab.
   Or:
   Select the "Save" icon in the toolbar, then select the "Export" softkey.
2. Select the "Export Config" softkey to configure the export settings.
   a) Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".
   b) Optionally, select the "Include Instrument Measurement Settings" option to insert additional information in the export file header.
   c) If necessary, change the decimal separator to be used for the ASCII export file.
3. Select the "Export Trace to ASCII file" button.
4. In the file selection dialog box, select the storage location and file name for the export file.

5. Select "Save" to close the dialog box and export the data to the file.

7.3.3 How to Export a Peak List

You can save the results of a marker peak list to an ASCII file.

1. Press the MKR FUNCT key.
2. Select the "Marker Peak List" softkey.
3. Configure the peak search and list settings as described in "Marker Peak List Configuration" on page 344.
4. Set the marker peak list "State" to "On".
5. Press the RUN SINGLE key to perform a single sweep measurement and create a marker peak list.
6. Select the "Marker Peak List" softkey to display the "Marker Peak List" dialog box again.
7. If necessary, change the decimal separator to be used for the ASCII export file.
8. Select the "Export Peak List" button.
9. In the file selection dialog box, select the storage location and file name for the export file.
10. Select "Save" to close the dialog box and export the peak list data to the file.

7.3.4 Reference: File Format Descriptions

This reference describes in detail the format of the export files for result data.

For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see chapter 4.5.7, "Reference: SEM File Descriptions", on page 120.

The file format for Spurious Emissions measurement results is described in chapter 4.6.6, "Reference: ASCII Export File Format (Spurious)", on page 137.

7.3.4.1 Reference: ASCII File Export Format

Trace data can be exported to a file in ASCII format for further evaluation in other applications

(For details see chapter 7.3.2, "How to Export Trace Data and Numerical Results", on page 377).

The file consists of the header containing important scaling parameters and a data section containing the trace data. Optionally, the header can be excluded from the file (see "Include Instrument Measurement Settings" on page 300).

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace), followed by the measured data in one or several columns (depending on the measurement) which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs may require a different handling of the decimal point. Thus you can define the decimal separator to be used (decimal point or comma, see "Decimal Separator" on page 300).

If the spectrogram display is selected when you select the "ASCII Trace Export" softkey, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Table 7-3: ASCII file format for trace export

File contents	Description
Header data	
Type;R&S FSW;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Rf Att;20;dB	Input attenuation
El Att;2.0;dB	Electrical attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth

File contents	Description
SWT;0.005;s	Sweep time
Sweep Count;20;	Number of sweeps set
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Data section for individual window	
Window;1;Frequency Sweep	Window number and name
Trace 1;;	Selected trace
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAX-HOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVER-AGE,RMS,SAMPLE,QUASIPEAK
Values; 1001;	Number of measurement points
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ..;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

Table 7-4: ASCII file format for spectrogram trace export

File contents	Description
Header	
Type;R&S FSW;	Instrument model

File contents	Description
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;**SPECTROGRAM**	Operating mode
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Ref Position;75; %	Position of reference level referred to diagram limits (0 % = lower edge)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
Rf Att;20;dB	Input attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPEAK
Sweep Count;20;	Number of sweeps set
Data section	
Trace 1:;;	Selected trace
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points
Frames;2;	**Number of exported frames**
Frame;0;	**Most recent frame number**
Timestamp;17.Mar 11;11:27:05.990	**Timestamp of this frame**

File contents	Description
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values, identical to spectrum data: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Frame;-1;	**Next frame**
Timestamp;17.Mar 11;11:27:05.342	**Timestamp of this frame**
...	

7.4 Creating Screenshots of Current Measurement Results and Settings

In order to document the graphical results and the most important settings for the currently performed measurement, you can create a hardcopy or screenshot of the current display. Screenshots can either be printed or stored to a file.

7.4.1 Print and Screenshot Settings

The settings for saving and printing screenshots are configured via the "Print" menu which is displayed when you select the "Print" icon in the toolbar.

For step-by-step instructions see chapter 7.4.2, "How to Store or Print Screenshots of the Display", on page 386.

Remote commands for these settings are described in chapter 10.7.4, "Storing or Printing Screenshots", on page 768.

To print a screensot of the current display with the current settings immediately, without switching to the "Print" menu, use the "Print immediately" icon at the right-hand side of the toolbar.

Printing or Storing a Screenshot (Print Screen)

Starts to print out or store all measurement results displayed on the screen: diagrams, traces, markers, marker lists, limit lines, etc., including the channel and status bars. Optionally, comments and the date and time are included at the bottom margin of the printout. All displayed items belonging to the software user interface (e.g. softkeys or dialog boxes) are not printed out.

Whether the output is sent to the printer or stored in a file or the clipboard depends on the selected device and the device settings.

If the output is stored to a file, a file selection dialog box is opened to select the file name and location. The default path is `C:\r_s\instr\user`.

The "Print" menu is displayed to configure printing.

SCPI command:

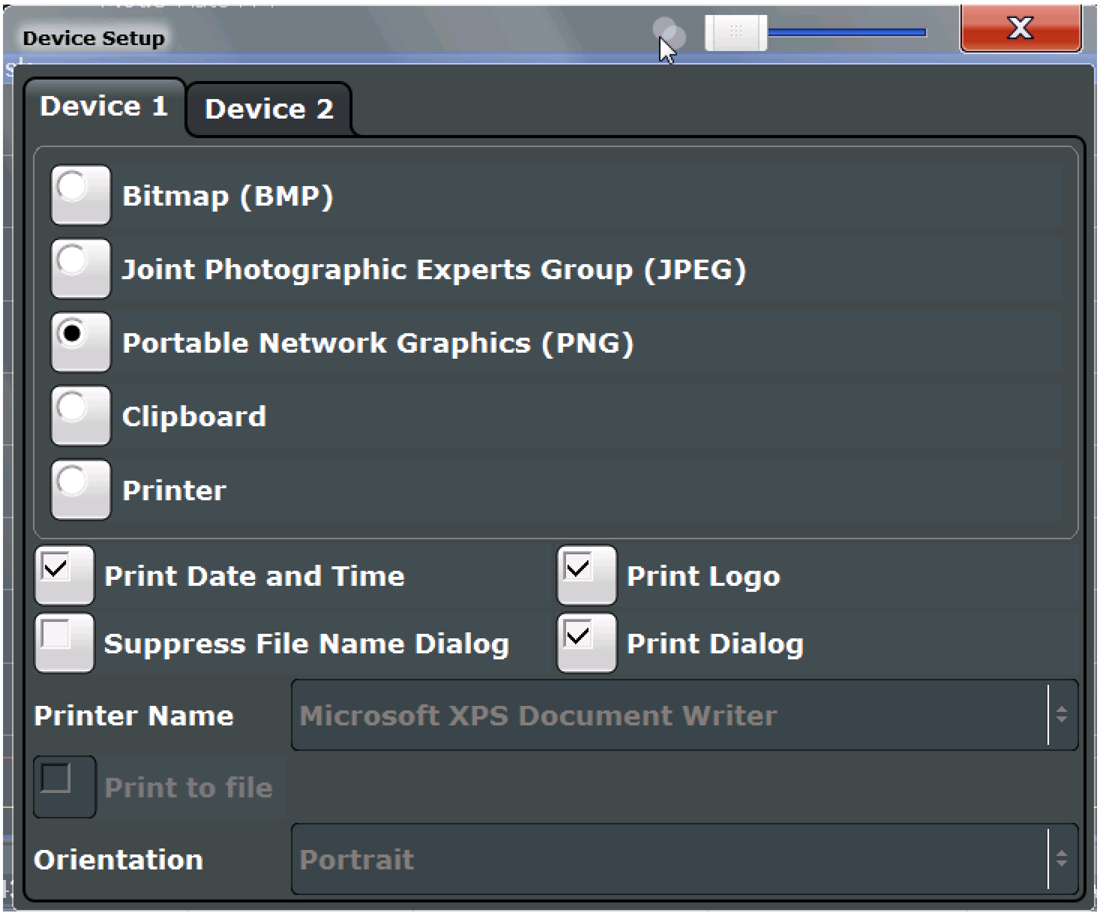
`HCOPy:ITEM:ALL` on page 772

`HCOPy[:IMMediate<device>]` on page 771

`HCOPy[:IMMediate<device>]:NEXT` on page 772

Device Setup

Defines the behavior of the "Print Screen" function, depending on which device is selected. Two different devices can be configured, e.g. one for printing and one for storage to a file.



Output Medium ← Device Setup

Defines the medium to which the screenshot is printed or stored.

"File formats"	Stores the screenshot to a file in the selected format. The file name is queried at the time of storage.
"Clipboard"	Stores the screenshot to the clipboard.
"Printer"	Prints the screenshot on the printer selected from the "Name" list.

SCPI command:

`HCOPy:DEVice:LANGuage<device>` on page 771

Print Date and Time ← Device Setup

Activates/deactivates the printout of the current date and time at the bottom of the screenshot.

Print Logo ← Device Setup

Activates/deactivates the printout of the Rohde & Schwarz company logo in the upper left corner.

Suppress File Name Dialog ← Device Setup
When the screenshot is stored to a file, the file selection dialog box is not displayed. Instead, the current storage location and file name are used (default: `C:\r_S\instr\user`). Each new the file name is extended by a consecutive number, e.g. `File002`, `File003` etc.

Print Dialog ← Device Setup
Includes any currently displayed dialog in the screenshot.

Printer Name ← Device Setup
Defines the printer to print to.

SCPI command:
`SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]?` on page 773
`SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?` on page 773
`SYSTem:COMMunicate:PRINter:SELect<device>` on page 773

Print to File ← Device Setup
If a printer is selected as the output medium, use this option to store the data in a `.prn` file using the selected printer driver.

Orientation ← Device Setup
Selects the page orientation of the printout: portrait or landscape (printer only)

SCPI command:
`HCOPy:PAGE:ORIentation<device>` on page 772

Device
Two different printout devices can be configured, e.g. one for printing and one for storage to a file. When the "Print Screen" function is executed, the selected device and its settings determine the behavior.

SCPI command:
`HCOPy:DESTination<device>` on page 770

Colors
Opens the "Print Color" dialog box to configure the colors for printing screenshots. For details see chapter 8.4.3, "Display Theme and Colors", on page 416.

Comment
Defines an optional comment to be printed with the screenshot of the display. Maximum 120 characters are allowed. 60 characters fit in one line. In the first line, at any point a manual line-feed can be forced by entering "@".

Date and time are inserted automatically. The comment is printed below the diagram area, but not displayed on the screen. If a comment should not be printed, it must be deleted.

SCPI command:
`HCOPy:ITEM:WINDow:TEXT` on page 772

Install Printer

Opens the standard Windows dialog box to install a new printer. All printers that are already installed are displayed.

Only user accounts with administrator rights can install a printer.

For further information refer to the Microsoft Windows documentation.

7.4.2 How to Store or Print Screenshots of the Display

► If the R&S FSW has already been set up according to your current requirements, simply press the "Print immediate" icon ( ) at the far right end of the toolbar.

A screenshot of the current measurement display is printed or stored to a file, as configured.

To set up screenshot outputs

This configuration assumes a printer has already been installed. To install a new printer, use the Install Printer softkey.

1. Select the "Printer" tool in the toolbar.
2. Select the "Device Setup" softkey.
3. Select the tab for Device 1 or Device 2 to configure a device.
4. To set up the print function to store a screenshot to a file, select the required file format as the output medium.
   To set up the print function to store a screenshot to the clipboard, select "Clip-board" as the output medium.
   To set up the print function to print a screenshot on a printer, select "Printer" as the output medium and an installed printer from the "Name" list.
5. For printout, select the page orientation.
6. Optionally, deactivate the date and time or the logo so they are not added to the screenshot.
7. Select "OK" to close the "Device Setup" dialog box.
8. Toggle the "Device" softkey to the device configuration you want to use.
9. Optionally, configure the colors to be used for printout, e.g. as displayed on the screen instead of inversed.
10. Optionally, add a comment to be included with the screenshot.
11. Select the "Print Screen" softkey or the "Printer" or "Screenshot" tool in the toolbar to execute the print function and check the results.
12. If you configured the print function to store the screenshot to a file, enter a file name in the file selection dialog box.

8 General Instrument Setup

Some basic instrument settings can be configured independantly of the selected operating mode or application. Usually, you will configure most of these settings initially when you set up the instrument according to your personal preferences or requirements and then only adapt individual settings to special circumstances when necessary. Some special functions are provided for service and basic system configuration.

8.1 Basics on Alignment

When you put the instrument into operation for the first time or when strong temperature changes occur, it may be necessary to align the data to a reference source (see also "Temperature check" on page 388).

During instrument start, the installed hardware is checked against the current firmware version to ensure the hardware is supported. If not, an error message is displayed ("WRONG_FW") and you are asked to update the firmware. Until the firmware version is updated, self-alignment fails.

The correction data and characteristics required for the alignment are determined by comparison of the results at different settings with the known characteristics of the high-precision calibration signal source at 64 MHz.

Alignment results

The alignment results are displayed and contain the following information:

- date and time of last correction data record
- overall results of correction data record
- list of found correction values according to function/module

The results are classified as follows:

PASSED	Calibration successful without any restrictions
CHECK	Deviation of correction value larger than expected, correction could however be performed
FAILED	Deviations of correction value too large, no correction was possible. The found correction data is not applicable.

The results are available until the next self-alignment process is started or the instrument is switched off.

Temperature check

During self-alignment, the instrument's (frontend) temperature is also measured (as soon as the instrument has warmed up completely). This temperature is used as a reference for a continuous temperature check during operation. If the current temperature deviates from the stored self-alignment temperature by a certain degree, a warning is displayed in the status bar indicating the resulting deviation in the measured power levels. A status bit in the `STATUs:QUEStionable:TEMPerature` register indicates a possible deviation. The current temperature of the RF Frontend can be queried using a remote command (see `SOURce:TEMPerature:FRONtend?` on page 785).

Touch screen alignment

When the device is delivered, the touch screen is initially calibrated. However, to ensure that the touch screen responds to the finger contact correctly, a touch screen alignment is required.

Alignment of the touch screen is useful:

- At first use
- After an image update or after exchanging a hard disk
- If you notice that touching a specific point on the screen does not achieve the correct response
- If the position of the instrument has been changed and you cannot look straight on the screen
- If another person operates the instrument

8.2 Basics on Transducer Factors

The transducer allows you to manipulate the trace at discrete trace points to correct the signal coming from an input device. Transducers are often used to correct the frequency response for antennas, for example. The transducer is configured by defining transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line and can be stored on the instrument.

In the Spectrum application, the correction factor from all active transducers is calculated for each displayed trace point once in advance and is added to the result of the level measurement during the sweep. If the sweep range changes, the correction values are calculated again. If several measured values are combined in one point, only one value is taken into consideration. If the active transducer line is not defined for the entire sweep range, the missing values are replaced by zeroes.

When a transducer is used, the trace is shifted by a calculated factor. However, an upward shift reduces the dynamic range for the displayed values. Thus, the reference level can be adapted automatically to restore the original dynamic range. The reference level is shifted by the maximum transducer factor. By default, if transducers are active the reference level function is adapted automatically to obtain the best dynamic performance.

If a transducer factor is active, "TDF" is displayed in the channel bar.

Y-Axis Unit

The individual transducer factors can be defined as absolute values or relative (dB) values. However, all factors for one transducer line use the same unit. As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings since the R&S FSW and the active transducer are regarded as one measuring instrument. Only for relative transducer factors (unit dB), the unit originally set on the instrument is maintained and can be changed.

When all transducers have been switched off, the R&S FSW returns to the unit that was used before a transducer was activated.

Configuration

The R&S FSW supports transducer lines with a maximum of 1001 data points. Eight of the transducer lines stored in the instrument can be activated simultaneously. The number of transducer lines stored in the instrument is only limited by the capacity of the storage device used.

A transducer line consists of the following data:

- A maximum of 1001 data points with a position and value
- A unit for the values
- A name to distinguish the transducer lines

Validity

The transducer factors must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSW since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

8.3 General Instrument Settings

Instrument settings can be configured via the SETUP key.

Network and Remote Settings, Display Settings

Settings for network and remote operation are described in chapter 9, "Network and Remote Operation", on page 428.

Display settings are described in chapter 8.4, "Display Settings", on page 410.

8.3.1 Reference Frequency Settings

The reference frequency settings are defined in the "Reference" dialog box which is displayed when you press the SETUP key and then select "Reference".

Reference Frequency Input

The R&S FSW can use the internal reference source or an external reference source as the frequency standard for all internal oscillators. A 10 MHz crystal oscillator is used as the internal reference source. In the external reference setting, all internal oscillators of the R&S FSW are synchronized to the external reference frequency. External references are connected to one of the REF INPUT or the SYNC TRIGGER connectors on the rear panel. For details see the "Getting Started" manual.

Note: Optionally (R&S FSW-B4), the more precise OCXO signal can replace the internal reference source.

The default setting is the internal reference. When an external reference is used, "EXT REF" is displayed in the status bar.

The following reference inputs are available:

Table 8-1: Available Reference Frequency Input

Source	Frequency	Tuning Range	Loop Bandwidth	Description
Internal	10 MHz	-	1-100 Hz	Internal reference signal or OCXO (option R&S FSW-B4)
External Reference 10 MHz	10 MHz	+/- 6 ppm	1-100 Hz	External reference from REF INPUT 1..20 MHZ connector; Fixed external 10 MHZ reference frequency. Good phase noise performance
External Reference 1..20 MHz	1..20 MHz in 1 Hz steps	+/- 0.5 ppm	0.1 Hz (fixed)	Variable external reference frequency in 0.1 Hz steps from REF INPUT 1..20 MHZ connector; Good external phase noise suppression. Small tuning range.
		+/- 6 ppm	1-30 Hz	Variable external reference frequency in 0.1 Hz steps from REF INPUT 1..20 MHZ connector; Wide tuning range.
External Reference 100 MHz	100 MHz	+/- 6 ppm	1-300 Hz	External reference from REF INPUT 100 MHZ connector Good phase noise performance
Sync Trigger	100 MHz	+/- 6 ppm	1-300 Hz	External reference from SYNC TRIGGER INPUT connector

SCPI command:

`[SENSe:]ROSCillator:SOURce` on page 781
`SOURce:EXTernal:ROSCillator:EXTernal:FREQuency` on page 781

Behavior in case of missing external reference ← Reference Frequency Input

If an external reference is selected but none is available, there are different ways the instrument can react.

"Show Error Flag" The message "NO REF" is displayed to indicate that no synchronization is performed.

"Switch to internal reference" The instrument automatically switches back to the internal reference if no external reference is available. Note that you must re-activate the external reference if it becomes available again at a later time.

SCPI command:
[SENSe:]ROSCillator:SOURce on page 781
[SENSe:]ROSCillator:SOURce:EAUTo? on page 782

Tuning Range ← Reference Frequency Input
The tuning range is only available for the variable external reference frequency. It determines how far the frequency may deviate from the defined level in parts per million (10^{-6}).

"+/- 0.5 ppm" With this smaller deviation a very narrow fixed loop bandwidth of 0.1 Hz is realized. With this setting the instrument can synchronize to an external reference signal with a very precise frequency. Due to the very narrow loop bandwidth, unwanted noise or spurious components on the external reference input signal are strongly attenuated. Furthermore, the loop requires about 30 seconds to reach a locked state. During this locking process, "NO REF" is displayed in the status bar.

"+/- 6 ppm" The larger deviation allows the instrument to synchronize to less precise external reference input signals.

Frequency ← Reference Frequency Input
Defines the external reference frequency to be used (for variable connectors only).

Loop Bandwidth ← Reference Frequency Input
Defines the speed of internal synchronization with the reference frequency. The setting requires a compromise between performance and increasing phase noise.

For a variable external reference frequency with a narrow tuning range (+/- 0.5 ppm), the loop bandwidth is fixed to 0.1 Hz and cannot be changed.

Reference Frequency Output
A reference frequency can be provided by the R&S FSW to other devices that are connected to this instrument. If one of the following options is activated, the reference signal is output to the corresponding connector.

"Output 100 MHz"
Provides a 100 MHz reference signal to the REF OUTPUT 100 MHZ connector.

"Ouput 640 MHz"
Provides a 640 MHz reference signal to the REF OUTPUT 640 MHZ connector.

"Output Sync Trigger"
Provides a 100 MHz reference signal to the SYNC TRIGGER OUTPUT connector.

SCPI command:
[SENSe:]ROSCillator:O100 on page 780
[SENSe:]ROSCillator:O640 on page 780
[SENSe:]ROSCillator:SYNC on page 783

Resetting the Default Values
The values for the "Tuning Range", "Frequency" and "Loop Bandwidth" are stored for each source of "Reference Frequency Input". Thus, when you switch the input source, the previously defined settings are restored. You can restore the default values for all input sources using the "Preset Channel" function.

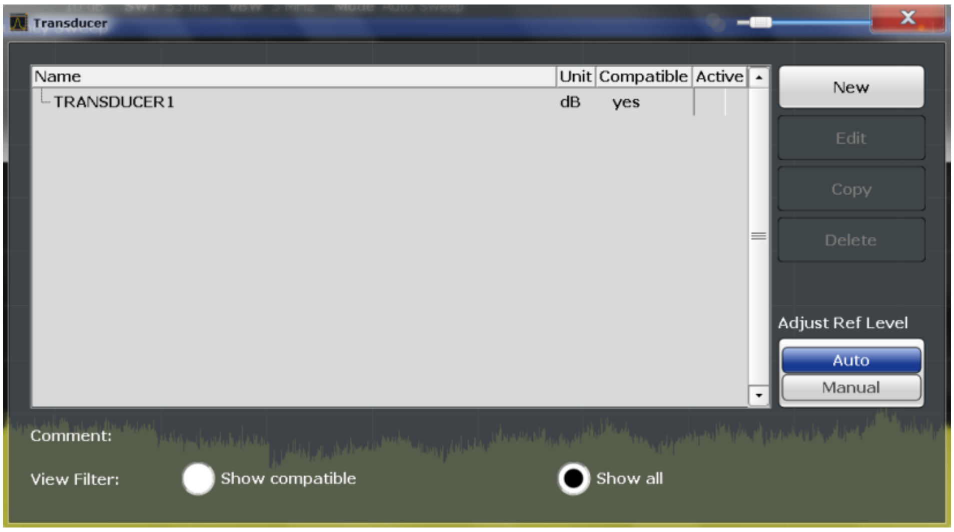
8.3.2 Transducer Settings

Up to 8 transducer lines can be activated simultaneously in the R&S FSW. Many more can be stored on the instrument.

The transducer settings are defined in the "Transducer" dialog box which is displayed when you press the SETUP key and then select "Transducer".

8.3.2.1 Transducer Management

The settings required to manage all transducer lines on the instrument are described here.



For the transducer line overview, the R&S FSW searches for all stored transducer lines with the file extension `.TDF` in the `trd` subfolder of the main installation folder. The overview allows you to determine which transducer lines are available and can be used for the current measurement.

For details on settings for individual lines see chapter 8.3.2.2, "Transducer Factors", on page 395.

For instructions on configuring and working with transducers see chapter 8.6.5, "How to Configure the Transducer", on page 423.

Name
The name of the stored transducer line.

Unit
The unit in which the y-values of the data points of the transducer line are defined.

The following units are available:
- dB
- dBm
- dBmV
- dBµV
- dBµV/m
- dBµA
- dBµA/m
- dBpW
- dBpT

Compatibility
Indicates whether the transducer factors are compatible with the current measurement settings.

For more information on which conditions a transducer line must fulfill to be compatible, see chapter 8.2, "Basics on Transducer Factors", on page 388.

Activating/Deactivating
Activates/deactivates the transducer line. Up to 8 transducer lines can be active at the same time.

SCPI command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 787
`[SENSe:]CORRection:TRANsducer[:STATe]` on page 787

Comment
An optional description of the transducer line.

Included Lines in Overview (View Filter)
Defines which of the stored lines are included in the overview. The view can be restricted to compatible lines only or include all lines found. Whether a line is compatible or not is indicated in the Compatibility setting.

Adjusting the Reference Level
Activates or deactivates the automatic adjustment of the reference level to the selected transducer factor.

"Auto" Activates the automatic adjustment. The original dynamic range is restored by shifting the reference level by the maximum transducer factor.

"Man" Deactivates the automatic adjustment. Adjust the reference level via the "Amplitude" menu.

SCPI command:
`[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe]` on page 785

Create New Line
Create a new transducer line.

SCPI command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 787

Edit Line
Edit an existing transducer line configuration.

Copy Line
Copy the selected transducer line configuration to create a new line.

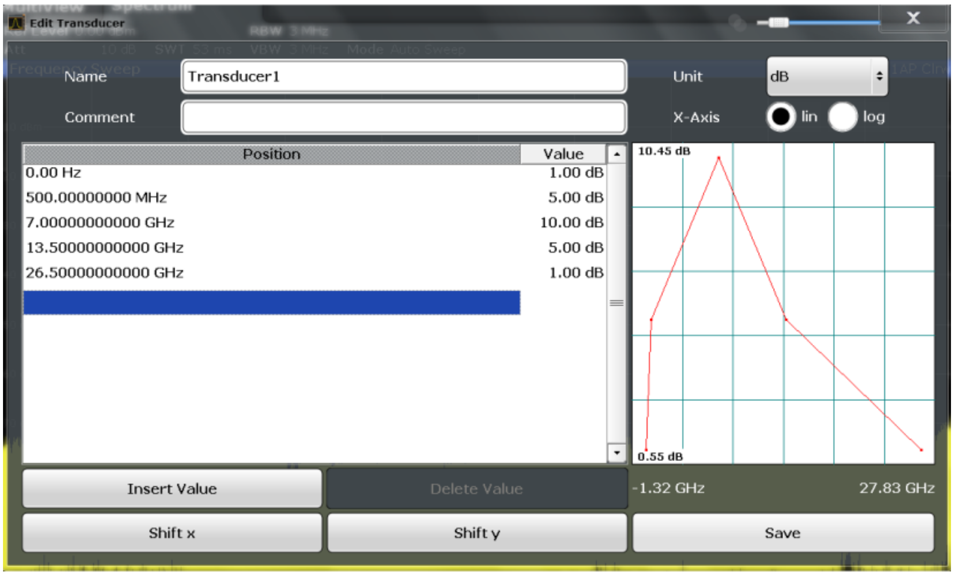
Delete Line
Delete the selected transducer line.

SCPI command:
`[SENSe:]CORRection:TRANsducer:DELete` on page 786

8.3.2.2 Transducer Factors

The settings and functions available for individual transducer lines are described here.

For instructions on creating and editing transducer lines see chapter 8.6.5, "How to Configure the Transducer", on page 423.



Name

Defines the transducer line name. All names must be compatible with the Windows7 conventions for file names. The transducer data is stored under this name (with a `.TDF` extension) in the `trd` subfolder of the main installation folder.

SCPI command:

`[SENSe:]CORRection:TRANsducer:SELect` on page 787

Comment

Defines an optional comment for the transducer line. The text may contain up to 40 characters.

SCPI command:

`[SENSe:]CORRection:TRANsducer:COMMent` on page 786

Unit

The unit in which the y-values of the data points of the transducer line are defined.

As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings unless dB is used.

SCPI command:

`[SENSe:]CORRection:TRANsducer:UNIT` on page 787

X-Axis Scaling
Describes the scaling of the horizontal axis on which the data points of the transducer line are defined. Scaling can be linear or logarithmic.

SCPI command:
`[SENSe:]CORRection:TRANsducer:SCALing` on page 786

Data points
Each transducer line is defined by a minimum of 2 and a maximum of 50 data points. Each data point is defined by its position (x-axis) and value (y-value).

The data points must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSW since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

SCPI command:
`[SENSe:]CORRection:TRANsducer:DATA` on page 786

Insert Value
Inserts a data point in the transducer line above the selected one in the "Edit Transducer" dialog box.

Delete Value
Deletes the selected data point in the "Edit Transducer" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width.

Shift y
Shifts the y-value of each data point vertically by the defined shift width.

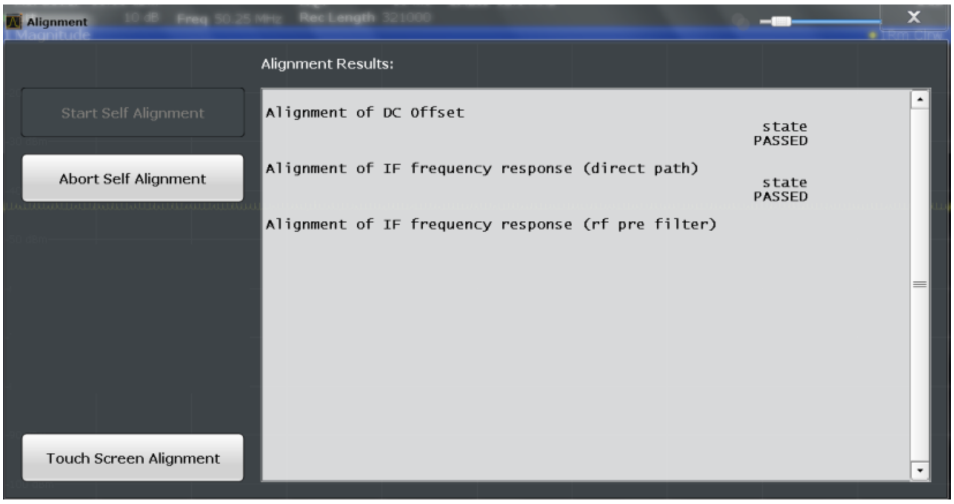
Save
Saves the currently edited transducer line under the name defined in the "Name" field.

SCPI command:
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 764
`MMEMory:STORe:STATe` on page 767

8.3.3 Alignment Settings

Both the instrument and the touch screen can be aligned when necessary (see chapter 8.1, "Basics on Alignment", on page 387).

The alignment settings are defined in the "Alignment" dialog box which is displayed when you press the SETUP key and then select "Alignment".



Starting a Self-alignment

Starts recording correction data for the instrument. If the correction data acquisition fails or if the correction values are deactivated, a corresponding message is displayed in the status field.

For details see chapter 8.1, "Basics on Alignment", on page 387.

Note:

A running Sequencer operation is aborted when you start a self-alignment.

SCPI command:

`*CAL?` on page 494

Aborting the Self-alignment

As long as the self-alignment data is being collected the procedure can be cancelled using the "Abort Self-alignment" button.

SCPI command:

`ABORt` on page 508

Starting the Touch Screen Alignment

Starts the touch screen alignment.

Tap the 4 markers on the screen as you are asked to do. The touch screen is aligned according to the executed pointing operations.

Alignment Results

Information on whether the alignment was performed succesfully and on the applied correction data is displayed. The results are available until the next self-alignment process is started or the instrument is switched off.

8.3.4 System Configuration Settings

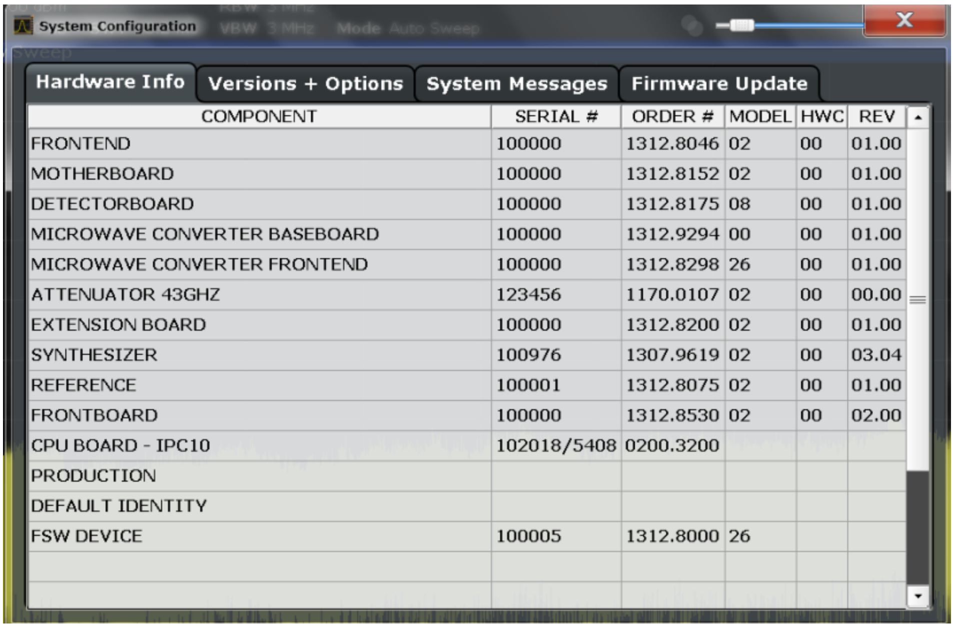
The system configuration information and settings are provided in the "System Configuration" dialog box which is displayed when you press the SETUP key and then select "System Configuration".

8.3.4.1 Hardware Information

An overview of the installed hardware in your R&S FSW is provided in the "Hardware Info" tab of the "System Configuration" dialog box.

Every listed component is described by its serial number, order number, model information, hardware code, and hardware revision.

This information can be useful when problems occur with the instrument and you require support from Rohde & Schwarz.



COMPONENT	SERIAL #	ORDER #	MODEL	HWC	REV
FRONTEND	100000	1312.8046	02	00	01.00
MOTHERBOARD	100000	1312.8152	02	00	01.00
DETECTORBOARD	100000	1312.8175	08	00	01.00
MICROWAVE CONVERTER BASEBOARD	100000	1312.9294	00	00	01.00
MICROWAVE CONVERTER FRONTEND	100000	1312.8298	26	00	01.00
ATTENUATOR 43GHZ	123456	1170.0107	02	00	00.00
EXTENSION BOARD	100000	1312.8200	02	00	01.00
SYNTHESIZER	100976	1307.9619	02	00	03.04
REFERENCE	100001	1312.8075	02	00	01.00
FRONTBOARD	100000	1312.8530	02	00	02.00
CPU BOARD - IPC10	102018/5408	0200.3200			
PRODUCTION					
DEFAULT IDENTITY					
FSW DEVICE	100005	1312.8000	26		

SCPI command:

`DIAGnostic:SERVice:HWINfo?` on page 799

8.3.4.2 Information on Versions and Options

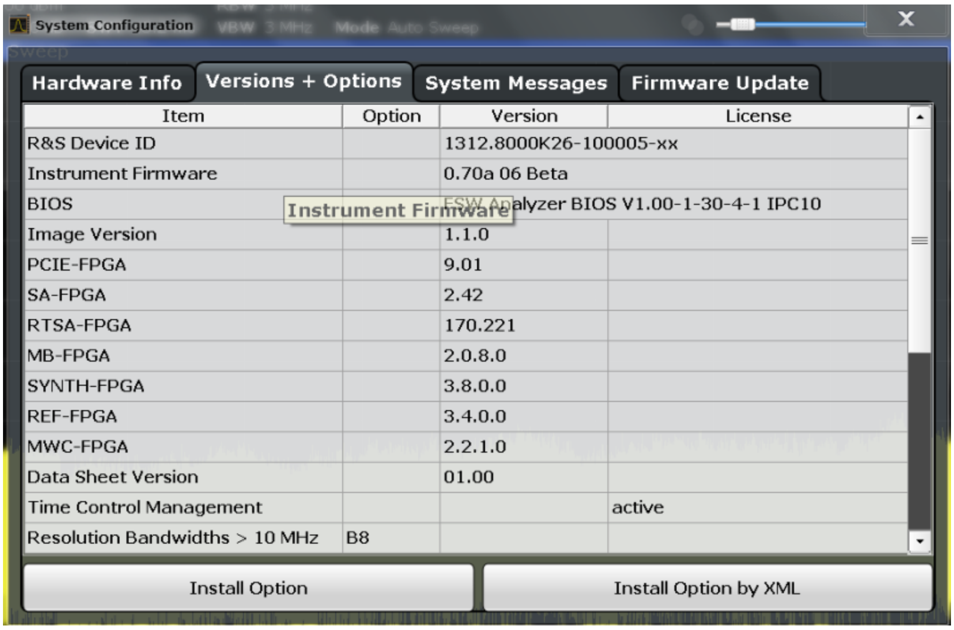
Information on the firmware version and options installed on your instrument is provided in the "Versions Options" tab of the "System Configuration" dialog box. The unique R&S device ID is also indicated here, as it is required for license and option administration.

You can also install new firmware options in this dialog box.

Expired option licenses

If an option is about to expire, a message box is displayed to inform you. You can then use the "Install Option" function to enter a new license key.

If an option has already expired, a message box appears for you to confirm. In this case, all instrument functions are unavailable (including remote control) until the R&S FSW is rebooted. You must then use the "Install Option" function to enter the new license key.



For details on options refer to the "Getting Started" manual, "Checking the Supplied Items".

SCPI commands:

`SYSTem:FORMat:IDENt` on page 801

`DIAGnostic:SERVice:BIOSinfo?` on page 798

Install Option

Opens an edit dialog box to enter the license key for the option that you want to install.

Only user accounts with administrator rights are able to install options.

Install Option by XML

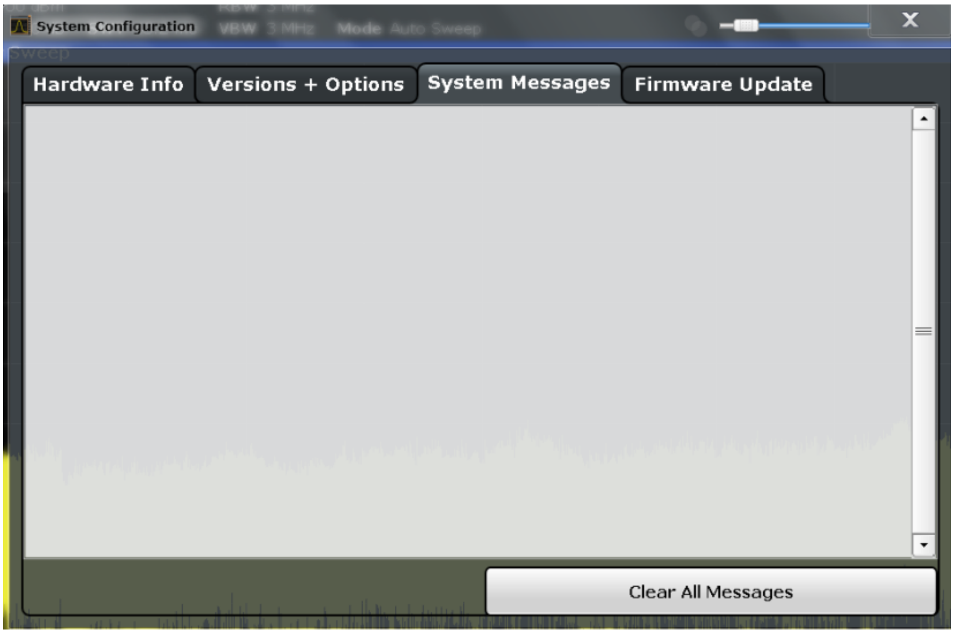
Opens a file selection dialog box to install an additional option to the R&S FSW using an XML file. Enter or browse for the name of an XML file that contains the option key and press "Select".

Only user accounts with administrator rights are able to install options.

8.3.4.3 System Messages

The system messages generated by the R&S FSW are displayed in the "System Messages" tab of the "System Configuration" dialog box.

The messages are displayed in the order of their occurrence; the most recent messages are placed at the top of the list. Messages that have occurred since you last visited the system messages tab are marked with an asterisk '*'.



If the number of error messages exceeds the capacity of the error buffer, "Message buffer overflow" is displayed. To clear the message buffer use the "Clear All Messages" button.

The following information is available:

No	device-specific error code
Message	brief description of the message
Component	hardware messages: name of the affected module
	software messages: name of the affected software
Date/Time	date and time of the occurrence of the message

SCPI command:

SYSTem:ERRor:LIST? on page 800

8.3.4.4 Firmware Updates

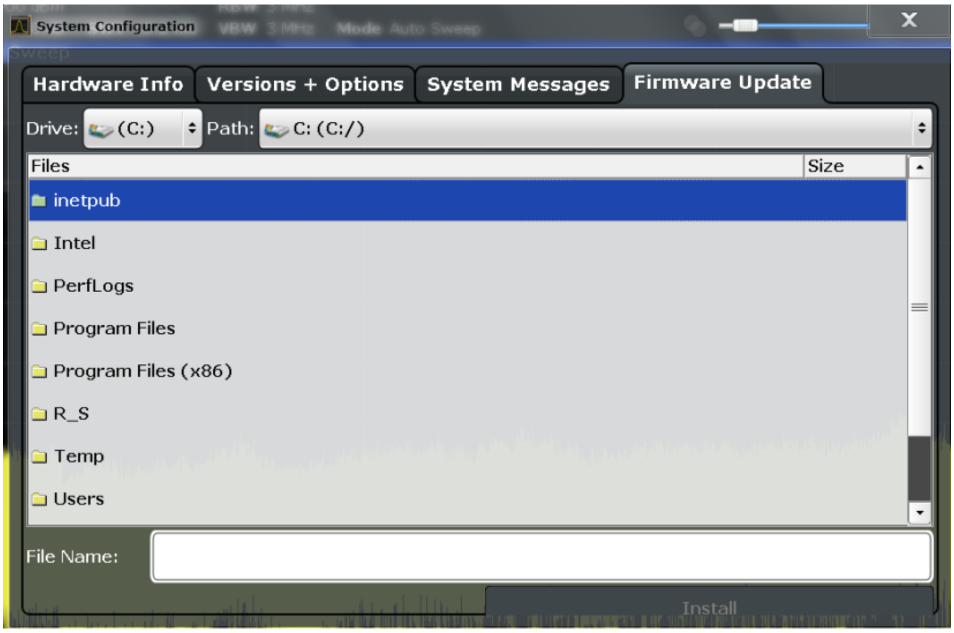
During instrument start, the installed hardware is checked against the current firmware version to ensure the hardware is supported. If not, an error message is displayed ("WRONG_FW") and you are asked to update the firmware. Until the firmware version is updated, self-alignment fails. To see which components are not supported, see the System Messages.

The firmware on your R&S FSW may also need to be updated in order to enable additional new features or if reasons for improvement come up. Ask your sales representative or check the Rohde&Schwarz website for availability of firmware updates. A firmware update package includes at least a setup file and release notes.

Before updating the firmware on your instrument, read the release notes delivered with the firmware version.

As of firmware version 1.60, administrator rights are no longer required to perform a firmware update.

The firmware can be updated in the "Firmware Update" tab of the "System Configuration" dialog box.

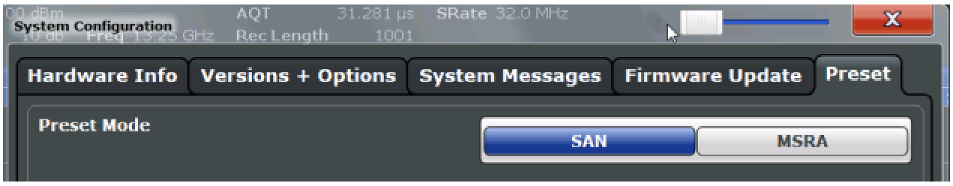


Enter the name or browse for the firmware installation file and press the "Install" button.

8.3.4.5 Preset

The default operating mode is Signal and Spectrum Analyzer mode (SAN), however, the presetting can be changed to Multi-Standard Radio Analysis (MSRA). The defined operating mode is activated when you switch on the R&S FSW or press the PRESET key.

The presettings can be defined in the "Preset" tab of the "System Configuration" dialog box.



For details on operating modes see chapter 3, "Applications and Operating Modes", on page 18.

SCPI command:

`SYSTem:PRESet:COMPatible` on page 801

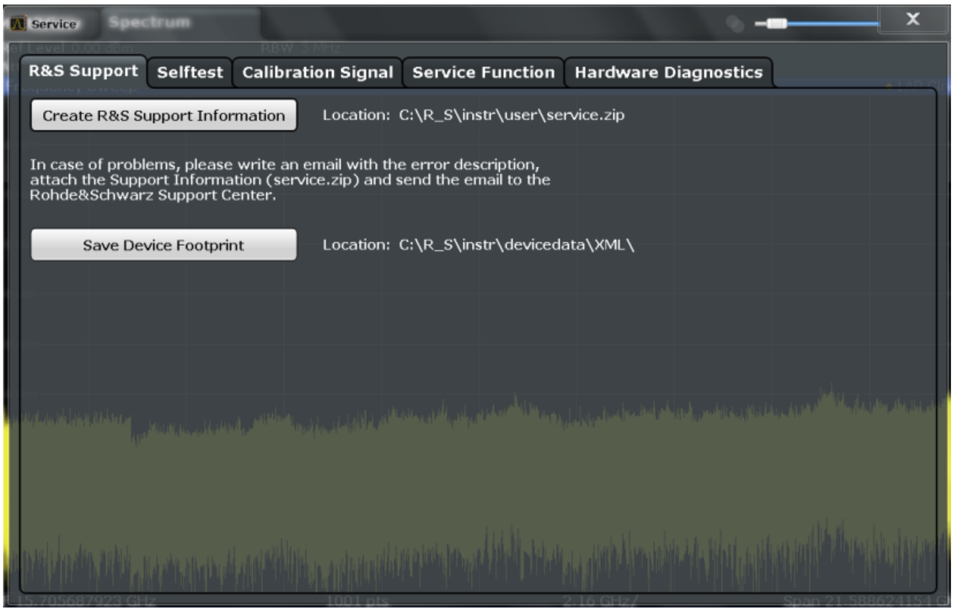
8.3.5 Service Functions

When unexpected problems arise with the R&S FSW some service functions may help you solve them.

The service functions are available in the "Service" dialog box which is displayed when you press the SETUP key and then select "Service".

8.3.5.1 R&S Support Information

In case of errors you can store useful information for troubleshooting and send it to your Rohde & Schwarz support center.



Creating R&S Support Information

Creates a *.zip file with important support information. The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display.

This data is stored to the `C:\R_S\Instr\user\service.zip` file on the instrument.

If you contact the Rohde&Schwarz support to get help for a certain problem, send these files to the support in order to identify and solve the problem faster.

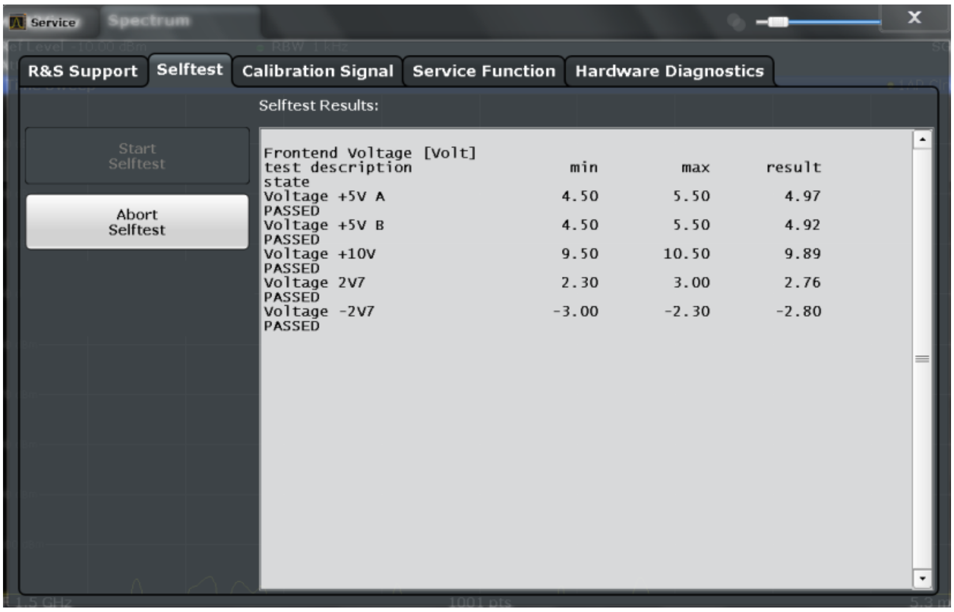
Save Device Footprint

Creates an *.xml file with information on installed hardware, software, image and FPGA versions. The *.xml file is stored under `C:\R_S\Instr\devicedata\xml\` on the instrument. It is also included in the `service.zip` file.

8.3.5.2 Selftest Settings and Results

If the R&S FSW fails you can perform a self test of the instrument to identify any defective modules.

The selftest settings and results are available in the "Selftest" tab of the "Service" dialog box.



Once the self test is started, all modules are checked consecutively and the test result is displayed. You can abort a running test.

In case of failure a short description of the failed test, the defective module, the associated value range and the corresponding test results are indicated.

A running Sequencer process is aborted when you start a self-alignment.

SCPI command:

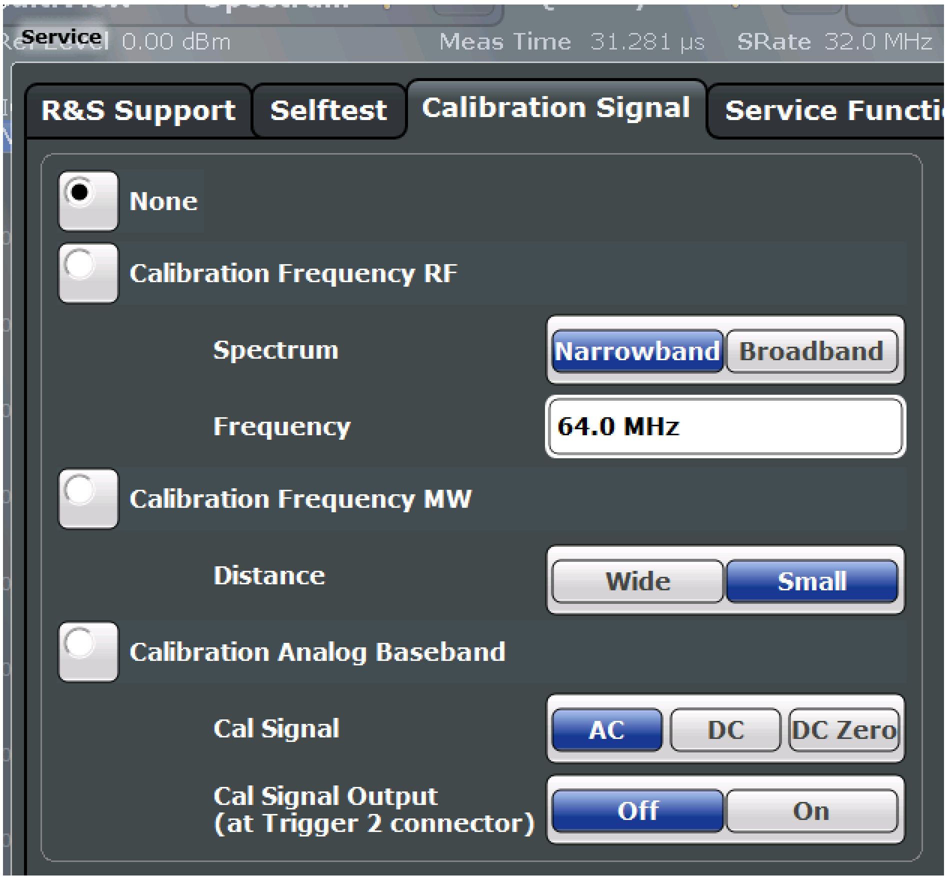
`*TST?` on page 498

`DIAGnostic:SERVice:STESt:RESult?` on page 784

8.3.5.3 Calibration Signal Display

Alternatively to the RF input signal from the front panel connector you can use the instrument's calibration signal as the input signal, for example to perform service functions on.

The calibration signal settings are available in the "Calibration Signal" tab of the "Service" dialog box.



None

Uses the current RF signal at the input, i.e. no calibration signal (default).

SCPI command:

DIAGnostic:SERVice:INPut[:SELect] on page 784

Calibration Frequency RF

Uses the internal calibration signal as the RF input signal.

SCPI command:

DIAGnostic:SERVice:INPut:PULSed:CFRequency on page 783

Spectrum ← Calibration Frequency RF

Defines whether a broadband or narrowband calibration signal is sent to the RF input.

"Narrowband" Used to calibrate the absolute level of the frontend at 64 MHz.

"Broadband" Used to calibrate the IF filter.

SCPI command:

DIAGnostic:SERVice:INPut:RF:SPECtrum on page 784

Frequency ← Calibration Frequency RF

Defines the frequency of the internal broadband calibration signal to be used for IF filter calibration (max. 64 MHz). For narrowband signals, 64 MHz is sent.

Calibration Frequency MW

Uses the microwave calibration signal as the RF input (for frequencies greater than 8 GHz; for R&S FSW 26 only). This function is used to calibrate the YIG-filter on the microwave converter.

The microwave calibration signal is pulsed. You can define whether the distance between input pulses is small or wide.

SCPI command:

DIAGnostic:SERVice:INPut:MC:DISTance on page 783

Calibration Analog Baseband

Uses an internal calibration signal as input to the optional Analog Baseband interface. This signal is only available if the R&S FSW-B71 option is installed.

SCPI command:

DIAG:SERV:INP[:SEL] on page 803

Calibration Signal Type ← Calibration Analog Baseband

Defines the type of calibration signal to be used for Analog Baseband.

"AC" 1.5625 MHz square wave AC signal

"DC" 1.5625 MHz square wave DC signal

"DC zero" no signal

SCPI command:

DIAG:SERV:INP:AIQ[:TYPE] on page 803

Calibration Signal Output ← Calibration Analog Baseband

If enabled, the Analog Baseband calibration signal is output to the TRIGGER INPUT/ OUTPUT connector (Trigger 2) on the front panel of the R&S FSW.

SCPI command:

DIAG:SERV:INP:AIQ:OUT on page 803

8.3.5.4 Service Functions

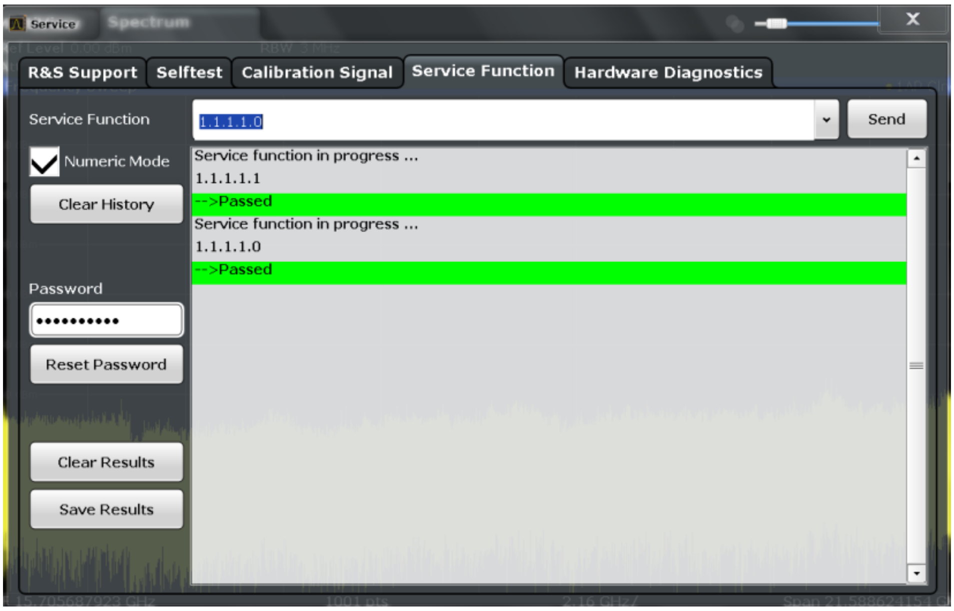
NOTICE

Using service functions

The service functions are not necessary for normal measurement operation. Incorrect use can affect correct operation and/or data integrity of the R&S FSW.

Therefore, only user accounts with administrator rights can use service functions and many of the functions can only be used after entering a password. These functions are described in the instrument service manual.

The service functions are available in the "Service Function" tab of the "Service" dialog box.



Service Function

Selects the service function by its numeric code or textual name.

The selection list includes all functions previously selected (since the last "Clear History" action).

SCPI command:

`DIAGnostic:SERVice:SFUNction` on page 802

Numeric Mode
If activated, the service function is selected by its numeric code. Otherwise, the function is selected by its textual name.

Send
Starts the selected service function.

SCPI command:
`DIAGnostic:SERVice:SFUNction` on page 802

Clear History
Deletes the list of previously selected service functions.

Password
Most service functions require a special password as they may disrupt normal operation of the R&S FSW. There are different levels of service functions, depending on how restrictive their use is handled. Each service level has a different password.

"Reset Password" returns to the lowest (least restrictive) service level.

Clear Results
Clears the result display for all previously performed service functions.

SCPI command:
`DIAGnostic:SERVice:SFUNction:RESults:DELete` on page 802

Save Results
Opens a file selection dialog box to save the results of all previously performed service functions to a file.

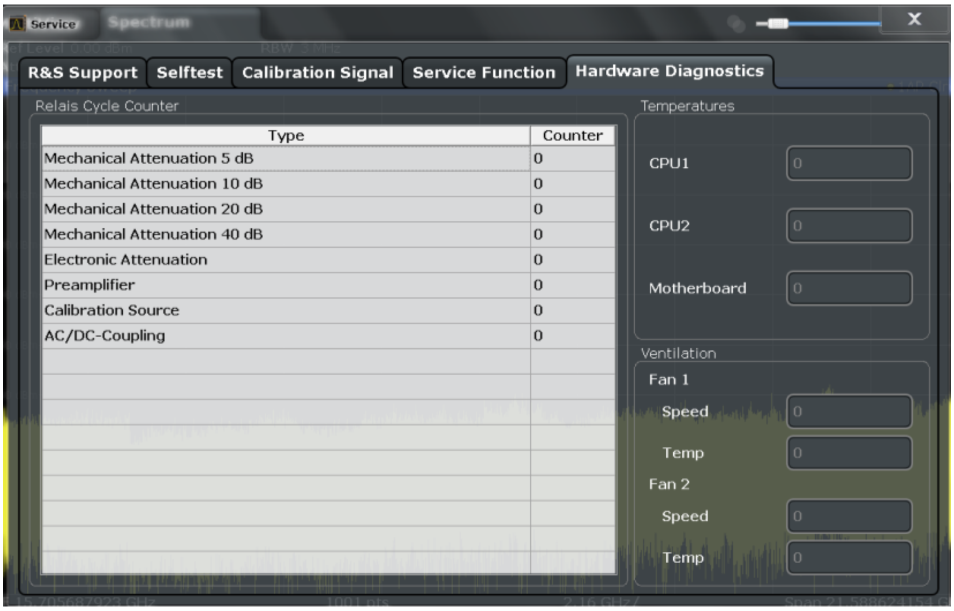
SCPI command:
`DIAGnostic:SERVice:SFUNction:RESults:SAVE` on page 802

Result List
The Results List indicates the status and results of the executed service functions.

8.3.5.5 Hardware Diagnostics

In case problems occur with the instrument hardware, some diagnostic tools provide information that may support troubleshooting.

The hardware diagnostics tools are available in the "Hardware Diagnostics" tab of the "Service" dialog box.



Relay Cycle Counter

The hardware relays built into the R&S FSW may fail after a large number of switching cycles (see data sheet). The counter indicates how many switching cycles the individual relays have performed since they were installed.

SCPI command:

`DIAGnostic:INFO:CCOunter?` on page 798

Temperatures

Some hardware parts fail at high temperatures. Several temperature sensors in the R&S FSW provide the current temperature for the CPUs and the motherboard, which are indicated here.

Ventilation

High temperatures in the R&S FSW may occur when the fans fail. The current speed and temperatures of the built-in fans are displayed. High temperatures or very slow fan speed may indicate a hardware problem.

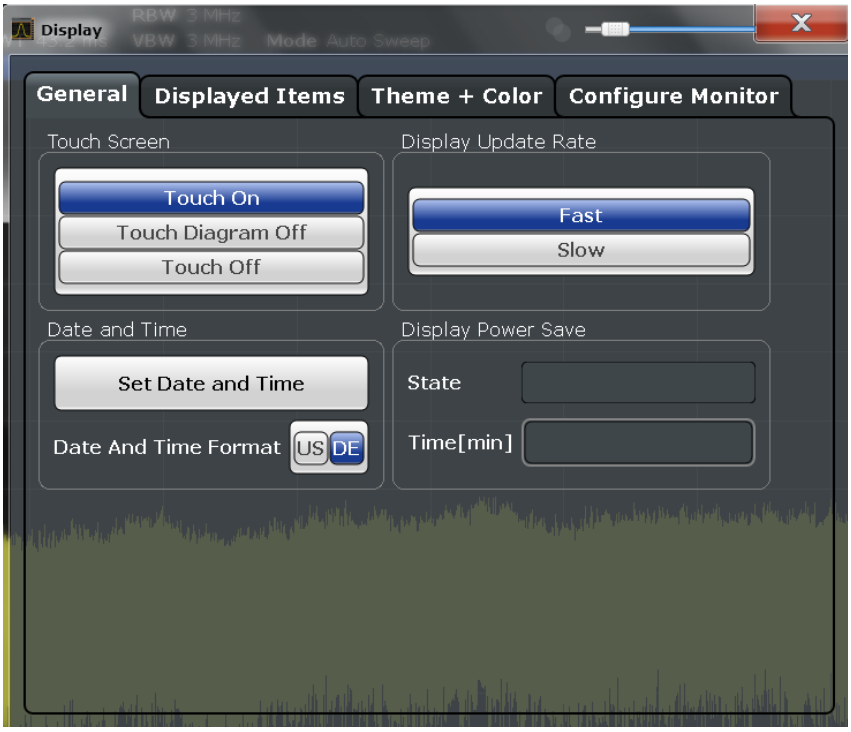
8.4 Display Settings

Some general display settings are available regardless of the current application or operating mode. For information on optimizing your display for measurement results see chapter 6.1, "Result Display Configuration", on page 273.

The general display settings are defined in the "Display" dialog box which is displayed when you press the SETUP key and then select "Display".

8.4.1 General Display Settings

This section includes general screen display behavior and date and time display. These settings are available in the "General" tab of the "Display" dialog box.



Deactivating and Activating the Touch Screen

The touch screen function can be deactivated, e.g. when the instrument is being used for demonstration purposes and tapping the screen should not provoke an action.

To reactivate the touch screen, simply press the SETUP key on the front panel. The "Display" dialog box is opened automatically and the "Touch Screen" option is set to "ON".

"TOUCH ON" Touch screen function is active for the entire screen

"TOUCH OFF" Touch screen is deactivated for the entire screen

"TOUCH DIAGRAM OFF"
Touch screen is deactivated for the diagram area of the screen, but active for the surrounding softkeys, toolbars and menus

SCPI command:
`DISPlay:TOUChscreen:STATe` on page 790

Display Update Rate
By default, a fast update rate ensures the most recent measurement results on the display. However, when performance is poor due to slow data transfer (for example during remote control), it may be helpful to decrease the frequency with which the screen display is updated.

Setting the Date and Time
The current date and time on the instrument is set using the standard Windows "Date and Time Properties" dialog box which is displayed when you select the "Set Date and Time" button in the "Display" dialog box, or when you tap the date and time display in the status bar.

Date and Time Format
Switches the time and date display on the screen between US and German (DE) format.

SCPI command:
`DISPlay[:WINDow]:TIME:FORMat` on page 791

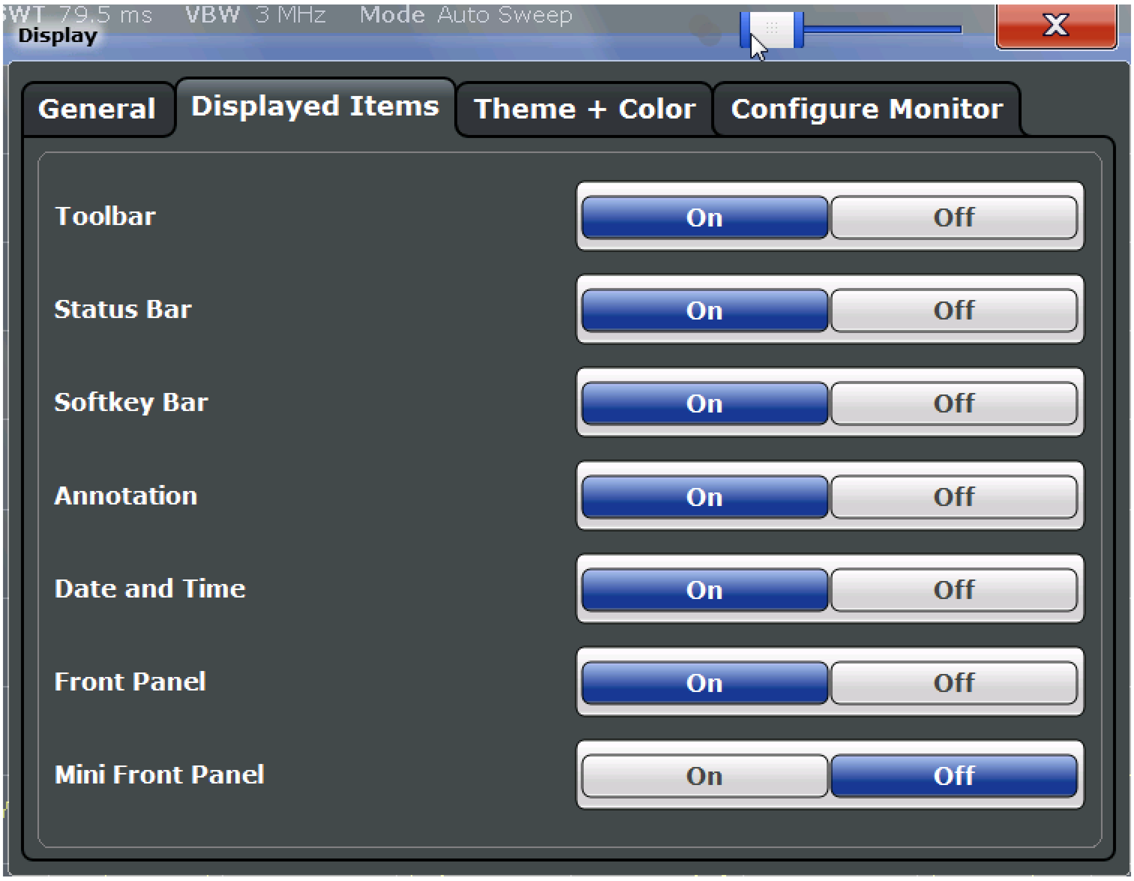
Display Power Save Function
The touch screen can be set to a power-save mode in which the display is temporarily switched off, including the backlight. This is useful during remote control, for example, or when a measurement with a long duration is running that needs not be monitored. You can define a waiting time after which the power-save mode sets in automatically if no manual interaction with the instrument occurs.

To switch the display back on, tap the screen or press a key.

SCPI command:
`DISPlay:PSAVe[:STATe]` on page 789
`DISPlay:PSAVe:HOLDoff` on page 789

8.4.2 Displayed Items

Several elements on the screen display can be hidden or shown as required, for example to enlarge the display area for the measurement results. These settings are available in the "Displayed Items" tab of the "Display" dialog box.



Toolbar

The toolbar provides access to frequently used functions via icons at the top of the screen. Some functions, such as zooming, finding help, printing screenshots or storing and loading files are not accessible at all without the toolbar.

SCPI command:

`DISPlay:TBAR[:STATe]` on page 790

Status Bar

The status bar beneath the diagram indicates the global instrument settings, the instrument status and any irregularities during measurement or display.

Some of the information displayed in the status bar can be queried from the status registry via remote commands, see chapter 10, "Remote Commands", on page 493.

SCPI command:

`DISPlay:SBAR[:STATe]` on page 789

Softkey Bar
Softkeys are virtual keys provided by the software. Thus, more functions can be provided than those that can be accessed directly via the function keys on the device.

The functions provided by the softkeys are often also available via dialog boxes. However, some functions may not be accessible at all without the softkey bar.

Note: The softkey bar is hidden while the SmartGrid is displayed and restored automatically when the SmartGrid is closed.

SCPI command:
`DISPlay:SKEYs[:STATe]` on page 790

Diagram Footer (Annotation)
The diagram footer beneath the diagram contains information on the x-axis of the diagram display, such as the current center frequency and span settings, the displayed span per division and the number of sweep points.

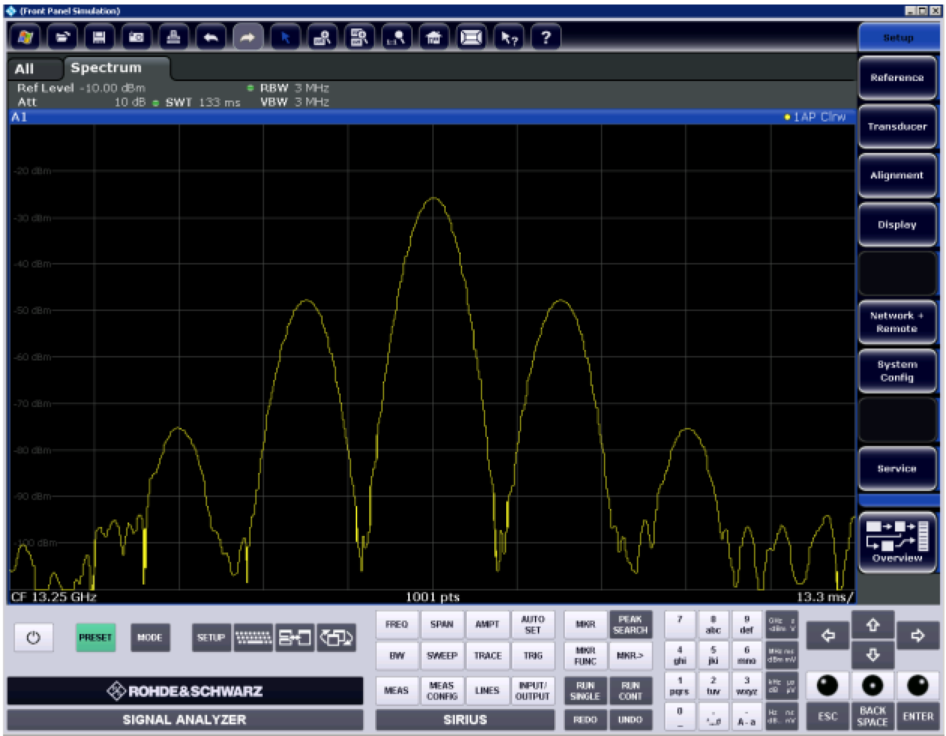
SCPI command:
`DISPlay:ANNotation:FREQuency` on page 788

Date and Time
The date and time display can be switched off independantly of the status bar.

You can set the current date and time and configure the display format in the "General" tab of the "Display" dialog box.

SCPI command:
`DISPlay[:WINDow]:TIME` on page 790

Front Panel
The "Front Panel" display simulates the entire front panel of the device (except for the external connectors) on the screen. This allows you to interact with the R&S FSW without requiring the keypad and keys located on the front panel of the device. This is useful, for example, when working with an external monitor or operating via remote control from a computer.



To activate or deactivate the front panel temporarily, press the F6 key on the external keyboard (if available) or the remote computer.

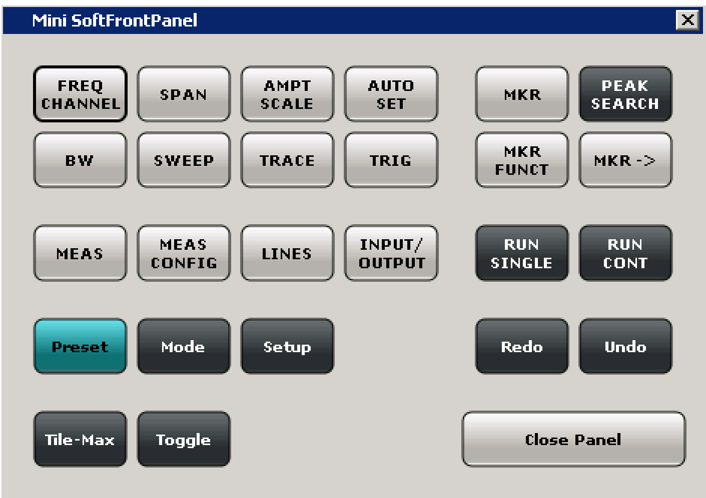
For more information see chapter 8.6.7, "How to Work with the Soft Front Panels", on page 426.

SCPI command:

`SYSTem:DISPlay:FPANel[:STATe]` on page 791

Mini Front Panel

If you require a front panel display but do not want to lose too much space for results in the display area, a mini front panel is available. The mini version displays only the main function hardkeys in a separate window in the display area. This window can be closed automatically after pressing a key ("Auto Close" option), or remain open, as desired.



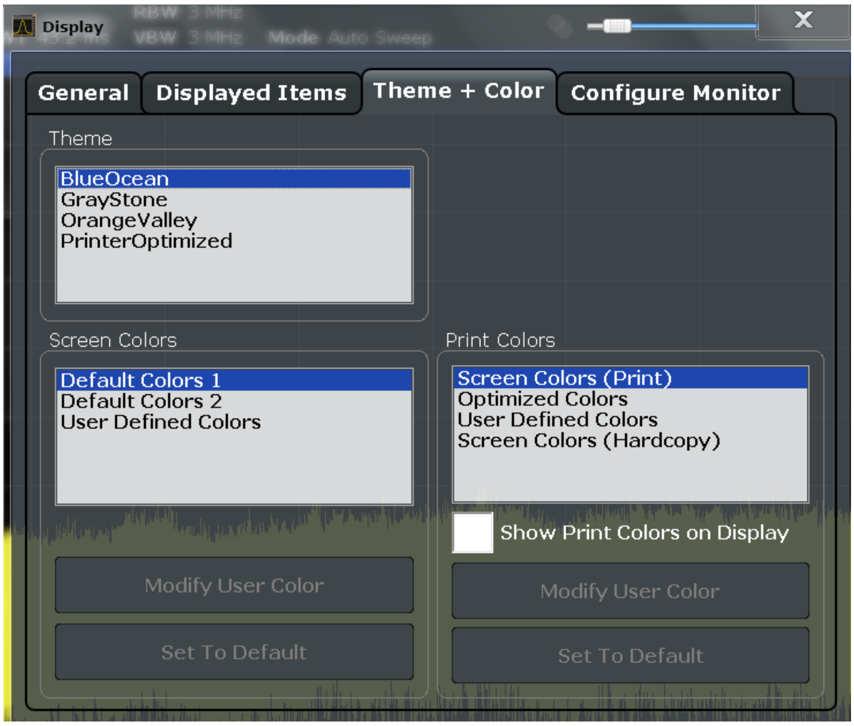
Note:
You can also activate the Mini Front Panel using the key combination ALT + M (be aware of the keyboard language defined in the operating system!). This is useful when you are working from a remote PC and the Front Panel function is not active.

SCPI command:
SYSTem:DISPlay:FPANel[:STATe] on page 791

8.4.3 Display Theme and Colors

You can configure the used colors and styles of display elements on the screen. These settings are available in the "Theme + Color" tab of the "Display" dialog box.

For step-by-step instructions see chapter 8.6.6, "How to Configure the Colors for Display and Printing", on page 425.



Theme

The theme defines the colors and style used to display softkeys and other screen objects. The default theme is "BlueOcean".

SCPI command:

`DISPlay:THEMe:SELect` on page 793

Screen colors

Two different color sets are provided by the instrument, a third user-defined set can be configured.

The default color schemes provide optimum visibility of all screen objects when regarding the screen from above or below. Default setting is "Default Colors 1".

If "User Defined Colors" is selected, a user-defined color set can be defined.

SCPI command:

`DISPlay:CMAP<item>:DEFault<colors>` on page 792

Print colors

Defines the color settings used for printout. In addition to the predefined settings, a user-defined color set can be configured.

If "Show Print Colors on Display" is activated, the currently selected print colors are displayed as a preview for your selection.

Optimized Colors	Selects an optimized color setting for the printout to improve the visibility of the colors (default setting). Trace 1 is blue, trace 2 black, trace 3 green, and the markers are turquoise. The background is always printed in white and the grid in black.
Screen Colors (Print)	Selects the current screen colors for the printout. The background is always printed in white and the grid in black.
Screen Colors (Hardcopy)	Selects the current screen colors without any changes for a hardcopy.
User Defined Colors	Selects the user-defined color setting.

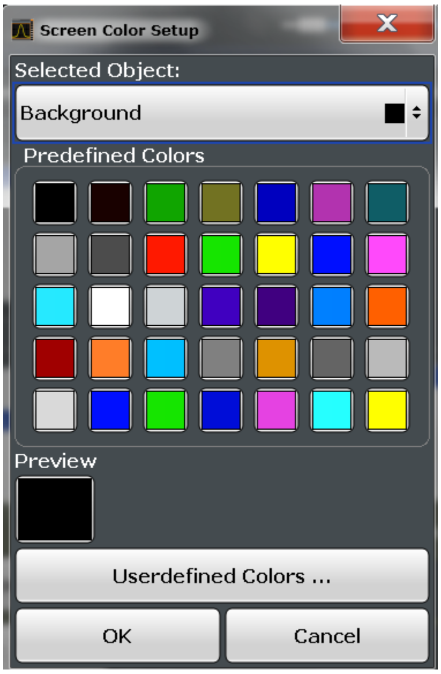
SCPI command:

`HCOPy:CMAP<item>:DEFault<colors>` on page 769

Modifying User-Defined Colors

You can configure the colors used to display and print individual screen objects according to your specific requirements.

The colors are configured in the (identical) "Screen Color Setup"/"Printer Color Setup" dialog boxes.



Selecting the Object ← Modifying User-Defined Colors
Selects the object for which the color is to be defined. Colors can be defined for the following objects:

- Background
- Grid
- Individual traces
- Display lines
- Limit lines and check results
- Markers and marker information

SCPI command:
Each object is assigned to a specific suffix of the CMAP commands, see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

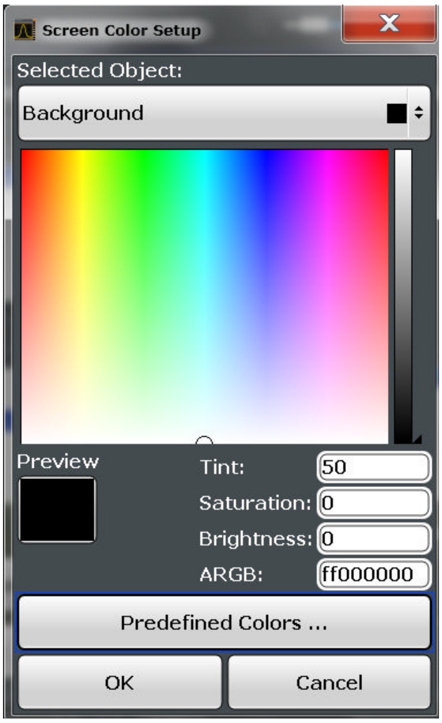
Predefined Colors ← Modifying User-Defined Colors
Displays the available colors from the predefined color set that can be used for the selected object.

SCPI command:
`HCOPy:CMAP<item>:PDEFined` on page 770

Preview
Indicates the currently selected color that will be used for the selected object.

Defining User-specific Colors
In addition to the colors in the predefined color set you can configure a user-specific color to be used for the selected object.

When you select "Userdefined Colors", the set of predefined colors is replaced by a color palette and color configuration settings.



The color palette allows you to select the color directly. The color settings allow you to define values for tint, saturation and brightness.

SCPI command:

HCOPy:CMAP<item>:HSL on page 769

Restoring the User Settings to Default Colors

In addition to the predefined color settings, a user-defined setting can be configured. By default, the same settings as defined in "Default Colors 1" are used. They can then be modified according to user-specific requirements (see "Modifying User-Defined Colors" on page 417).

The "Set to Default" function restores the original default settings for the user-defined color set. You can select which of the three default settings are restored.

SCPI command:

DISPlay:CMAP<item>:PDEFined on page 793

8.5 External Monitor Settings

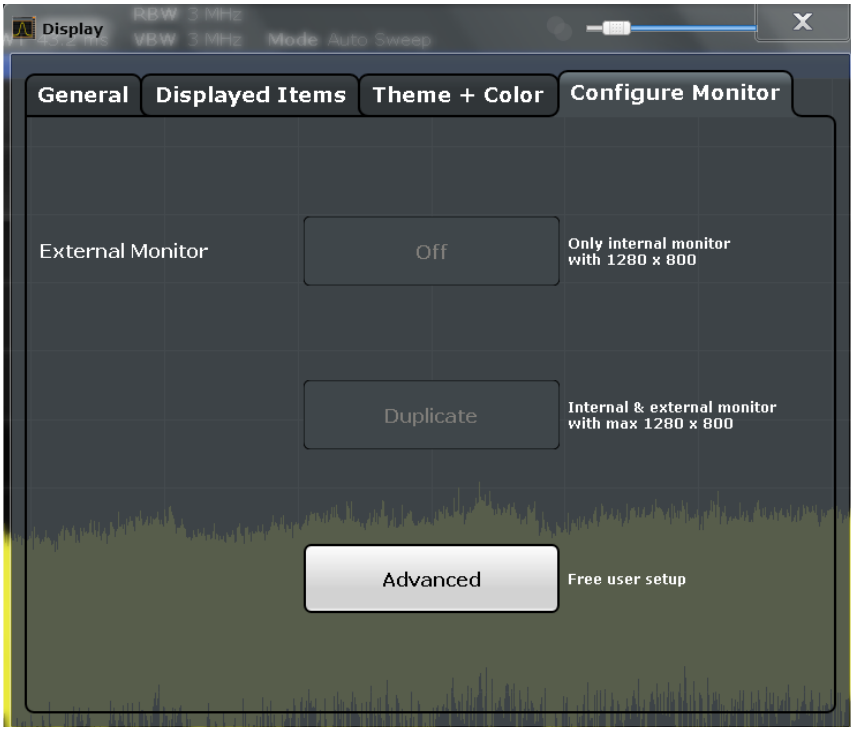
You can connect an external monitor (or projector) to the DVI or DISPLAY PORT connector on the instrument's rear panel (see the R&S FSW Getting Started manual).

Which display device is used by the instrument is configured in the "Configure Monitor" tab of the "Display" dialog box.

Screen resolution and format

The touch screen of the R&S FSW is calibrated for a 16:10 format. If you connect a monitor or projector using a different format (e.g. 4:3), the calibration will not be correct and the screen will not react to your touch actions properly.

The touch screen has a screen resolution of 1280x800 pixels. Most external monitors have a higher screen resolution. If the screen resolution of the monitor is set higher than the instrument's resolution, the application window uses an area of 1280x800 pixels on the monitor display. For full screen display, adjust the monitor's screen resolution.



External Monitor Off

Only the internal monitor of the R&S FSW is used for display.

Duplicate

Both the internal and the external monitor are used.

Advanced

User-defined configuration; opens the standard Windows configuration dialog box to configure the display devices to be used

8.6 How to Configure the Basic Instrument Settings

The following step-by-step instructions demonstrate how to configure the basic instrument settings. For details on individual functions and settings see chapter 8.3, "General Instrument Settings", on page 389.

The remote commands required to perform these tasks are described in chapter 8.3, "General Instrument Settings", on page 389.

8.6.1 How to Perform a Self Test

The self test does not need to be repeated every time the instrument is switched on. It is only necessary when instrument malfunction is suspected.

Operating temperature

Before performing this functional test, make sure that the instrument has reached its operating temperature (for details, refer to the data sheet).

1. Press the SETUP key.
2. Press the "Service" softkey.
3. Press the "Selftest" softkey.

   Once the instrument modules have been checked successfully, a message is displayed.

8.6.2 How to Align the Instrument and the Touch Screen

Operating temperature

Before performing this functional test, make sure that the instrument has reached its operating temperature (for details, refer to the data sheet).

To perform a self-alignment

1. Press the SETUP key.
2. Select the "Alignment" softkey.
3. Select the "Start Self-alignment" button.
4. To abort the self-alignment process, select the "Abort Self-alignment" button.

   Once the system correction values have been calculated successfully, a message is displayed.

To display the alignment results again later

- Press the SETUP key.
- Press the "Alignment" softkey.

To align the touch screen

1. Press the SETUP key.
2. Select the "Alignment" softkey.
3. Select "Touch Screen Alignment".

   A blinking cross appears in the lower left corner of the screen.
4. Touch and hold the blinking cross until it stops blinking.
   Repeat this action for the crosses in the other corners.

8.6.3 How to Install an R&S FSW Option

Additional options for the R&S FSW can be enabled using a license key. To obtain the license key, consult your sales representative. You need the device ID and serial number of your instrument to get a license key (see chapter 8.3.4, "System Configuration Settings", on page 399). No additional installation is required.

8.6.4 How to Update the Instrument Firmware

1. Download the update package from the Rohde&Schwarz website and store it on a memory stick, on the instrument, or on a server network drive that can be accessed by the instrument.
2. **NOTICE!** Stop measurement. The firmware update must not be performed during a running measurement.

   If a measurement is running, stop it by pressing the highlighted RUN CONT or RUN SINGLE key.
3. Press the SETUP key.
4. Select the "Firmware Update" tab.
5. In the file selection dialog box select the `FSWSetup*.exe` file.
6. Tap "Install" to start the update.
7. After the firmware update, the R&S FSW reboots automatically.
8. Depending on the previous firmware version, a reconfiguration of the hardware might be required during the first startup of the firmware. The reconfiguration starts automatically, and a message box informs you about the process. When the reconfiguration has finished, the instrument again reboots automatically.

Note: Do not switch off the instrument during the reconfiguration process!

Now the firmware update is complete. It is recommended that you perform a self-alignment after the update (see chapter 8.6.2, "How to Align the Instrument and the Touch Screen", on page 421).

8.6.5 How to Configure the Transducer

Configuring the transducer is very similar to configuring limit lines.

The transducer settings are defined in the "Transducer" dialog box which is displayed when you press the SETUP key and then select "Transducer".

The following tasks are described:

- "How to find compatible transducer lines" on page 423
- "How to activate and deactivate a transducer" on page 423
- "How to edit existing transducer lines" on page 423
- "How to copy an existing transducer line" on page 424
- "How to delete an existing transducer line" on page 424
- "How to configure a new transducer line" on page 424
- "How to move the transducer line vertically or horizontally" on page 425

How to find compatible transducer lines

► In the "Transducer" dialog box, select the "View filter" option: "Show compatible".

All transducer lines stored on the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a transducer

1. To activate a transducer select a transducer line in the overview and select the "Active" setting for it.

   The trace is automatically recalculated for the next sweep after a transducer line is activated.

2. To deactivate a transducer line, deactivate the "Active" setting for it.

   After the next sweep, the originally measured values are displayed.

How to edit existing transducer lines

Existing transducer line configurations can be edited.

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Edit" button.
3. Edit the line configuration as described in "How to configure a new transducer line" on page 424.

4. Save the new configuration by selecting the "Save" button.

   The trace is automatically recalculated for the next sweep if the transducer line is active.

How to copy an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Copy" button.

   The "Edit Transducer" dialog box is opened with the configuration of the selected transducer.
3. Define a new name to create a new transducer with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new transducer line" on page 424.
5. Save the new configuration by selecting the "Save" button.

   The new transducer line is displayed in the overview and can be activated.

How to delete an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Delete" button.
3. Confirm the message.

   The transducer line is deleted. After the next sweep, the originally measured values are displayed.

How to configure a new transducer line

1. In the "Transducer" dialog box, select the "New" button.

   The "Edit Transducer" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new transducer line.
3. Define the scaling for the x-axis.
4. Define the data points: minimum 2, maximum 50:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.

d) Repeat this to insert all other data points.
To insert a data point before an existing one, select the data point and then "Insert Value".
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
To delete a data point, select the entry and then "Delete Value".

5. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
6. Save the new configuration by selecting the "Save" button.
The new transducer line is displayed in the overview and can be activated.

How to move the transducer line vertically or horizontally

A configured transducer line can easily be moved vertically or horizontally. Thus, a new transducer line can be easily generated based upon an existing transducer line which has been shifted.

1. In the "Line Config" dialog box, select the transducer line.
2. Select the "Edit" button.
3. In the "Edit transducer Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
4. Save the shifted data points by selecting the "Save" button.
If activated, the trace is recalculated after the next sweep.

8.6.6 How to Configure the Colors for Display and Printing

You can configure the style and colors with which various screen objects are displayed or printed.

To select a color set

1. Press the SETUP key and select the "Display" softkey.
2. Select the "Theme + Color" tab.
3. In the "Screen Colors" area, select a predefined set of colors to be used for screen display, or select "User Defined Colors" to configure the color set yourself.
4. In the "Print Colors" area, select a predefined set of colors to be used for printing screenshots, or select "User Defined Colors" to configure the color set yourself.
Activate the "Show Print Colors on Display" option to see a preview of the print colors.

To configure a user-defined color set

1. In the "Theme + Color" tab of the "Display" dialog box select "User Defined Colors" either for the screen or the print colors.
2. Select "Modify User Color".

   The "Screen Color Setup" dialog box is opened.
3. From the "Selected Object" list, select the object to which you want to assign a color.
4. Select a color from the "Predefined Colors" or select the "Userdefined Colors..." button to define a different color.

   The "Preview" area indicates the currently selected color.
5. To assign a user-specific color to the selected object, do one of the following:
   - Select the color from the palette.
   - Enter values for the "Tint", "Saturation", and "Brightness".
     Note: In the continuous color spectrum ("Tint") red is represented by 0% and blue by 100%.
   - Enter an "ARGB" value in hexadecimal format.
6. Select the next object to which you want to assign a color from the "Selected Object" list and assign a color as described.
   Repeat these steps until all objects you want to configure have been assigned a color.
7. Select "OK" to close the dialog box and apply the colors to the assigned objects.

8.6.7 How to Work with the Soft Front Panels

Basic operation with the soft front panels is identical to normal operation, except for the following aspects:

To activate a key, select the key on the touch screen.

To simulate the use of the rotary knob, use the additional keys displayed between the keypad and the arrow keys:

Icon	Function
	Turn left
	Enter
	Turn right

Mini Front Panel

The Mini Front Panel provides only the hardkeys on the touchscreen, in order to operate the R&S FSW via an external monitor or remote desktop.

By default, the "Auto close" option is activated and the Mini Front Panel window closes automatically after you select a key. This is useful if you only require the Mini Front Panel display occassionally to press a single function key.

If you want the window to remain open, deactivate the "Auto close" option. You can close the window manually by selecting "Close Panel" or the key combination ALT + M (be aware of the keyboard language defined in the operating system!).

To display the soft front panel or mini front panel

1. Press the SETUP key and select the "Display" softkey.
2. Select the "Displayed Items" tab.
3. Select "Front Panel: On" or "Mini Front Panel: On".

To activate or deactivate the front panel temporarily, press the F6 key on the external keyboard (if available) or on the remote computer.

9 Network and Remote Operation

In addition to working with the R&S FSW interactively, located directly at the instrument, it is also possible to operate and control it from a remote PC. Various methods for remote control are supported:

- Connecting the instrument to a (LAN) network
- Using the LXI browser interface in a LAN network
- Using the Windows Remote Desktop application in a LAN network
- Connecting a PC via the GPIB interface

How to configure the remote control interfaces is described in chapter 9.5, "How to Set Up a Network and Remote Control", on page 474.

9.1 Remote Control Basics

Basic information on operating an instrument via remote control is provided here. this information applies to all applications and operating modes on the R&S FSW.

9.1.1 Remote Control Interfaces and Protocols

The instrument supports different interfaces for remote control. The following table gives an overview.

Table 9-1: Remote control interfaces and protocols

Interface	Protocols, VISA*) address string	Remarks
Local Area Network (LAN)	Protocols: **VXI-11, HiSLIP** VISA*) address string: TCPIP::host_address[::LAN_device_name][::INSTR] **Raw socket** VISA*) address string: TCPIP::host_address::port::SOCKET	A LAN connector is located on the rear panel of the instrument. The interface is based on TCP/IP and supports various protocols. For a description of the protocols refer to: VXI-11 Protocol HiSLIP Protocol Socket Communication
GPIB (IEC/ IEEE Bus Interface)	VISA*) address string: GPIB::primary address[::INSTR] (no secondary address)	A GPIB bus interface (option R&S FSW-B10) according to the IEC 625.1/ IEEE 488.1 standard is located on the rear panel of the instrument. For a description of the interface refer to 9.1.1.2 GPIB Interface (IEC 625/ IEEE 418 Bus Interface).
USB	VISA*) address string: USB::<vendor ID>::<product_ID>::<serial_number>[::INSTR]	USB connectors are located on the rear panel of the instrument. For a description of the interface refer to 9.1.1.3 USB Interface.

*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control using the indicated interfaces (see also chapter 9.1.3, "VISA Libraries", on page 433).

Within this interface description, the term GPIB is used as a synonym for the IEC/IEEE bus interface.

9.1.1.1 LAN Interface

To be integrated in a LAN, the instrument is equipped with a LAN interface, consisting of a connector, a network interface card and protocols. The network card can be operated with the following interfaces:

- 10 Mbit/s Ethernet IEEE 802.3

- 100 Mbit/s Ethernet IEEE 802.3u
- 1Gbit/s Ethernet IEEE 802.3ab

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol. They are connected using a commercial RJ45 cable (shielded or unshielded twisted pair category 5). The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and the VISA program library must be installed on the controller.

VISA library

Instrument access is usually achieved from high level programming platforms using VISA as an intermediate abstraction layer. VISA encapsulates the low level VXI, GPIB, LAN or USB function calls and thus makes the transport interface transparent for the user. See chapter 9.1.3, "VISA Libraries", on page 433 for details.

The R&S FSW supports various LAN protocols such as LXI, RSIB, raw socket or the newer HiSLIP protocol.

IP address

Only the IP address or a valid DNS host name is required to set up the connection. The host address is part of the "VISA resource string" used by the programs to identify and control the instrument.

The VISA resource string has the form:

```
TCPIP::host address[::LAN device name][::INSTR]
```

or

```
TCPIP::host address::port::SOCKET
```

where:

- **TCPIP** designates the network protocol used
- **host address** is the IP address or host name of the device
- **LAN device name** defines the protocol and the instance number of a sub-instrument;
  - `inst0` selects the VXI-11 protocol (default)
  - `hislip0` selects the newer HiSLIP protocol
- **INSTR** indicates the instrument resource class (optional)
- **port** determines the used port number
- **SOCKET** indicates the raw network socket resource class

Example:

- Instrument has the IP address *192.1.2.3*; the valid resource string using VXI-11 protocol is:
  `TCPIP::192.1.2.3::INSTR`
- The DNS host name name is *FSW-123456*; the valid resource string using HiSLIP is:
  `TCPIP::FSW-123456::hislip0`
- A raw socket connection can be established using:
  `TCPIP::192.1.2.3::5025::SOCKET`

Identifying instruments in a network

If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by means of the resource string.

For details on configuring the LAN connection, see chapter 9.5.1, "How to Configure a Network", on page 475.

VXI-11 Protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

HiSLIP Protocol

The HiSLIP (**Hi**gh **S**peed **L**AN **I**nstrument **P**rotocol) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - one for fast data transfer, the other for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

Note that HiSLIP data is sent to the device using the "fire and forget" method with immediate return, as opposed to VXI-11, where each operation is blocked until a VXI-11 device handshake returns. Thus, a successful return of a VISA operation such as `viWrite()` does not guarantee that the instrument has finished or started the requested command, but is delivered to the TCP/IP buffers.

Socket Communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred as “Raw Ethernet communication”, does not necessary require a VISA installation on the remote controller side.

The simplest way to establish socket communication is to use the built-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For better utilization and to enable automation by means of programs, user defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. All Signal and Spectrum Analyzers use port number 5025 for this purpose. The port is configured for communication on a command-to-command basis and for remote control from a program.

9.1.1.2 GPIB Interface (IEC 625/IEEE 418 Bus Interface)

A GPIB interface is integrated on the rear panel of the instrument. By connecting a PC to the R&S FSW via the GPIB connection you can send remote commands to control and operate the instrument.

To be able to control the instrument via the GPIB bus, the instrument and the controller must be linked by a GPIB bus cable. A GPIB bus card, the card drivers and the program libraries for the programming language used must be provided in the controller. The controller must address the instrument with the GPIB bus address (see chapter 9.5.1.5, "How to Change the GPIB Instrument Address", on page 481). You can set the GPIB address and the ID response string. The GPIB language is set as SCPI by default and cannot be changed for the R&S FSW.

Notes and Conditions

In connection with the GPIB interface, note the following:

- Up to 15 instruments can be connected
- The total cable length is restricted to a maximum of 15 m or 2 m times the number of devices, whichever is less; the cable lenth between two instruments should not exceed 2 m.
- A wired "OR"-connection is used if several instruments are connected in parallel.
- Any connected IEC-bus cables should be terminated by an instrument or controller.

9.1.1.3 USB Interface

For remote control via the USB connection, the PC and the instrument must be connected via the USB type B interface. A USB connection requires the VISA library to be installed. VISA detects and configures the R&S instrument automatically when the USB connection is established. You do not have to enter an address string or install a separate driver.

USB address

The used USB address string is:

`USB::<vendor ID>::<product ID>::<serial number>[::INSTR]`

where:

- <vendor ID> is the vendor ID for Rohde&Schwarz
- <product ID> is the product ID for the R&S instrument
- <serial number> is the individual serial number on the rear of the instrument

Example:

`USB::0x0AAD::0x00C6::100001::INSTR`

0x0AAD is the vendor ID for Rohde&Schwarz

0xC6 is the product ID for the R&S FSW13

100001 is the serial number of the particular instrument

9.1.2 SCPI (Standard Commands for Programmable Instruments)

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. The instrument supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

9.1.3 VISA Libraries

VISA is a standardized software interface library providing input and output functions to communicate with instruments. The I/O channel (LAN or TCP/IP, USB, GPIB,...) is selected at initialization time by means of the channel–specific address string ("VISA resource string") indicated in table 9-1, or by an appropriately defined VISA alias (short name).

A VISA installation is a prerequisite for remote control using the following interfaces:

- chapter 9.1.1.1, "LAN Interface", on page 429

- chapter 9.1.1.2, "GPIB Interface (IEC 625/IEEE 418 Bus Interface)", on page 432
- chapter 9.1.1.3, "USB Interface", on page 433

For more information about VISA refer to the user documentation.

9.1.4 Messages

The messages transferred on the data lines are divided into the following categories:

- Interface messages
  Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They are used to communicate between the controller and the instrument. Interface messages can only be sent by instruments that have GPIB bus functionality. For details see the sections for the required interface.
- Instrument messages
  Instrument messages are employed in the same way for all interfaces, if not indicated otherwise in the description. Structure and syntax of the instrument messages are described in chapter 9.1.5, "SCPI Command Structure", on page 435. A detailed description of all messages available for the instrument is provided in the chapter "Remote Control Commands".
  There are different types of instrument messages, depending on the direction they are sent:
  – Commands
  – Instrument responses

Commands

Commands (program messages) are messages the controller sends to the instrument. They operate the instrument functions and request information. The commands are subdivided according to two criteria:

- According to the effect they have on the instrument:
  – **Setting commands** cause instrument settings such as a reset of the instrument or setting the frequency.
  – **Queries** cause data to be provided for remote control, e.g. for identification of the instrument or polling a parameter value. Queries are formed by directly appending a question mark to the command header.
- According to their definition in standards:
  – **Common commands**: their function and syntax are precisely defined in standard IEEE 488.2. They are employed identically on all instruments (if implemented). They refer to functions such as management of the standardized status registers, reset and self test.
  – **Instrument control commands** refer to functions depending on the features of the instrument such as frequency settings. Many of these commands have also been standardized by the SCPI committee. These commands are marked as "SCPI compliant" in the command reference chapters. Commands without this SCPI label are device-specific, however, their syntax follows SCPI rules as permitted by the standard.

Instrument responses

Instrument responses (response messages and service requests) are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

9.1.5 SCPI Command Structure

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (keywords). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.

9.1.5.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (*) and possibly one or more parameters.

Examples:

*RST	RESET	Resets the instrument.
*ESE	EVENT STATUS ENABLE	Sets the bits of the event status enable registers.
*ESR?	EVENT STATUS QUERY	Queries the contents of the event status register.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.

9.1.5.2 Syntax for Device-Specific Commands

Not all commands used in the following examples are necessarily implemented in the instrument.

For demonstration purposes only, assume the existence of the following commands for this section:

- `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`
- `FORMat:READings:DATA <type>[,<length>]`
- `HCOPy:DEVice:COLor <Boolean>`
- `HCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`
- `HCOPy[:IMMediate]`
- `HCOPy:ITEM:ALL`
- `HCOPy:ITEM:LABel <string>`
- `HCOPy:PAGE:DIMensions:QUADrant[<N>]`
- `HCOPy:PAGE:ORIentation LANDscape | PORTrait`
- `HCOPy:PAGE:SCALe <numeric value>`
- `MMEMory:COPY <file_source>,<file_destination>`
- `SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>`
- `SENSe:FREQuency:STOP <numeric value>`
- `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}`

Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

Example:

`HCOPy:DEVice:COLor ON` is equivalent to `HCOP:DEV:COL ON`.

Case-insensitivity

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

Numeric suffixes

If a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command. Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

Example:

Definition: `HCOPy:PAGE:DIMensions:QUADrant[<N>]`

Command: `HCOP:PAGE:DIM:QUAD2`

This command refers to the quadrant 2.

Different numbering in remote control

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

Optional mnemonics

Some command systems permit certain mnemonics to be inserted into the header or omitted. These mnemonics are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

Example:

Definition: `HCOPy[:IMMediate]`

Command: `HCOP:IMM` is equivalent to `HCOP`

Optional mnemonics with numeric suffixes

Do not omit an optional mnemonic if it includes a numeric suffix that is relevant for the effect of the command.

Example:

Definition:`DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`

Command: `DISP:MAX ON` refers to window 1.

In order to refer to a window other than 1, you must include the optional `WINDow` parameter with the suffix for the required window.

`DISP:WIND2:MAX ON` refers to window 2.

Parameters

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (,). For a description of the parameter types, refer to chapter 9.1.5.3, "SCPI Parameters", on page 438.

Example:

Definition:`HCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`

Command:`HCOP:DEV:CMAP:COL:RGB 3,32,44`

Special characters

|	**Parameters**
	A vertical stroke in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.
	Example:
	Definition:`HCOPy:PAGE:ORIentation LANDscape | PORTrait`
	Command `HCOP:PAGE:ORI LAND` specifies landscape orientation
	Command `HCOP:PAGE:ORI PORT` specifies portrait orientation
	Mnemonics
	A selection of mnemonics with an identical effect exists for several commands. These mnemonics are indicated in the same line; they are separated by a vertical stroke. Only one of these mnemonics needs to be included in the header of the command. The effect of the command is independent of which of the mnemonics is used.
	Example:
	Definition`SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>`
	The two following commands with identical meaning can be created:
	`SENS:BAND:RES 1`
	`SENS:BWID:RES 1`

[ ]	Mnemonics in square brackets are optional and may be inserted into the header or omitted. **Example**: `HCOPy[:IMMediate]` `HCOP:IMM` is equivalent to `HCOP`

{ }	Parameters in curly brackets are optional and can be inserted once or several times, or omitted.
	Example: `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}`
	The following are valid commands:
	`SENS:LIST:FREQ 10`
	`SENS:LIST:FREQ 10,20`
	`SENS:LIST:FREQ 10,20,30,40`

9.1.5.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). Allowed parameters are:

- Numeric values
- Special numeric values
- Boolean parameters
- Text
- Character strings
- Block data

The parameters required for each command and the allowed range of values are specified in the command description.

Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Allowed unit prefixes are G (giga), MA (mega), MOHM and MHZ are also allowed), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

Example: `SENS:FREQ:STOP 1.5GHz` = `SENS:FREQ:STOP 1.5E9`

Units

For physical quantities, the unit can be entered. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

If the unit is missing, the basic unit is used.

Example:

`SENSe:FREQ:STOP 1.5GHz` = `SENSe:FREQ:STOP 1.5E9`

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the `PCT` string.

Example:

`HCOP:PAGE:SCAL 90PCT`

Special numeric values

The texts listed below are interpreted as special numeric values. In the case of a query, the numeric value is provided.

- **MIN/MAX**
  MINimum and MAXimum denote the minimum and maximum value.
- **DEF**
  DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the *RST command.
- **UP/DOWN**
  UP, DOWN increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.
- **INF/NINF**

INFinity, Negative INFinity (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.

- **NAN**
  Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Example:

Setting command: `SENSe:LIST:FREQ MAXimum`

Query: `SENS:LIST:FREQ?, Response: 3.5E9`

Queries for special numeric values

The numeric values associated to `MAXimum/MINimum/DEFault` can be queried by adding the corresponding mnemonics to the command. They must be entered following the quotation mark.

Example: `SENSe:LIST:FREQ? MAXimum`

Returns the maximum numeric value as a result.

Boolean Parameters

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. The numeric values are provided as the response for a query.

Example:

Setting command: `HCOPy:DEV:COL ON`

Query: `HCOPy:DEV:COL?`

Response: `1`

Text parameters

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example:

Setting command: `HCOPy:PAGE:ORIentation LANDscape`

Query: `HCOP:PAGE:ORI?`

Response: `LAND`

Character strings

Strings must always be entered in quotation marks (' or ").

Example:

`HCOP:ITEM:LABel "Test1"` or `HCOP:ITEM:LABel 'Test1'`

Block data

Block data is a format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example:

`FORMat:READings:DATA #45168xxxxxxxx`

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.

9.1.5.4 Overview of Syntax Elements

The following table provides an overview of the syntax elements:

:	The colon separates the mnemonics of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk marks a common command.
' ' "	Quotation marks introduce a string and terminate it (both single and double quotation marks are possible).
#	The hash symbol introduces binary, octal, hexadecimal and block data. ● Binary: #B10110 ● Octal: #O7612 ● Hexa: #HF3A7 ● Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

9.1.5.5 Structure of a command line

A command line may consist of one or several commands. It is terminated by one of the following:

- a <New Line>

- a <New Line> with EOI
- an EOI together with the last data byte

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:

`MMEM:COPY "Test1","MeasurementXY";:HCOP:ITEM ALL`

This command line contains two commands. The first command belongs to the MMEM system, the second command belongs to the HCOP system.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

Example:

`HCOP:ITEM ALL;:HCOP:IMM`

This command line contains two commands. Both commands are part of the `HCOP` command system, i.e. they have one level in common.

When abbreviating the command line, the second command begins with the level below HCOP. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

`HCOP:ITEM ALL;IMM`

A new command line always begins with the complete path.

Example:

`HCOP:ITEM ALL`

`HCOP:IMM`

9.1.5.6 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

- The requested parameter is transmitted without a header.
  Example: `HCOP:PAGE:ORI?`, Response: `LAND`
- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.
  Example: `SENSe:FREQuency:STOP? MAX`, Response: `3.5E9`
- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the `Unit` command. The response `3.5E9` in the previous example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as `0` (for OFF) and `1` (for ON).

Example:
Setting command: `HCOPy:DEV:COL ON`
Query: `HCOPy:DEV:COL?`
Response: `1`

- Text (character data) is returned in a short form.
  Example:
  Setting command: `HCOPy:PAGE:ORIentation LANDscape`
  Query: `HCOP:PAGE:ORI?`
  Response: `LAND`

9.1.6 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command is one which finishes executing before the next command starts executing. Commands that are processed quickly are usually implemented as sequential commands.
- An overlapping command is one which does not automatically finish executing before the next command starts executing. Usually, overlapping commands take longer to process and allow the program to do other tasks while being executed. If overlapping commands do have to be executed in a defined order, e.g. in order to avoid wrong measurement results, they must be serviced sequentially. This is called synchronization between the controller and the instrument.

Setting commands within one command line, even though they may be implemented as sequential commands, are not necessarily serviced in the order in which they have been received. In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line.

Example: Commands and queries in one message

The response to a query combined in a program message with commands that affect the queried value is not predictable.

The following commands always return the specified result:

`:FREQ:STAR 1GHZ;SPAN 100;:FREQ:STAR?`

Result:

`1000000000` (1 GHz)

Whereas the result for the following commands is not specified by SCPI:

`:FREQ:STAR 1GHz;STAR?;SPAN 1000000`

The result could be the value of `STARt` before the command was sent since the instrument might defer executing the individual commands until a program message terminator is received. The result could also be 1 GHz if the instrument executes commands as they are received.

As a general rule, send commands and queries in different program messages.

Example: Overlapping command with *OPC

The instrument implements `INITiate[:IMMediate]` as an overlapped command. Assuming that `INITiate[:IMMediate]` takes longer to execute than `*OPC`, sending the following command sequence results in initiating a sweep and, after some time, setting the `OPC` bit in the `ESR`:

`INIT; *OPC.`

Sending the following commands still initiates a sweep:

`INIT; *OPC; *CLS`

However, since the operation is still pending when the instrument executes `*CLS`, forcing it into the "Operation Complete Command Idle" State (OCIS), `*OPC` is effectively skipped. The `OPC` bit is not set until the instrument executes another `*OPC` command.

9.1.6.1 Preventing Overlapping Execution

To prevent an overlapping execution of commands, one of the commands *OPC, *OPC? or *WAI can be used. All three commands cause a certain action only to be carried out after the hardware has been set. By suitable programming, the controller can be forced to wait for the corresponding action to occur.

*Table 9-2: Synchronization using *OPC, *OPC? and *WAI*

Command	Action	Programming the controller
*OPC	Sets the Operation Complete bit in the ESR after all previous commands have been executed.	• Setting bit 0 in the ESE • Setting bit 5 in the SRE • Waiting for service request (SRQ)
*OPC?	Stops command processing until 1 is returned. This is only the case after the Operation Complete bit has been set in the ESR. This bit indicates that the previous setting has been completed.	Sending *OPC? directly after the command whose processing should be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Sending *WAI directly after the command whose processing should be terminated before other commands are executed.

Command synchronization using *WAI or *OPC? appended to an overlapped command is a good choice if the overlapped command takes only little time to process. The two synchronization techniques simply block overlapped execution of the command.

For time consuming overlapped commands it is usually desirable to allow the controller or the instrument to do other useful work while waiting for command execution. Use one of the following methods:

***OPC with a service request**

1. Set the OPC mask bit (bit no. 0) in the ESE: *ESE 1
2. Set bit no. 5 in the SRE: *SRE 32 to enable ESB service request.
3. Send the overlapped command with *OPC

4. Wait for a service request

   The service request indicates that the overlapped command has finished.

***OPC? with a service request**

1. Set bit no. 4 in the SRE: *SRE 16 to enable MAV service request.
2. Send the overlapped command with *OPC?
3. Wait for a service request

   The service request indicates that the overlapped command has finished.

Event Status Register (ESE)

1. Set the OPC mask bit (bit no. 0) in the ESE: *ESE 1
2. Send the overlapped command without *OPC, *OPC? or *WAI
3. Poll the operation complete state periodically (by means of a timer) using the sequence: *OPC; *ESR?

   A return value (LSB) of 1 indicates that the overlapped command has finished.

***OPC? with short timeout**

1. Send the overlapped command without *OPC, *OPC? or *WAI
2. Poll the operation complete state periodically (by means of a timer) using the sequence: <short timeout>; *OPC?
3. A return value (LSB) of 1 indicates that the overlapped command has finished. In case of a timeout, the operation is ongoing.
4. Reset timeout to former value
5. Clear the error queue with `SYStem:ERRor?` to remove the "-410, Query interrupted" entries.

Using several threads in the controller application

As an alternative, provided the programming environment of the controller application supports threads, separate threads can be used for the application GUI and for controlling the instrument(s) via SCPI.

A thread waiting for a *OPC? thus will not block the GUI or the communication with other instruments.

9.1.7 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue. Both can be queried via GPIB bus or LAN interface (`STATus`... commands, see chapter 10.9, "Using the Status Register", on page 804).

9.1.7.1 Hierarchy of Status Registers

As shown in the following figure, the status information is of hierarchical structure.

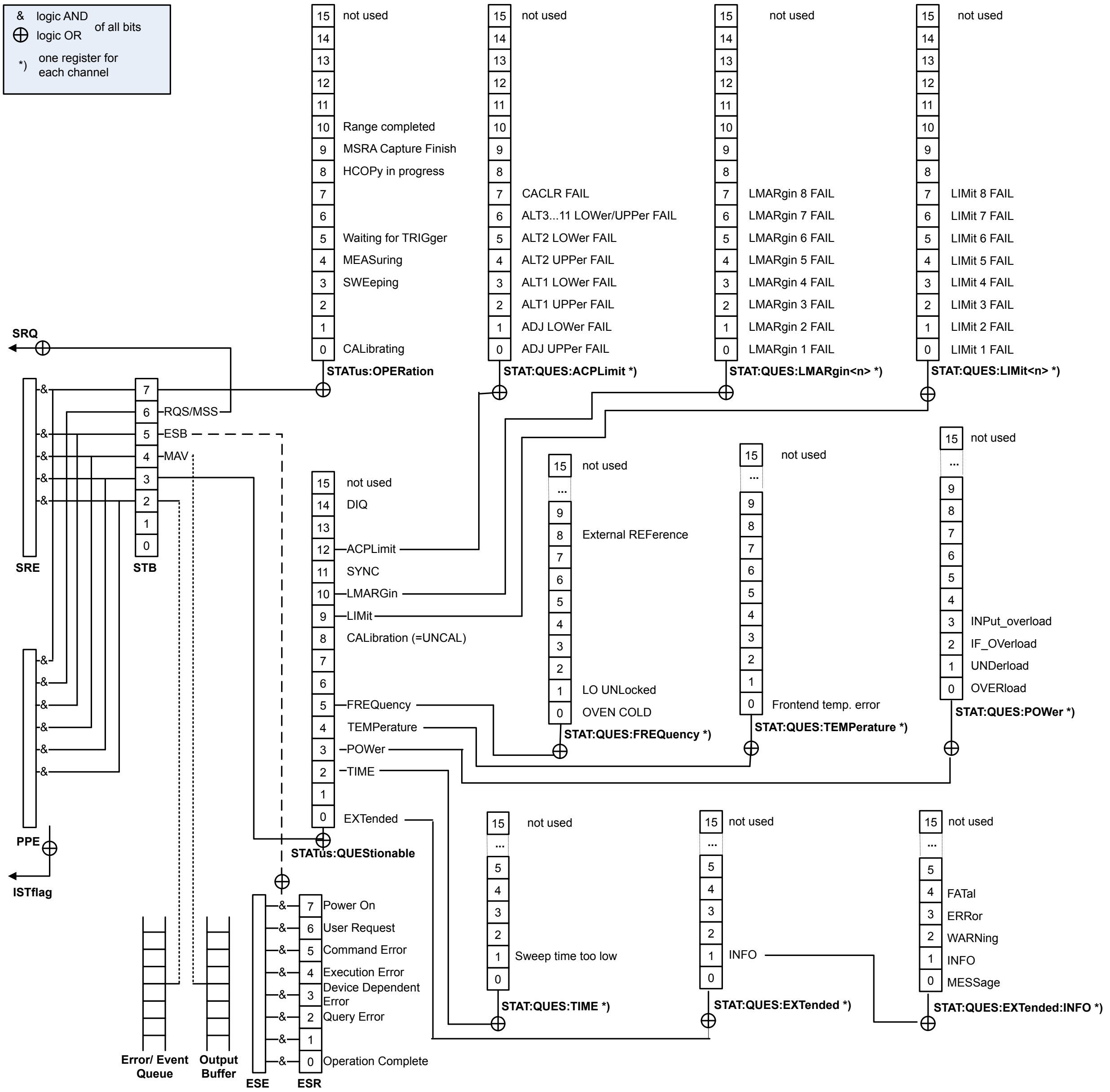


Fig. 9-1: Graphical overview of the R&S FSW status registers hierarchy

- **STB, SRE**
  The STatus Byte (STB) register and its associated mask register Service Request Enable (SRE) form the highest level of the status reporting system. The STB provides a rough overview of the instrument status, collecting the information of the lower-level registers.
- **ESR, SCPI registers**
  The STB receives its information from the following registers:

- The Event Status Register (ESR) with the associated mask register standard Event Status Enable (ESE).
- The STATus:OPERation and STATus:QUEStionable registers which are defined by SCPI and contain detailed information on the instrument.

- **IST, PPE**
The IST flag ("Individual STatus"), like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills the same function for the IST flag as the SRE for the service request.
- **Output buffer**
The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in the overview.

All status registers have the same internal structure.

SRE, ESE

The service request enable register SRE can be used as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be used as the ENABle part of the ESR.

9.1.7.2 Structure of a SCPI Status Register

Each standard SCPI register consists of 5 parts. Each part has a width of 16 bits and has different functions. The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integers.

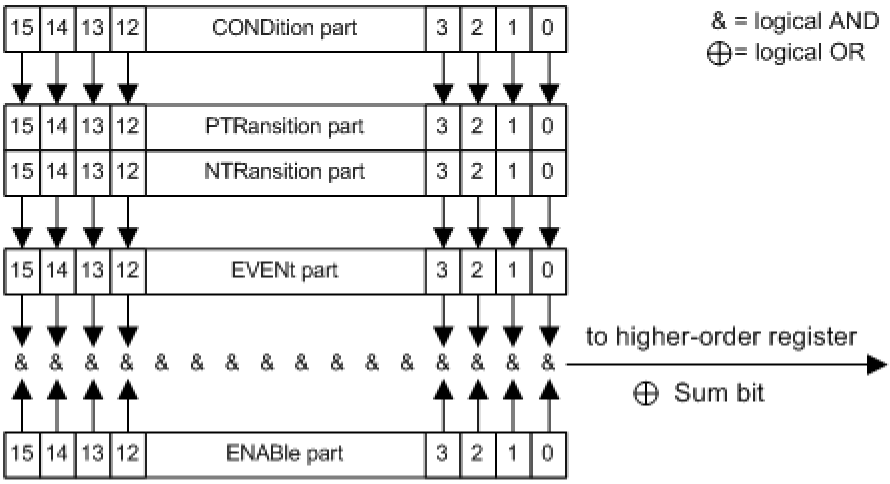


Fig. 9-2: The status-register model

Description of the five status register parts

The five parts of a SCPI register have different properties and functions:

- **CONDition**
  The CONDition part is written into directly by the hardware or the sum bit of the next lower register. Its contents reflect the current instrument status. This register part can only be read, but not written into or cleared. Its contents are not affected by reading.
- **PTRansition**
  The two transition register parts define which state transition of the CONDition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.
  The Positive-TRansition part acts as a transition filter. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
  – PTR bit =1: the EVENt bit is set.
  – PTR bit =0: the EVENt bit is not set.

  This part can be written into and read as required. Its contents are not affected by reading.
- **NTRansition**
  The Negative-TRansition part also acts as a transition filter. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
  – NTR bit =1: the EVENt bit is set.
  – NTR bit =0: the EVENt bit is not set.

  This part can be written into and read as required. Its contents are not affected by reading.
- **EVENt**
  The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument. This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.
- **ENABle**
  The ENABle part determines whether the associated EVENt bit contributes to the sum bit (see below). Each bit of the EVENt part is "ANDed" with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an "OR" function (symbol '+').
  ENABle bit = 0: the associated EVENt bit does not contribute to the sum bit
  ENABle bit = 1: if the associated EVENt bit is "1", the sum bit is set to "1" as well.
  This part can be written into and read by the user as required. Its contents are not affected by reading.

Sum bit

The sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.

The instrument automatically generates the sum bit for each register. Thus an event can lead to a service request throughout all levels of the hierarchy.

9.1.7.3 Contents of the Status Registers

In the following sections, the contents of the status registers are described in more detail.

Status Byte (STB) and Service Request Enable Register (SRE)

The `STatus Byte` (STB) is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The STB can thus be compared with the `CONDition` part of an SCPI register and assumes the highest level within the SCPI hierarchy.

The STB is read using the command `*STB?` or a serial poll.

The `STatus Byte` (STB) is linked to the `Service Request Enable` (SRE) register. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated. The SRE can be set using the command `*SRE` and read using the command `*SRE?`.

Table 9-3: Meaning of the bits used in the status byte

Bit No.	Meaning
0...1	Not used
2	Error Queue not empty The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a service request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with remote control.
3	QUEStionable status sum bit The bit is set if an `EVENt` bit is set in the `QUEStionable` status register and the associated `ENABle` bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the `QUEStionable` status register.
4	MAV bit (message available) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller.
5	ESB bit Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	MSS bit (master status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	`OPERation` status register sum bit The bit is set if an `EVENt` bit is set in the `OPERation` status register and the associated `ENABle` bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by polling the `OPERation` status register.

IST Flag and Parallel Poll Enable Register (PPE)

As with the SRQ, the IST flag combines the entire status information in a single bit. It can be read by means of a parallel poll (see "Parallel Poll" on page 459) or using the command *IST?.

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are "ANDed" with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The IST flag results from the "ORing" of all results. The PPE can be set using commands *PRE and read using command *PRE?.

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is defined in IEEE 488.2. It can be compared with the EVENt part of a SCPI register. The event status register can be read out using command *ESR?.

The ESE corresponds to the ENABle part of a SCPI register. If a bit is set in the ESE and the associated bit in the ESR changes from 0 to 1, the ESB bit in the STB is set. The ESE register can be set using the command *ESE and read using the command *ESE?.

Table 9-4: Meaning of the bits used in the event status register

Bit No.	Meaning
0	Operation Complete This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
1	Not used
2	Query Error This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	Device-dependent Error This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue.
4	Execution Error This bit is set if a received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue.
5	Command Error This bit is set if a command is received, which is undefined or syntactically incorrect. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue.
6	User Request This bit is set when the instrument is switched over to manual control.
7	Power On (supply voltage on) This bit is set on switching on the instrument.

STATus:OPERation Register

The STATus:OPERation register contains information on current activities of the R&S FSW. It also contains information on activities that have been executed since the last read out.

You can read out the register with STATus:OPERation:CONDition? or STATus:OPERation[:EVENt]?.

Table 9-5: 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 In applications, this bit is not used.
4	MEASuring Measurement is being performed in base unit (applications are not considered); identical to bit 3 In applications, this bit is not used.
5	Waiting for TRIgger Instrument is ready to trigger and waiting for trigger signal
6-7	Not used
8	HardCOPy in progress This bit is set while the instrument is printing a hardcopy.
9	For data acquisition in MSRA mode only: MSRA capture finish This bit is set if a data acquisition measurement was completed successfully in MSRA operating mode and data is available for evaluation For details on the MSRA operating mode see the R&S FSW MSRA User Manual.
10	Range completed This bit is set when a range in the sweep list has been completed if "Stop after Range" has been activated.
11-14	Not used
15	This bit is always 0.

STATus:QUEStionable Register

The STATus:QUEStionable register contains information on instrument states that do not meet the specifications.

The STAT:QUES:SYNC register is used by the applications and is thus described in the individual applications' User Manuals.

You can read out the register with `STAT:QUES:COND` or `STAT:QUES:EVEN`.

The `STATus:QUEStionable` register "sums up" the information from all subregisters (e.g. bit 2 sums up the information for all `STATus:QUEStionable:TIMe` registers). For some subregisters, there may be separate registers for each active channel. Thus, if a status bit in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific subregisters. In this case, you must check the subregister of each channel to determine which channel caused the error. By default, querying the status of a subregister always returns the result for the currently selected channel.

Table 9-6: Meaning of the bits used in the STATus:QUEStionable register

Bit No.	Meaning
0 - 1	Unused
2	TIMe This bit is set if a time error occurs in any of the active channels. The STATus:QUEStionable:TIMe Register provides more information on the error type.
3	POWer This bit is set if the measured power level in any of the active channels is questionable. The STATus:QUEStionable:POWer Register provides more information on the error type.
4	TEMPerature This bit is set if the temperature is questionable.
5	FREQuency This bit is set if there is anything wrong with the frequency of the local oscillator or the reference frequency in any of the active channels. The STATus:QUEStionable:FREQuency Register provides more information on the error type.
6 - 7	Unused
8	CALibration This bit is set if the R&S FSW is unaligned ("UNCAL" display)
9	LIMit (device-specific) This bit is set if a limit value is violated in any of the active channels in any window. The STATus:QUEStionable:LIMit Register provides more information on the error type.
10	LMARgin (device-specific) This bit is set if a margin is violated in any of the active channels in any window. The STATus:QUEStionable:LMARgin Register provides more information on the error type.
11	SYNC (device-specific) This bit is set if the R&S FSW is not synchronized to the signal that is applied. The R&S FSW is not synchronized if: ● it cannot synchronize to midamble during a measurement or premeasurement ● it cannot find a burst during a measurement or premeasurement ● the results deviate too much from the expected value during premeasurements

Bit No.	Meaning
12	ACPLimit (device-specific) This bit is set if a limit during ACLR measurements is violated in any of the active channels. The STATus:QUEStionable:ACPLimit Register provides more information on the error type.
13	Unused
14	Digital I/Q (device-specific) This bit is set if a connection error occurs at the Digital Baseband Interface (R&S FSW-B17) For details see the R&S FSW I/Q Analyzer User Manual.
15	This bit is always 0.

STATus:QUEStionable:ACPLimit Register

The STATus:QUEStionable:ACPLimit register contains information about the results of a limit check during ACLR measurements. A separate ACPLimit register exists for each active channel.

You can read out the register with`STATus:QUEStionable:ACPLimit:CONDition?` or `STATus:QUEStionable:ACPLimit[:EVENt]?`

Table 9-7: Meaning of the bits used in the STATus:QUEStionable:ACPLimit register

Bit No.	Meaning
0	ADJ UPPer FAIL This bit is set if the limit is exceeded in the **upper adjacent** channel
1	ADJ LOWer FAIL This bit is set if the limit is exceeded in the **lower adjacent** channel.
2	ALT1 UPPer FAIL This bit is set if the limit is exceeded in the **upper 1st alternate** channel.
3	ALT1 LOWer FAIL This bit is set if the limit is exceeded in the **lower 1st alternate** channel.
4	ALT2 UPPer FAIL This bit is set if the limit is exceeded in the **upper 2nd alternate** channel.
5	ALT2 LOWer FAIL This bit is set if the limit is exceeded in the **lower 2nd alternate** channel.
6	ALT3 … 11 LOWer/UPPer FAIL This bit is set if the limit is exceeded in one of the lower or upper alternate channels 3 … 11.
7	CACLR FAIL This bit is set if the limit is exceeded in one of the gap (CACLR) channels.
8 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:EXTended Register

The STATus:QUEStionable:EXTended register contains further status information not covered by the other status registers of the R&S FSW. A separate EXTended register exists for each active channel.

You can read out the register with STATus:QUEStionable:EXTended:CONDition? or STATus:QUEStionable:EXTended[:EVENt]?

Table 9-8: Meaning of the bits used in the STATus:QUEStionable:EXTended register

Bit No.	Meaning
0	not used
1	INFO This bit is set if a status message is available for the application. Which type of message occurred is indicated in the STATus:QUEStionable:EXTended:INFO Register.
2 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:EXTended:INFO Register

The STATus:QUEStionable:EXTended:INFO register contains information on the type of messages that occur during operation of the R&S FSW. A separate INFO register exists for each active channel.

You can read out the register with STATus:QUEStionable:EXTended:INFO:CONDition? or STATus:QUEStionable:EXTended:INFO[:EVENt]?. You can query all messages that occur for a specific channel using the command SYSTem:ERRor:EXTended? on page 800.

Table 9-9: Meaning of the bits used in the STATus:QUEStionable:EXTended:INFO register

Bit No.	Meaning
0	MESSage This bit is set if event or state has occurred that may lead to an error during further operation.
1	INFO This bit is set if an informational status message is available for the application.
2	WARNing This bit is set if an irregular situation occurs during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
3	ERRor This bit is set if an error occurs during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be completed correctly.
4	FATal This bit is set if a serious error occurs in the application and regular operation is no longer possible.

Bit No.	Meaning
5 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:FREQuency Register

The STATus:QUEStionable:FREQuency register contains information about the condition of the local oscillator and the reference frequency. A separate frequency register exists for each active channel.

You can read out the register with `STATus:QUEStionable:FREQuency:CONDition?` or `STATus:QUEStionable:FREQuency[:EVENt]?`.

Table 9-10: Meaning of the bits used in the STATus:QUEStionable:FREQuency register

Bit No.	Meaning
0	OVEN COLD This bit is set if the reference oscillator has not yet attained its operating temperature. "OCXO" is displayed.
1	LO UNLocked This bit is set if the local oscillator no longer locks. "LOUNL" is displayed.
2 to 7	Not used
8	EXTernalREFerence This bit is set if you have selected an external reference oscillator but did not connect a useable external reference source. In that case the synthesizer can not lock. The frequency in all probability is not accurate.
9 to 14	Not used
15	This bit is always 0.

STATus:QUEStionable:LIMit Register

The STATus:QUEStionable:LIMit register contains information about the results of a limit check when you are working with limit lines.

A separate LIMit register exists for each active channel and for each window.

You can read out the register with `STATus:QUEStionable:LIMit<n>:CONDition?` or `STATus:QUEStionable:LIMit<n>[:EVENt]?`.

Table 9-11: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.

Bit No.	Meaning
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:LMARgin Register

This register contains information about the observance of limit margins.

A separate LMARgin register exists for each active channel and for each window.

It can be read using the commands `STATus:QUEStionable:LMARgin:CONDition?` and `STATus:QUEStionable:LMARgin[:EVENt]?`.

Table 9-12: Meaning of the bits used in the STATus:QUEStionable:LMARgin register

Bit No.	Meaning
0	LMARgin 1 FAIL This bit is set if limit margin 1 is violated.
1	LMARgin 2 FAIL This bit is set if limit margin 2 is violated.
2	LMARgin 3 FAIL This bit is set if limit margin 3 is violated.
3	LMARgin 4 FAIL This bit is set if limit margin 4 is violated.
4	LMARgin 5 FAIL This bit is set if limit margin 5 is violated.
5	LMARgin 6 FAIL This bit is set if limit margin 6 is violated.
6	LMARgin 7 FAIL This bit is set if limit margin 7 is violated.
7	LMARgin 8 FAIL This bit is set if limit margin 8 is violated.

Bit No.	Meaning
8 to 14	Not used
15	This bit is always 0.

STATus:QUEStionable:POWer Register

The STATus:QUEStionable:POWer register contains information about possible overload situations that may occur during operation of the R&S FSW. A separate power register exists for each active channel.

You can read out the register with STATus:QUEStionable:POWer:CONDition? or STATus:QUEStionable:POWer[:EVENt]?

Table 9-13: Meaning of the bits used in the STATus:QUEStionable:POWer register

Bit No.	Meaning
0	OVERload This bit is set if an overload occurs at the RF input, causing signal distortion but not yet causing damage to the device. The R&S FSW displays the keyword "OVLD".
1	UNDerload This bit is set if an underload occurs at the RF input. The R&S FSW displays the keyword "UNLD".
2	IF_OVerload This bit is set if an overload occurs in the IF path. The R&S FSW displays the keyword "IFOVL".
3	Input Overload This bit is set if the signal level at the RF input connector exceeds the maximum (see chapter 5.2.1.1, "RF Input Protection", on page 183). The RF input is disconnected from the input mixer to protect the device. In order to re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input (see INPut:ATTenuation:PROTection:RESet on page 659). The R&S FSW displays the keyword "INPUT OVLD".
4 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:TEMPerature Register

The STATus:QUEStionable:TEMPerature register contains information about possible temperature deviations that may occur during operation of the R&S FSW. A separate temperature register exists for each active channel.

Table 9-14: Meaning of the bits used in the STATus:QUEStionable:TEMPerature register

Bit No.	Meaning
0	This bit is set if the frontend temperature sensor deviates by a certain degree from the self-alignment temperature. During warmup, this bit is always 0. For details see "Temperature check" on page 388.
1 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:TIMe Register

The STATus:QUEStionable:TIMe register contains information about possible time errors that may occur during operation of the R&S FSW. A separate time register exists for each active channel.

You can read out the register with `STATus:QUEStionable:TIME:CONDition?` or `STATus:QUEStionable:TIME[:EVENt]?`

Table 9-15: Meaning of the bits used in the STATus:QUEStionable:TIMe register

Bit No.	Meaning
0	not used
1	Sweep time too low This bit is set if the sweep time is too low and thus calibration fails. Note: the STATus:QUEStionable bit for CALibration is not affected by this error.
2 to 14	Unused
15	This bit is always 0.

9.1.7.4 Application of the Status Reporting System

The purpose of the status reporting system is to monitor the status of one or several devices in a measuring system. To do this and react appropriately, the controller must receive and evaluate the information of all devices. The following standard methods are used:

- **Service request** (SRQ) initiated by the instrument
- **Serial poll** of all devices in the bus system, initiated by the controller in order to find out who sent a SRQ and why
- **Parallel poll** of all devices
- Query of a **specific instrument status** by means of commands
- Query of the **error queue**

Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. As evident from figure 9-1, an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The `ENABle` parts of the status registers can be set such that arbitrary bits in an arbitrary status register initiate an SRQ. In order to make use of the possibilities of the service request effectively, all bits should be set to "1" in enable registers SRE and ESE.

Use of the command *OPC to generate an SRQ at the end of a sweep

1. `CALL InstrWrite(analyzer, "*ESE 1")` 'Set bit 0 in the ESE (Operation Complete)
2. `CALL InstrWrite(analyzer, "*SRE 32")` 'Set bit 5 in the SRE (ESB)
3. `CALL InstrWrite(analyzer, "*INIT;*OPC")` ' Generate an SRQ after operation complete

   After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should cause the instrument to initiate a service request if errors occur. The program should react appropriately to the service request.

A detailed example for a service request routine can be found in chapter 10.12.1, "Service Request", on page 845.

Serial Poll

In a serial poll, just as with command `*STB`, the status byte of an instrument is queried. However, the query is realized via interface messages and is thus clearly faster.

The serial poll method is defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the controller.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller using a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to a logical "0" or "1".

In addition to the SRE register, which determines the conditions under which an SRQ is generated, there is a Parallel Poll Enable register (PPE) which is ANDed with the STB bit by bit, considering bit 6 as well. This register is ANDed with the STB bit by bit, considering bit 6 as well. The results are ORed, the result is possibly inverted and then sent as a response to the parallel poll of the controller. The result can also be queried without parallel poll using the command `*IST?`.

The instrument first has to be set for the parallel poll using the command `PPC`. This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using `PPE`.

The parallel poll method is mainly used to find out quickly which one of the instruments connected to the controller has sent a service request. To this effect, SRE and PPE must be set to the same value.

Query of an instrument status

Each part of any status register can be read using queries. There are two types of commands:

- The common commands `*ESR?`, `*IDN?`, `*IST?`, `*STB?` query the higher-level registers.
- The commands of the `STATus` system query the SCPI registers (`STATus:QUEStionable`...)

The returned value is always a decimal number that represents the bit pattern of the queried register. This number is evaluated by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Decimal representation of a bit pattern

The STB and ESR registers contain 8 bits, the SCPI registers 16 bits. The contents of a status register are specified and transferred as a single decimal number. To make this possible, each bit is assigned a weighted value. The decimal number is calculated as the sum of the weighted values of all bits in the register that are set to 1.

Bits	0	1	2	3	4	5	6	7	...
Weight	1	2	4	8	16	32	64	128	...

Example:

The decimal value 40 = 32 + 8 indicates that bits no. 3 and 5 in the status register (e.g. the `QUEStionable` status summary bit and the `ESB` bit in the `STatus` Byte) are set.

Error Queue

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain text error messages that can be looked up in the Error Log or queried via remote control using `SYSTem:ERRor[:NEXT]?` or `SYSTem:ERRor:ALL?`. Each call of `SYSTem:ERRor[:NEXT]?` provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

9.1.7.5 Reset Values of the Status Reporting System

The following table contains the different commands and events causing the status reporting system to be reset. None of the commands, except `*RST` and `SYSTem:PRESet`, influence the functional instrument settings. In particular, `DCL` does not change the instrument settings.

Table 9-16: Resetting the status reporting system

Event	**Switching on supply voltage** **Power-On-Status-Clear**		**DCL, SDC** **(Device Clear, Selected Device Clear)**	***RST or SYS-Tem:PRE-Set**	**STA-Tus:PRE-Set**	***CLS**
Effect	**0**	**1**				
Clear STB, ESR	-	yes	-	-	-	yes
Clear SRE, ESE	-	yes	-	-	-	-
Clear PPE	-	yes	-	-	-	-
Clear EVENt parts of the registers	-	yes	-	-	-	yes
Clear ENABle parts of all OPERation and QUEStionable registers; Fill ENABle parts of all other registers with "1".	-	yes	-	-	yes	-
Fill PTRansition parts with "1"; Clear NTRansition parts	-	yes	-	-	yes	-
Clear error queue	yes	yes	-	-	-	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	-	-	-

1) The first command in a command line that immediately follows a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

9.1.8 General Programming Recommendations

Initial instrument status before changing settings

Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the instrument status. Thus, when a command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the *RST command) and then implement the required settings.

Command sequence

As a general rule, send commands and queries in different program messages. Otherwise, the result of the query may vary depending on which operation is performed first (see also chapter 9.1.6.1, "Preventing Overlapping Execution", on page 444).

Reacting to malfunctions

The service request is the only possibility for the instrument to become active on its own. Each controller program should instruct the instrument to initiate a service request in case of malfunction. The program should react appropriately to the service request.

Error queues

The error queue should be queried after every service request in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

9.2 GPIB Languages

The R&S FSW analyzer family supports a subset of the GPIB commands used by other devices. Thus it can emulate other devices in order to use existing remote control programs.

The device model to be emulated is selected manually using "SETUP > Network + Remote > GPIB tab > Language". Via the GPIB interface using the `SYSTem:LANGuage` on page 809 command.

In order to emulate device models that are not part of the selection list of the GPIB "Language" setting, you can modify the identification string received in response to the ID command ("Identification String" setting). Thus, any device model whose command set is compatible with one of the supported device models can be emulated.

Supported languages

Language	Comment
SCPI	
71100C	Compatible to 8566A/B
71200C	Compatible to 8566A/B
71209A	Compatible to 8566A/B
8560E	
8561E	
8562E	
8563E	

Language	Comment
8564E	
8565E	
8566A	Command sets A and B are available. Command sets A and B differ in the rules regarding the command structure.
8566B	
8568A	Command sets A and B are available. Command sets A and B differ in the rules regarding the command structure.
8568A_DC	Uses DC input coupling by default if supported by the instrument
8568B	Command sets A and B are available. Command sets A and B differ in the rules regarding the command structure.
8568B_DC	Uses DC input coupling by default if supported by the instrument
8591E	Compatible to 8594E
8594E	Command sets A and B are available. Command sets A and B differ in the rules regarding the command structure.
FSEA	
FSEB	
FSEM	
FSEK	
PSA89600	

Notes:

- If you select a language other than "SCPI", the GPIB address is set to 18 if it was 20 before.
- The Start/stop frequency, reference level and number of sweep points are adapted to the selected instrument model.
- When you switch between remote control languages, the following settings or changes are made:
  SCPI:
  The instrument performs a PRESET.
  8566A/B, 8568A/B, 8594E; FSEA, FSEB, FSEM; FSEK:
  – The instrument performs a PRESET.
  – The following instrument settings are changed:

Table 9-17: Instrument settings for emulation of 8566A/B, 8568A/B, 8594E; FSEA, FSEB, FSEM; FSEK instruments

Model	# of Trace Points	Start Freq.	Stop Freq.	Ref Level	Input Coupling
8566A/B	1001	2 GHz	22 GHz	0 dBm	AC
8568A/B	1001	0 Hz	1.5 GHz	0 dBm	AC
8560E	601	0 Hz	2.9 GHz	0 dBm	AC

Model	# of Trace Points	Start Freq.	Stop Freq.	Ref Level	Input Coupling
8561E	601	0 Hz	6.5 GHz	0 dBm	AC
8562E	601	0 Hz	13.2 GHz	0 dBm	AC
8563E	601	0 Hz	26.5 GHz	0 dBm	AC
8564E	601	0 Hz	40 GHz	0 dBm	AC
8565E	601	0 Hz	50 GHz	0 dBm	AC
8594E	401	0 Hz	3 GHz	0 dBm	AC
FSEA	500	0 Hz	3.5 GHz	-20 dBm	AC
FSEB	500	0 Hz	7 GHz	-20 dBm	AC
FSEM	500	0 Hz	26.5 GHz	-20 dBm	AC
FSEK	500	0 Hz	40 GHz	-20 dBm	AC

Note: The stop frequency indicated in the table may be limited to the corresponding frequency of the R&S FSW, if required.

9.3 The IECWIN Tool

The R&S FSW is delivered with *IECWIN* installed, an auxiliary tool provided free of charge by R&S. IECWIN is a program to send SCPI commands to a measuring instrument either interactively or from a command script.

The R&S IECWIN32 tool is provided free of charge. The functionality may change in a future version without notice.

IECWIN offers the following features:

- Connection to instrument via several interfaces/protocols (GPIB, VISA, named pipe (if IECWIN is run on the instrument itself), RSIB)
- Interactive command entry
- Browsing available commands on the instrument
- Error checking following every command
- Execution of command scripts
- Storing binary data to a file
- Reading binary data from a file
- Generation of a log file

For command scripts, IECWIN offers the following features:

- Synchronization with the instrument on every command
- Checking expected result for query commands (as string or numeric value)
- Checking for expected errors codes

- Optional pause on error
- Nested command scripts
- Single step mode
- Conditional execution, based on the *IDN and *OPT strings

You can use the IECWIN to try out the programming examples provided in the R&S FSW User Manuals.

Starting IECWIN

IECWIN is available from the Windows task bar on the R&S FSW, or by executing the following file:

```
C:\Program Files (x86)\Rohde-Schwarz\FSW\<1.10 or higher>\
iecwin32.exe
```

You can also copy the program to any Windows PC or laptop. Simply copy the `iecwin32.exe`, `iecwin.chm` and `rsib32.dll` files from the location above to the same folder on the target computer.

When the tool is started, a "Connection settings" dialog box is displayed. Define the connection from the computer the IECWIN tool is installed on to the R&S FSW you want to control. If you are using the tool directly on the R&S FSW, you can use an NT Pipe (COM Parser) connection, which requires no further configuration. For help on setting up other connection types, check the tool's online help (by clicking the "Help" button in the dialog box) or refer to chapter 9.1, "Remote Control Basics", on page 429.

The IECWIN offers an online help with extensive information on how to work with the tool.

9.4 Network and Remote Control Settings

The network and remote control settings are defined in the "Network + Remote" dialog box which is displayed when you press the SETUP key and then select "Network + Remote".

The remote commands required to define these settings are described in chapter 10.8.6, "Configuring the Network and Remote Control", on page 795.

Step-by-step instructions are provided in chapter 9.5, "How to Set Up a Network and Remote Control", on page 474.

9.4.1 General Network Settings

The R&S FSW can be operated in a local area network (LAN), for example to control the instrument from a remote PC or use a network printer.

The general network settings are defined in the "Network" tab of the "Network + Remote" dialog box.

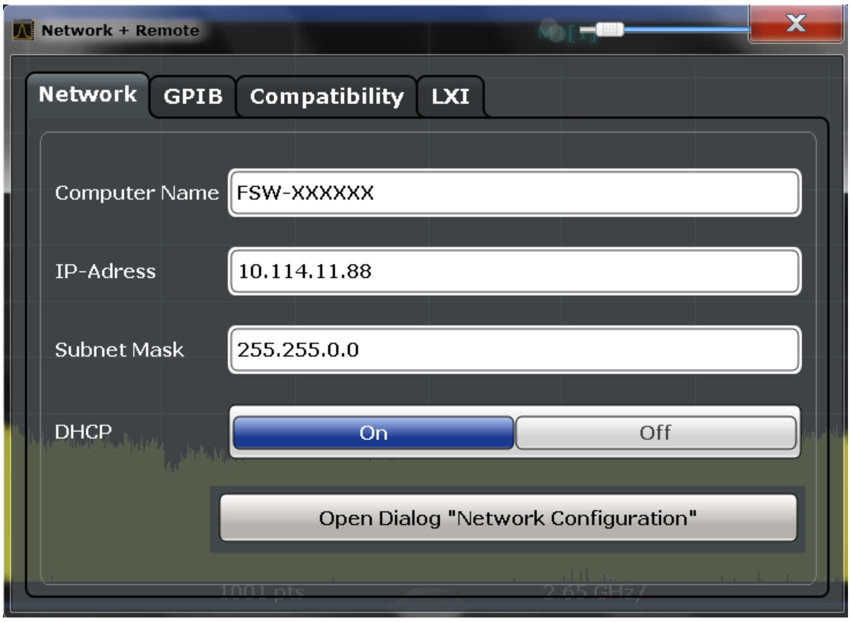
NOTICE

Risk of network problems

All parameters can be edited here; however, beware that changing the computer name has major effects in a network. For details, see chapter 9.5.1, "How to Configure a Network", on page 475.

For step-by-step instructions see chapter 9.5, "How to Set Up a Network and Remote Control", on page 474.

For details on setting up the R&S FSW for remote control, see chapter 9.5, "How to Set Up a Network and Remote Control", on page 474.



Computer Name

Each instrument is delivered with an assigned computer name, but this name can be changed. The naming conventions of Windows apply. If too many characters and/or numbers are entered, an error message is displayed in the status line.

IP Address
Defines the IP address. The TCP/IP protocol is preinstalled with the IP address 10.0.0.10. If the DHCP server is available ("DHCP On"), the setting is read-only.

The IP address consists of four number blocks separated by dots. Each block contains 3 numbers in maximum (e.g. 100.100.100.100), but also one or two numbers are allowed in a block (as an example see the preinstalled address).

Subnet Mask
Defines the subnet mask. The TCP/IP protocol is preinstalled with the subnet mask 255.255.255.0. If the DHCP server is available ("DHCP On"), this setting is read-only.

The subnet mask consists of four number blocks separated by dots. Each block contains 3 numbers in maximum (e.g. 100.100.100.100), but also one or two numbers are allowed in a block (as an example see the preinstalled address).

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

Network Configuration
Opens the standard Windows "Network Configuration" dialog box for further configuration.

9.4.2 GPIB Settings

Alternatively to connecting the R&S FSW to a LAN, the GPIB interface can be used to connect a remote PC. For details see chapter 9.1.1.2, "GPIB Interface (IEC 625/IEEE 418 Bus Interface)", on page 432).

The GPIB settings are defined in the "GPIB" tab of the "Network + Remote" dialog box.

GPIB Address

Defines the GPIB address. Values from 0 to 30 are allowed. The default address is 20.

SCPI command:

`SYSTem:COMMunicate:GPIB[:SELF]:ADDRess` on page 795

Identification String

Defines the identification string for the device which is provided as a response to the `*IDN?` query. Maximum 36 characters are allowed.

SCPI command:

`SYSTem:IDENtify[:STRing]` on page 796

Reset to Factory String

Restores the default identification string. Each instrument has a unique ID according to the following syntax:

Rohde&Schwarz,FSW,<Unique number>

SCPI command:

`SYSTem:IDENtify:FACTory` on page 796

Remote Display Update
Defines whether the instrument display is updated or switched off when changing from manual operation to remote control.

SCPI command:
SYSTem:DISPlay:UPDate on page 796

GPIB Terminator
Changes the GPIB receive terminator.

According to the standard, the terminator in ASCII is <LF> and/or <EOI>. For binary data transfers (e.g. trace data) from the control computer to the instrument, the binary code used for <LF> might be included in the binary data block, and therefore should not be interpreted as a terminator in this particular case. This can be avoided by changing the receive terminator to EOI.

SCPI command:
SYSTem:COMMunicate:GPIB[:SELF]:RTERminator on page 796

***IDN Format**
Defines the response format to the remote command *IDN? (see *IDN? on page 495). This function is intended for re-use of existing control programs together with the R&S FSW.

"Leg" Legacy format, compatible to the R&S FSP/FSU/FSQ family

"New" R&S FSW format

SCPI command:
SYSTem:FORMat:IDENt on page 801

I/O Logging
Activates or deactivates the SCPI error log function. All remote control commands received by the R&S FSW are recorded in the following log file:

C:\R_S\instr\ScpiLogging\ScpiLog.txt

Logging the commands may be extremely useful for debug purposes, e.g. in order to find misspelled keywords in control programs.

SCPI command:
SYSTem:CLOGging on page 780

9.4.3 Compatibility Settings

The R&S FSW can emulate the GPIB interface of other signal and spectrum analyzers, e.g. in order to use existing control applications.

Compatibility with former R&S signal and spectrum analyzers

As a rule, the R&S FSW supports most commands from previous R&S signal and spectrum analyzers such as the FSQ, FSP, FSU, or FSV. However, the default values, in particular the number of sweep points or particular bandwidths, may vary. Therefore, the R&S FSW can emulate these other devices, including their default values, in order to repeat previous measurements or support existing control applications as in legacy systems.

The required settings are configured in the "Compatibility" tab of the "Network +Remote" dialog box.

Language

Defines the system language used to control the instrument.

For details on the available GPIB languages, see chapter 10.10.2, "Reference: GPIB Commands of Emulated HP Models", on page 811.

Note: Emulating previous R&S signal and spectrum analyzers. As of firmware version 1.60, this function is also used to emulate previous R&S signal and spectrum analyzers.

As a rule, the R&S FSW supports most commands from previous R&S signal and spectrum analyzers such as the FSQ, FSP, FSU, or FSV. However, the default values, in particular the number of sweep points or particular bandwidths, may vary. Therefore, the R&S FSW can emulate these other devices, including their default values, in order to repeat previous measurements or support existing control applications as in legacy systems.

Note: For PSA89600 emulation, the option is indicated as "B7J" for the `*OPT?` query ("B7J, 140" or "B7J, 122" if Wideband is activated, see `SYST:PSA:WIDeband` on page 809).

SCPI command:

`SYSTem:LANGuage` on page 809

IF Gain

Configures the internal IF gain settings in HP emulation mode due to the application needs. This setting is only taken into account for resolution bandwidth < 300 kHz.

NORM	Optimized for high dynamic range, overload limit is close to reference level.
PULS	Optimized for pulsed signals, overload limit up to 10 dB above reference level.

This setting is only available if an HP language is selected (see "Language" on page 470).

SCPI command:

`SYSTem:IFGain:MODE` on page 808

Sweep Repeat

Controls a repeated sweep of the E1 and MKPK HI HP model commands (for details on the commands refer to chapter 10.10.2, "Reference: GPIB Commands of Emulated HP Models", on page 811). If the repeated sweep is OFF, the marker is set without sweeping before.

Note: In single sweep mode, switch off this setting before you set the marker via the E1 and MKPK HI commands in order to avoid sweeping again.

This setting is only available if a HP language is selected (see "Language" on page 470).

SCPI command:

`SYSTem:RSW` on page 810

Coupling

Controls the default coupling ratios in the HP emulation mode for:

- span and resolution bandwidth (Span/RBW)
- resolution bandwidth and video bandwidth (RBW/VBW)

For FSx, the standard parameter coupling of the instrument is used. As a result, in most cases a shorter sweep time is used than in case of HP.

This setting is only available if a HP language is selected (see "Language" on page 470).

SCPI command:

`SYSTem:HPCoupling` on page 808

Wideband

This setting defines which option is returned when the `*OPT?` query is executed, depending on the state of the wideband option.

It is only available for PSA89600 emulation.

"Off"	No wideband is used. The option is indicated as "B7J".
"40 MHz"	The 40 MHz wideband is used. The option is indicated as "B7J, 140".
"80 MHz"	The 80 MHz wideband is used. The option is indicated as "B7J, 122".

SCPI command:

`SYST:PSA:WIDeband` on page 809

Revision String

Defines the response to the `REV?` query for the revision number (HP emulation only, see "GPIB Address" on page 468). Max. 36 characters are allowed.

SCPI command:

`SYSTem:REVision[:STRing]` on page 810

Resetting the Factory Revision

Resets the response to the `REV?` query for the revision number to the factory default (HP emulation only, see "Language" on page 470).

SCPI command:

`SYSTem:REVision:FACTory` on page 810

9.4.4 LXI Settings

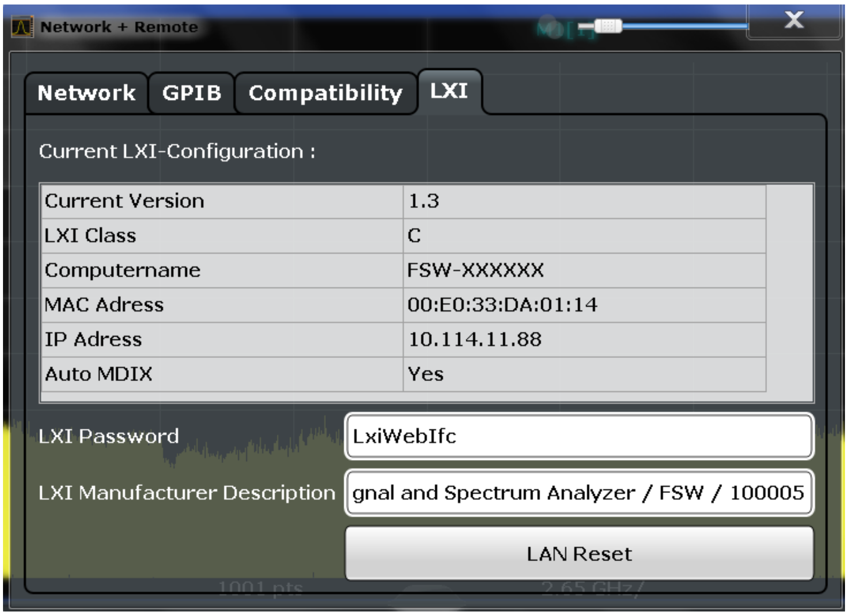
On the R&S FSW the LXI Class C functionality is already installed and enabled; thus, the instrument can be accessed via any web browser (e.g. the Microsoft Internet Explorer) to perform the following tasks:

- modifying network configurations
- modifying device configurations
- monitoring connections from the device to other devices

The "LXI" tab of the "Network + Remote" dialog box provides basic LXI functions and information for the R&S FSW.

Alternatively, you can change the LAN settings using the LXI Web browser interface, see chapter 9.5.1.4, "How to Configure the LAN Using the LXI Browser Interface", on page 478.

Only user accounts with administrator rights are able to use LXI functionality.



Current LXI Configuration

Displays the current LXI information from the R&S FSW (read-only).

"Current version"	Current LXI version
"LXI Class"	LXI device class
"Computer name"	Name of the R&S FSW as defined in the operating system (see also "Computer Name" on page 466)
"MAC address"	Media Access Control address (MAC address), a unique identifier for the network card in the R&S FSW
"IP address"	IP address of the R&S FSW as defined in the operating system (see also "IP Address" on page 467).
"Auto MDIX"	Enables the use of the built-in Auto-MDI(X) Ethernet functionality.

SCPI command:

`SYSTem:LXI:INFo?` on page 797

LXI Password

Password for LAN configuration. The default password is *LxiWebIfc*.

SCPI command:

`SYSTem:LXI:PASSword` on page 797

LXI Manufacturer Description

Instrument description of the R&S FSW

SCPI command:

SYSTem:LXI:MDEScription on page 797

LAN Reset

Resets the LAN configuration to its default settings (LCI function).

According to the LXI standard, an LCI must set the following parameters to a default state.

Parameter	Value
TCP/IP Mode	DHCP + Auto IP Address
Dynamic DNS	Enabled
ICMP Ping	Enabled
Password for LAN configuration	LxiWebIfc

The LAN settings are configured in the "Network" tab of the "Network + Remote" dialog box or using the instrument's LXI Browser interface.

SCPI command:

SYSTem:LXI:LANReset on page 797

9.5 How to Set Up a Network and Remote Control

NOTICE

Risk of network failure

Before connecting the instrument to the network or configuring the network, consult your network administrator. Errors may affect the entire network.

Remote operation

Remote operation of the instrument from a connected computer is possible using SCPI commands (see chapter 9.1.2, "SCPI (Standard Commands for Programmable Instruments)", on page 433). Sending remote commands requires the instrument to be configured in a LAN network or connected to a PC via the GPIB interface as described in chapter 9.5.1, "How to Configure a Network", on page 475.

Remote Desktop

In production test and measurement, a common requirement is central monitoring of the T&M instruments for remote maintenance and remote diagnostics. Equipped with the Remote Desktop software of Windows, the R&S FSW ideally meets requirements for use

in production. The computer that is used for remote operation is called "controller" here.
The following tasks can be performed using Remote Desktop:

- Access to the control functions via a virtual front panel (soft front panel)
- Printout of measurement results directly from the controller
- Storage of measured data on the controller's hard disk

This documentation provides basic instructions on setting up the Remote Desktop for the R&S FSW. For details refer to the Windows operating system documentation.

9.5.1 How to Configure a Network

A precondition for operating or monitoring the R&S FSW remotely is that it is connected to a LAN network or a PC connected to the GPIB interface. This is described here.

Windows Firewall Settings

A firewall protects an instrument by preventing unauthorized users from gaining access to it through a network. Rohde & Schwarz highly recommends the use of the firewall on your instrument. R&S instruments are shipped with the Windows firewall enabled and preconfigured in such a way that all ports and connections for remote control are enabled.
For more details on firewall configuration see the R&S White Paper "Malware Protection" (available at http://www.rohde-schwarz.com/appnote/1EF73) and the Windows help system.

9.5.1.1 How to Connect the Instrument to the Network

There are two methods to establish a LAN connection to the instrument:

- A non-dedicated network (Ethernet) connection from the instrument to an existing network made with an ordinary RJ-45 network cable. The instrument is assigned an IP address and can coexist with a computer and with other hosts on the same network.
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer made with a (crossover) RJ-45 network cable. The computer must be equipped with a network adapter and is directly connected to the instrument. The use of hubs, switches, or gateways is not required, however, data transfer is still performed using the TCP/IP protocol. An IP address has to be assigned to the instrument and the computer, see chapter 9.5.1.2, "How to Assign the IP Address", on page 476.
Note: As the R&S FSW uses a 1 GBit LAN, a crossover cable is not necessary (due to Auto-MDI(X) functionality).

► To establish a non-dedicated network connection, connect a commercial RJ-45 cable to one of the LAN ports.
To establish a dedicated connection, connect a (crossover) RJ-45 cable between the instrument and a single PC.

If the instrument is connected to the LAN, Windows automatically detects the network connection and activates the required drivers.

The network card can be operated with a 1 GBit Ethernet IEEE 802.3u interface.

9.5.1.2 How to Assign the IP Address

Depending on the network capacities, the TCP/IP address information for the instrument can be obtained in different ways.

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), all address information can be assigned automatically.
- If the network does not support DHCP, or if the instrument is set to use alternate TCP/IP configuration, the addresses must be set manually.

By default, the instrument is configured to use dynamic TCP/IP configuration and obtain all address information automatically. This means that it is safe to establish a physical connection to the LAN without any previous instrument configuration.

NOTICE

Risk of network errors

Connection errors can affect the entire network. If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the instrument to the LAN. Contact your network administrator to obtain a valid IP address.

Assigning the IP address on the R&S FSW

1. Press the SETUP key.
2. Press the "Network + Remote" softkey.
3. Select the "Network" tab.
4. In the "Network + Remote" dialog, toggle the "DHCP On/Off" setting to the required mode.
   If DHCP is "Off", you must enter the IP address manually, as described in the following steps.
   Note: When DHCP is changed from "On" to "Off", the previously set IP address and subnet mask are retrieved.
   If DHCP is "On", the IP address of the DHCP server is obtained automatically. The configuration is saved, and you are prompted to restart the instrument. You can skip the remaining steps.
   Note: When a DHCP server is used, a new IP address may be assigned each time the instrument is restarted. This address must first be determined on the instrument itself. Thus, when using a DHCP server, it is recommended that you use the permanent computer name, which determines the address via the DNS server.
5. Enter the "IP Address", for example *10.0.0.10*. The IP address consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.

6. Enter the "Subnet Mask", for example *255.255.255.0*. The subnet mask consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.
7. Close the dialog box.

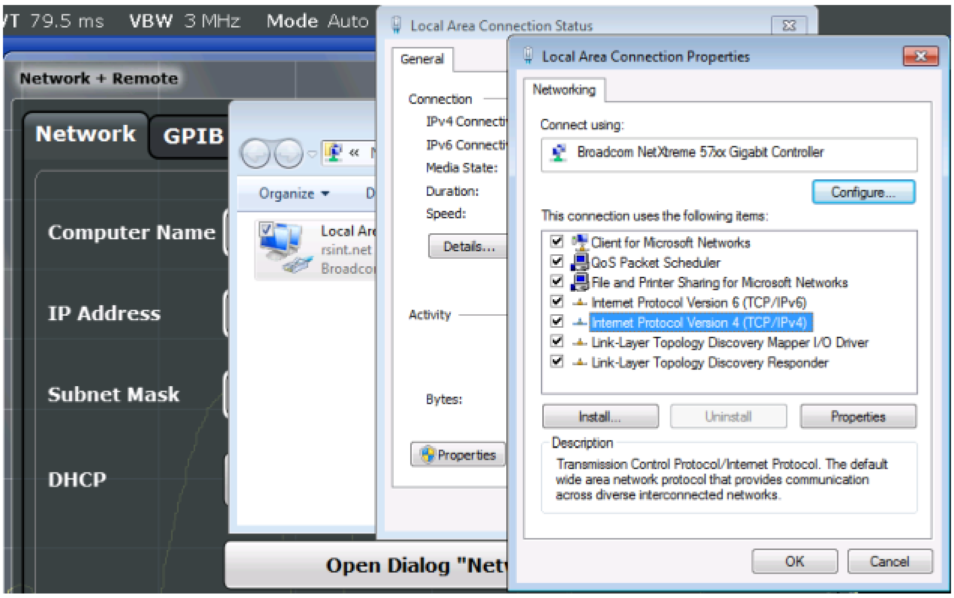
   If you have entered an invalid IP address or subnet mask, the message "out of range" is displayed in the status line. If the settings are correct, the configuration is saved, and you are prompted to restart the instrument.
8. Confirm the displayed message ("Yes" button) to restart the instrument.

Using a DNS server to determine the IP address

If a DNS server is configured on the R&S FSW, the server can determine the current IP address for the connection using the permanent computer name.

1. Obtain the name of your DNS domain and the IP addresses of the DNS and WINS servers on your network (see chapter 9.5.1.3, "How to Change the Instrument Name", on page 478).
2. Press the SETUP key and then the "Network + Remote" softkey.
3. In the "Network" tab, select the "Open Dialog 'Network Connections'" button.
4. Double-tap the "Local Area Network" icon.
5. In the "Local Area Connection Status" dialog box, select the "Properties" button.

   The items used by the LAN connection are displayed.
6. Tap the entry named "Internet Protocol Version 4 (TCP/IPv4)" to highlight it.



7. Select the "Properties" button.

8. On the "General" tab, select "Use the following DNS server addresses" and enter your own DNS addresses.

   For more information refer to the Windows operating system Help.

9.5.1.3 How to Change the Instrument Name

In a LAN that uses a DNS server (Domain Name System server), each PC or instrument connected in the LAN can be accessed via an unambiguous computer name instead of the IP address. The DNS server translates the host name to the IP address. This is especially useful when a DHCP server is used, as a new IP address may be assigned each time the instrument is restarted.

Each instrument is delivered with an assigned computer name, but this name can be changed.

To change the computer name

1. Press the SETUP key and then the "Network + Remote" softkey.
   The current "Computer Name" is displayed in the "Network" tab.
2. Enter the new computer name and close the dialog box.

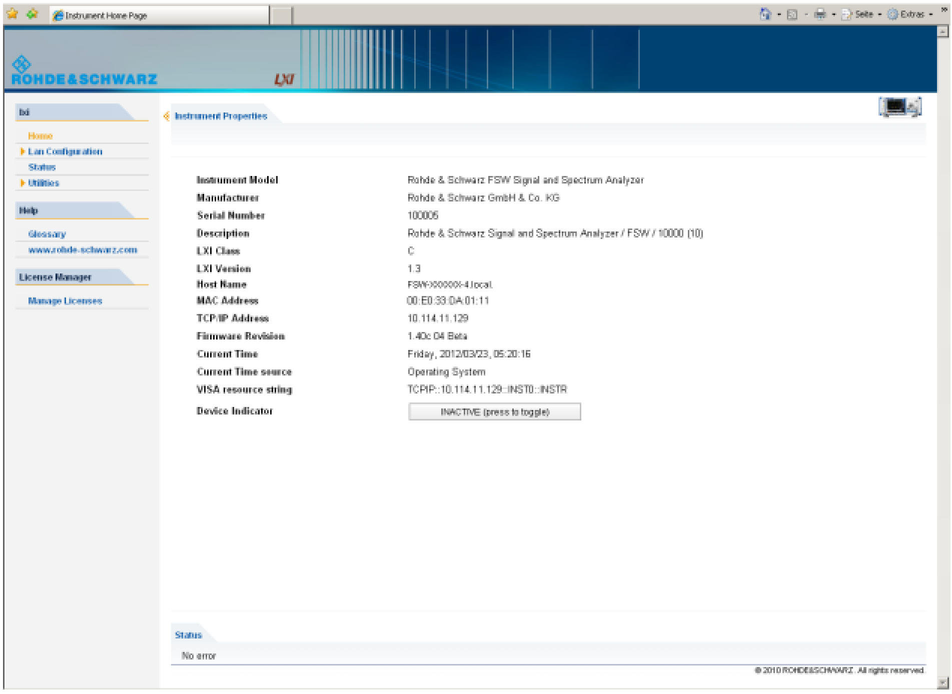
   The configuration is saved, and you are prompted to restart the instrument.
3. Confirm the displayed message ("Yes" button) to restart the instrument.

9.5.1.4 How to Configure the LAN Using the LXI Browser Interface

The instrument's LXI browser interface works correctly with all W3C compliant browsers.

► In the web browser, open the `http://<instrument-hostname>` or `http://<instrument-ip-address>` page, e.g. *http://10.113.10.203*.
  The default password to change LAN configurations is *LxiWebIfc*.

  The "Instrument Home Page" (welcome page) opens.



The instrument home page displays the device information required by the LXI standard including the VISA resource string in read-only format.

► Press the "Device Indicator" button on the "Instrument Home Page" to activate or deactivate the LXI status icon on the status bar of the R&S FSW. A green LXI status symbol indicates that a LAN connection has been established; a red symbol indicates an error, for example, that no LAN cable is connected. When a device is connecting to the instrument, the LXI logo blinks. The "Device Indicator" setting is not password-protected.

The most important control elements in the navigation pane of the browser interface are the following:

- "LAN Configuration" opens the menu with configuration pages.
- "Status" displays information about the LXI status of the instrument.
- "Help > Glossary" opens a document with a glossary of terms related to the LXI standard.

LAN Configuration

The LAN configuration consists of three parts:

- "IP configuration" provides all mandatory LAN parameters.
- "Advanced LAN Configuration" provides LAN settings that are not declared mandatory by the LXI standard.
- "Ping Client" provides the ping utility to verify the connection between the instrument and other devices.

IP Configuration

The "LAN Configuration > IP configuration" web page displays all mandatory LAN parameters and allows their modification.

The "TCP/IP Mode" configuration field controls how the IP address for the instrument gets assigned (see also chapter 9.5.1.2, "How to Assign the IP Address", on page 476). For the manual configuration mode, the static IP address, subnet mask, and default gateway are used to configure the LAN. The automatic configuration mode uses DHCP server or Dynamic Link Local Addressing (Automatic IP) to obtain the instrument IP address.

Changing the LAN configuration is password-protected. The default password is *LxiWeblfc* (notice upper and lower case characters).

You can change the LXI password in the "Network + Remote" dialog box, see chapter 9.4.4, "LXI Settings", on page 472.

Advanced LAN Configuration

The "LAN Configuration > Advanced LAN Configuration" parameters are used as follows:

- The "Negotiation" configuration field provides different Ethernet speed and duplex mode settings. In general, the "Auto Detect" mode is sufficient.
- "ICMP Ping" must be enabled to use the ping utility.
- "VXI-11" is the protocol that is used to detect the instrument in the LAN. According to the standard, LXI devices must use VXI-11 to provide a detection mechanism; other additional detection mechanisms are permitted.
- mDNS and DNS-SD are two additional protocols: Multicast DNS and DNS Service Discovery. They are used for device communication in zero configuration networks working without DNS and DHCP

Ping Client

Ping is a utility that verifies the connection between the LXI-compliant instrument and another device. The ping command uses the `ICMP` echo request and echo reply packets to determine whether the LAN connection is functional. Ping is useful for diagnosing IP network or router failures. The ping utility is not password-protected.

To initiate a ping between the LXI-compliant instrument and a second connected device:

1. Enable "ICMP Ping" on the "Advanced LAN Configuration" page (enabled after an LCI).
2. Enter the IP address of the second device **without the ping command and without any further parameters** into the "Destination Address" field (e.g. *10.113.10.203*).
3. Select "Submit".

9.5.1.5 How to Change the GPIB Instrument Address

In order to operate the instrument via remote control, it must be addressed using the GPIB address. The remote control address is factory-set to 20, but it can be changed if it does not fit in the network environment. For remote control, addresses 0 through 30 are allowed. The GPIB address is maintained after a reset of the instrument settings.

Setting the GPIB address

1. On the R&S FSW, press the SETUP key.
2. Press the "Network + Remote" softkey.
3. In the "Network + Remote" dialog box, select the "GPIB" tab.
4. In the "GPIB Address" field, enter a value between 0 and 30.

SCPI command:

```
SYST:COMM:GPIB:ADDR 18
```

9.5.2 How to Operate the Instrument Without a Network

To operate the instrument without a network connection either temporarily or permanently, no special measures are necessary. Windows automatically detects the interruption of the network connection and does not set up the connection when the instrument is switched on.

If you are not prompted to enter the user name and password, proceed as described in "Reactivating the automatic login mechanism" on page 483.

9.5.3 How to Log on to the Network

Windows requires that users identify themselves by entering a user name and password in a login window. You can set up two types of user accounts, either an administrator account with unrestricted access to the computer/domain or a standard user account with limited access. The instrument provides an auto-login function for the administrator account, i.e. login with unrestricted access is carried out automatically in the background. By default, the user name for the administrator account is "Instrument", and the user name for the standard user account is "NormalUser". In both cases the initial password is "894129". You can change the password in Windows for any user at any time. Some administrative tasks require administrator rights (e.g. firmware updates or the configuration of a LAN network). Refer to chapter 8, "General Instrument Setup", on page 387 to find out which functions are affected.

At the same time you log on to the operating system, you are automatically logged on to the network. As a prerequisite, the user name and the password must be identical on the instrument and on the network.

9.5.3.1 How to Create Users

After the software for the network has been installed, the instrument issues an error message the next time it is switched on because there is no user named "instrument" (= default user ID for Windows automatic login) in the network. Thus, a matching user must be created in the R&S FSW and in the network, the password must be adapted to the network password, and the automatic login mechanism must then be deactivated.

The network administrator is responsible for creating new users in the network. A new user can be created on the instrument using the "User Account" dialog box:

1. Select the "Windows" icon in the toolbar to access the operating system.
2. In the "Start" menu, select "Control Panel" and then select "User Accounts."
3. Select "Give other users access to this computer" and then "Add".
   The "Add New User" dialog box is displayed.
4. Enter the name of the new user in the text field and select "Next".
5. Define the level of access you want to allow the new user:
   - Select "Standard" to create an account with limited rights.
   - Select "Administrator" to create an account with administrator rights.

   Note: Full firmware functionality requires administrator rights.
6. Select the "Finish" button.
   The new user is created.

9.5.3.2 How to Change the User Password

After the new user has been created on the instrument, the password must be adapted to the network password. This is also done using the "User Accounts" dialog box.

1. Select the "Windows" icon in the toolbar to access the operating system.
2. In the "Start" menu, select "Control Panel" and then select "User Accounts".
3. Select "Manage User Accounts".
4. Select the desired user account and then "Reset Password...".
5. Enter the new password in the upper text line and repeat it in the following line.
6. Select the "Reset Password" button (at the end of the page).
   The new password is now active.

9.5.3.3 How to Activate or Deactivate the Automatic Login Mechanism

Deactivating the automatic login mechanism

When shipped, the instrument is already configured to automatically log on under Windows. To deactivate the automatic login mechanism, perform the following steps:

1. In the "Start" menu, select "Run".
   The "Run" dialog box is displayed.
2. Enter the command `C:\R_S\INSTR\USER\NO_AUTOLOGIN.REG`.
3. Press the ENTER key to confirm.
   The automatic login mechanism is deactivated. The next time you switch on the instrument, you are prompted to enter your user name and password before the firmware is started.

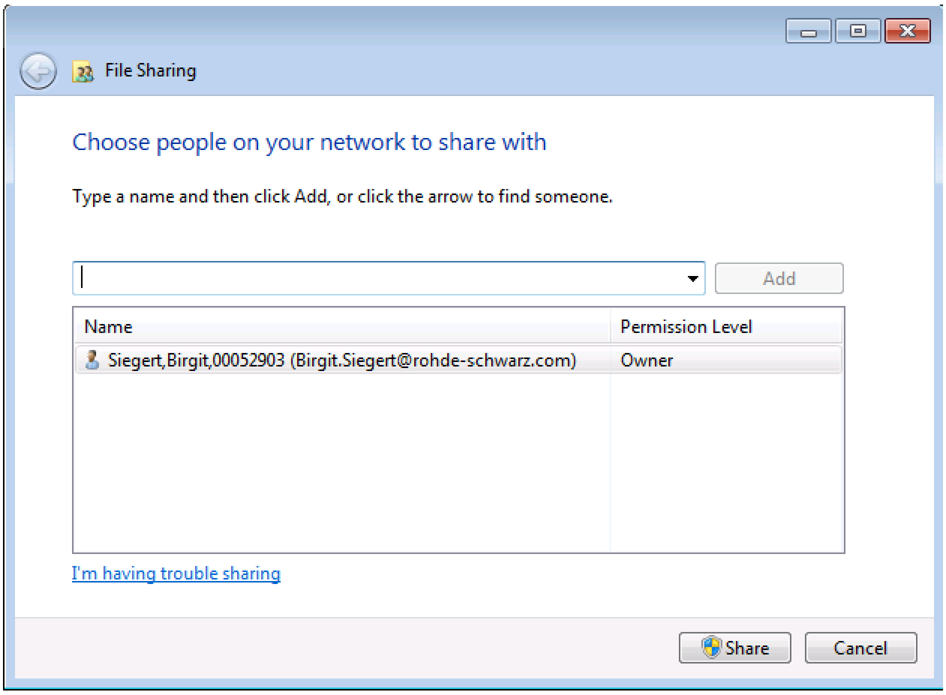
Reactivating the automatic login mechanism

1. In the "Start" menu, select "Run".
   The "Run" dialog box is displayed.
2. Enter the command `C:\R_S\INSTR\USER\AUTOLOGIN.REG`.
3. Press the ENTER key to confirm.
   The automatic login mechanism is reactivated. It will be applied the next time the instrument is switched on.

9.5.4 How to Share Directories (only with Microsoft Networks)

Sharing directories makes data available for other users. This is only possible in Microsoft networks. Sharing is a property of a file or directory.

1. In the "Start" menu, select "Programs", "Accessories" and then select "Windows Explorer".
2. Select the desired folder with the right mouse button.
3. In the context menu, select "Sharing with > Specific people".
   The dialog box for sharing a directory is displayed.



4. Select a user from the list or add a new name and select the "Add" button.
5. Select the "Share" button.
6. Select "Done" to close the dialog box.
   The drive is shared and can be accessed by the selected users.

9.5.5 How to Set Up Remote Desktop

Remote Desktop is a Windows application which can be used to access and control the instrument from a remote computer through a LAN connection. While the instrument is in operation, the instrument screen contents are displayed on the remote computer, and Remote Desktop provides access to all of the applications, files, and network resources of the instrument. Thus, remote operation of the R&S FSW is possible.

With Windows7, Remote Desktop Client is part of the operating system. For other versions of Windows, Microsoft offers the Remote Desktop Client as an add-on.

This section provides basic instructions on setting up the Remote Desktop for the R&S FSW. For details refer to the Windows operating system documentation.

9.5.5.1 How to Configure the R&S FSW for Remote Operation via Remote Desktop

1. Create a fixed IP address for the TCP/IP protocol as described in "Assigning the IP address on the R&S FSW" on page 476.

   Note: To avoid problems, use a fixed IP address.

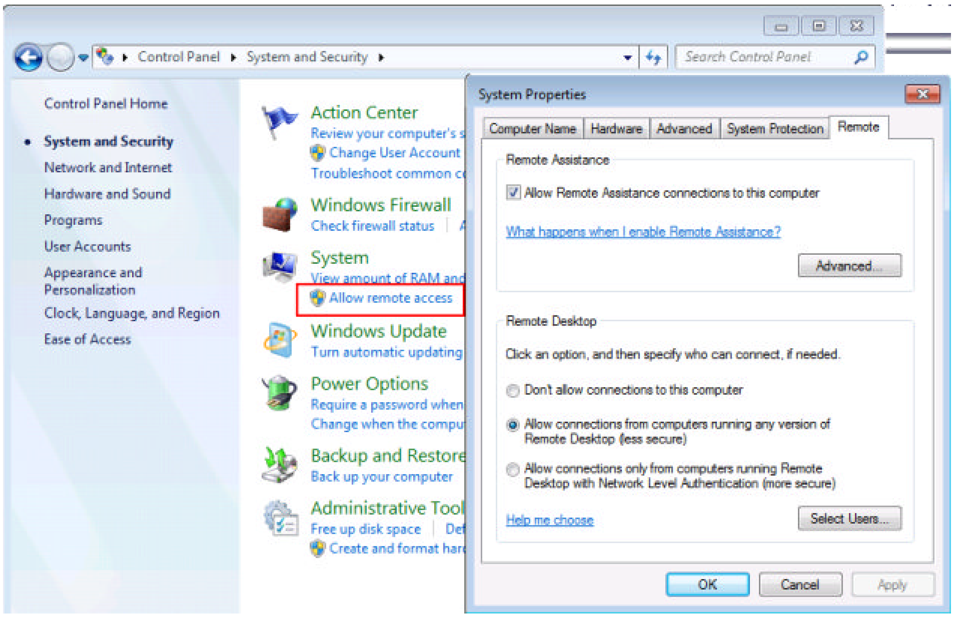
When a DHCP server is used, a new IP address is assigned each time the instrument is restarted. This address must first be determined on the instrument itself. Thus, using a DHCP server is not suitable for remote operation of the R&S FSW via Remote Desktop.

2. 

   Select the "Windows" icon in the toolbar to access the operating system.

3. In the "Start" menu, select the "Control Panel" and then "System and Security".

4. In the "System" area, select "Allow remote access".



5. In the "Remote" tab, in the "Remote Desktop" area, activate the "Allow connections from computers running Remote Desktop" option.

6. Define which users are to be given access to the R&S FSW via Remote Desktop.
   Note: The user account under which configuration is carried out is automatically enabled for Remote Desktop.

   a) Select the "Select Users" button.
   b) Select the users or create new user accounts as described in chapter 9.5.3.1, "How to Create Users", on page 482.
   c) Select "OK" to confirm the settings.

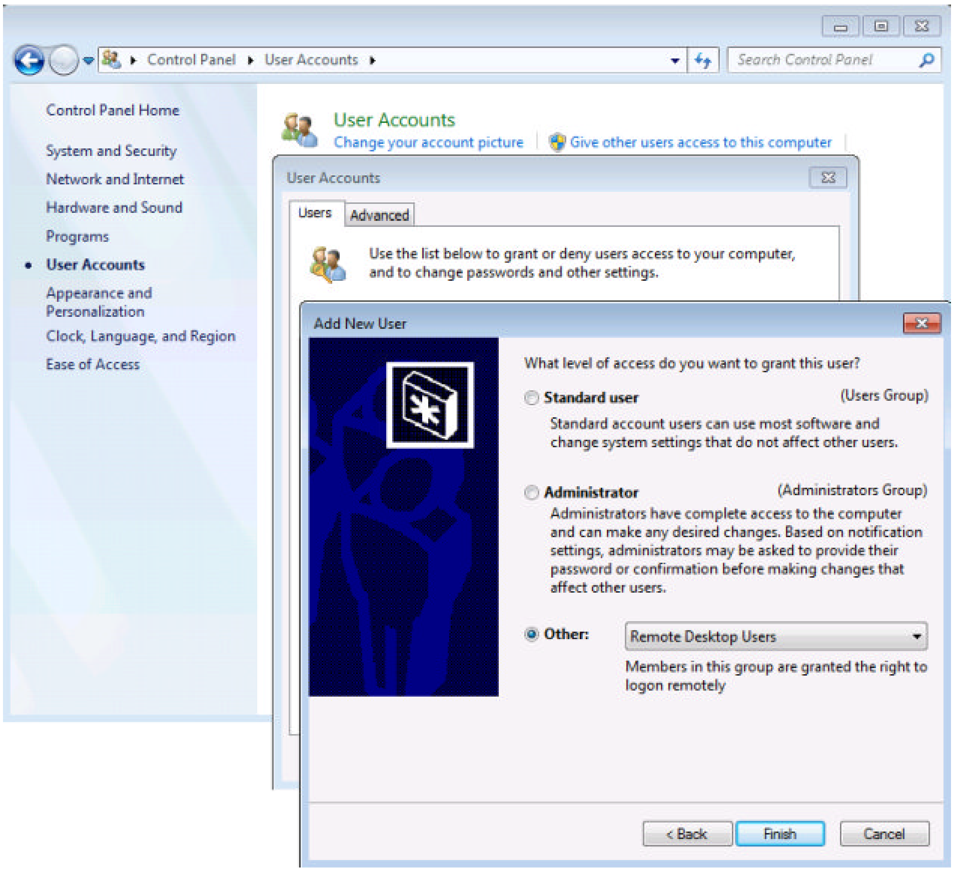
7. The R&S FSW is now ready for connection setup with the Remote Desktop program of the controller.

9.5.5.2 How to Add or Remove Users to the Remote Desktop Users Group

Only users in the Remote Desktop Users Group are allowed to connect to the R&S FSW via Remote Desktop. You can add the users to this group directly when you allow remote access on the R&S FSW, as described in chapter 9.5.5, "How to Set Up Remote Desktop", on page 484. Furthermore, you can add or remove users to this group at any time.

1. Select the "Windows" icon in the toolbar to access the operating system.
2. In the "Start" menu, select "Control Panel" and then select "User Accounts."
3. Select "Give other users access to this computer".
   The "User Accounts" dialog box is displayed with a list of users and the user group they are assigned to.
4. Give existing users the right to access the R&S FSW via Remote Desktop:
   a) Select the user from the list and then select the "Properties" button.
   b) As the level of access you want to allow the user, select "Other", then select "Remote Desktop Users" from the dropdown list.
   c) Select the "Finish" button.
      The user is added to the Remote Desktop Users Group.
5. Create new users who may access the R&S FSW via Remote Desktop:
   a) Select "Add".
   b) Enter the name of the new remote user in the text field and select "Next".

c) As the level of access you want to allow the new user, select "Other", then select "Remote Desktop Users" from the dropdown list.



d) Select the "Finish" button.
The user is created.

6. Remove users from the Remote Desktop Users Group:
   a) Select the user from the list and then select the "Remove" button.
   b) Select "OK" to confirm the action.

   Note: Users with administrator rights retain their access rights via Remote Desktop even when they have been removed from the Remote Desktop Users Group.

7. Select "OK" to close the dialog box.

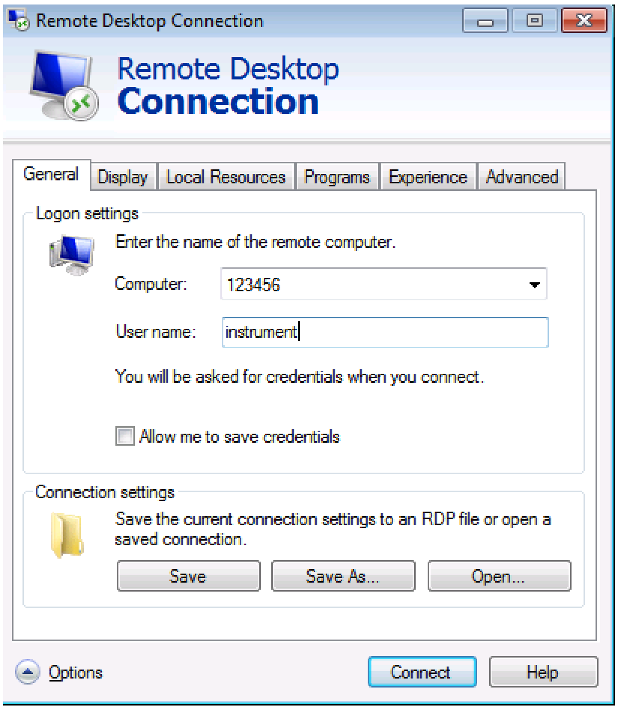
9.5.5.3 How to Configure the Controller

Remote Desktop Client

With Windows7, Remote Desktop Client is part of the operating system and can be accessed via "Start > Programs > Accessories > Communications > Remote Desktop Connection".

For other versions of Windows, Microsoft offers the Remote Desktop Client as an add-on.

1. In the "Start" menu of the controller, select "All Programs > Accessories > Remote Desktop Connection".
   The "Remote Desktop Connection" dialog box is displayed.
2. Select the "Options >>" button.
   The dialog box is expanded to display the configuration data.



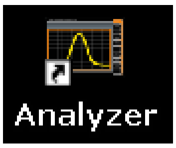
3. Open the "Experience" tab.
   The settings on this tab are used to select and optimize the connection speed.
4. In the list, select the appropriate connection (for example: LAN (10 Mbps or higher)).
   Depending on your selection (and how powerful the connection is), the options are activated or deactivated.
5. To improve the performance, you can deactivate the "Desktop background", "Show window contents while dragging" and "Menu and window animation" options.
6. Open the "Local Resources" tab to enable printers, local drives and serial interfaces.
7. If you will need to access drives of the controller from the R&S FSW (e.g. in order to store settings or to copy files from the controller to the R&S FSW), activate the "Disk drives" option.
   Windows will then map drives of the controller to the corresponding network drives.
8. To use printers connected to the controller while accessing them from the R&S FSW, activate the "Printers" options. Do not change the remaining settings.
9. Open the "Display" tab.
   The options to configure the R&S FSW screen display are displayed.

10. Under "Remote desktop size", you can set the size of the R&S FSW window on the desktop of the controller.
11. Under "Colors", do not change the settings.
12. Set the "Display the connection bar when I use the full screen" option:
If activated, a bar showing the network address of the R&S FSW will appear at the top edge of the screen. You can use this bar to reduce, minimize or close the window. If deactivated, the only way you can return to the controller desktop from the R&S FSW screen in full screen mode is to select "Disconnect" from the "Start" menu.

9.5.5.4 How to Start and Close the Remote Desktop

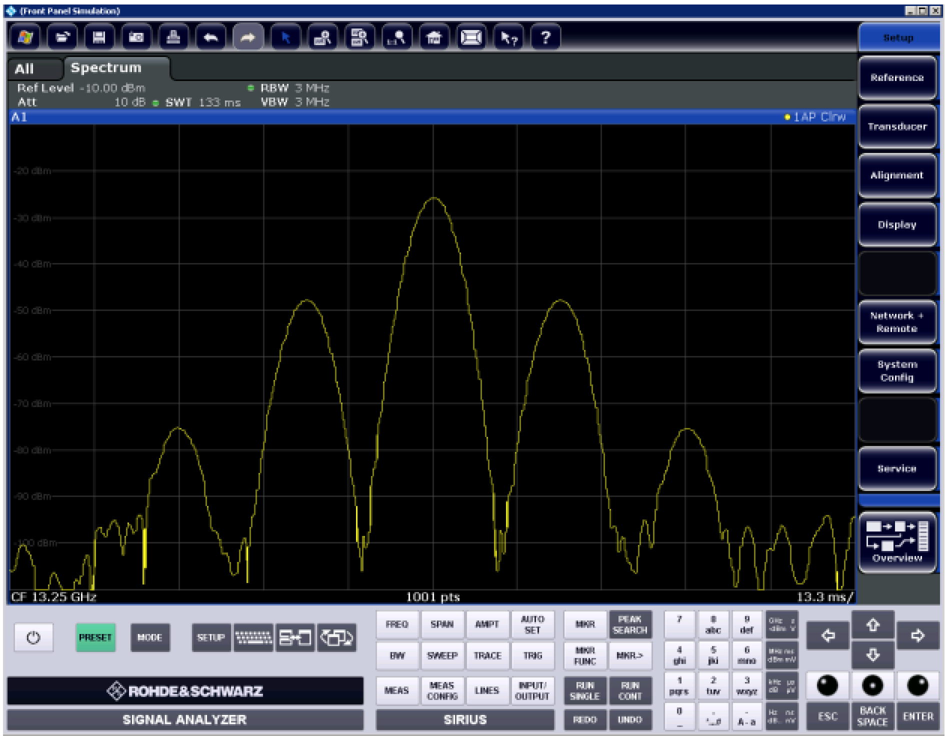
To set up a connection to the R&S FSW

1. In the "Remote Desktop Connection" dialog box (see chapter 9.5.5.3, "How to Configure the Controller", on page 487), open the "General" tab.
2. In the "Computer" field, enter the IP address of the R&S FSW.
In the "User name" field, enter *instrument* to log in as an administrator, or *Normal User* to log in as a standard user.
In the "Password" field, enter *894129*.
3. To save the connection configuration for later use:
   a) Select the "Save As" button.
   The "Save As" dialog box is displayed.
   b) Enter the name for the connection information (`*.RDP`).
4. To load an existing connection configuration:
   a) Select the "Open" button.
   The "Open" dialog box is displayed.
   b) Select the `*.RDP` file.
5. Select the "Connect" button.
The connection is set up.
6. If the "Disk drives" option is activated on the "Local Resources" tab, a warning is displayed indicating that the drives are enabled for access from the R&S FSW. Select "OK" to confirm the warning.
7. After a few moments, the R&S FSW screen is displayed.
If a dark screen appears or a dark square appears in the upper left-hand corner of the screen, you must restart the R&S FSW in order to see the modified screen resolution.

	• Press the key combination ALT + F4. • The R&S FSW firmware is shut down, which may take a few seconds. • On the desktop, double-tap the "Analyzer" icon.

The firmware restarts and then automatically opens the "Soft Front Panel", i.e. the user interface on which all front panel controls and the rotary knob are mapped to buttons. For details see chapter 8.6.7, "How to Work with the Soft Front Panels", on page 426.

8. To deactivate or activate the "Softfrontpanel", press the F6 key.
   After the connection is established, the R&S FSW screen is displayed in the "Remote Desktop" application window.



   The Windows "Start" menu can be made available by expanding the "Remote Desktop" window to full size.
   During the connection with the controller, the login entry is displayed on the R&S FSW screen.

To terminate Remote Desktop control

The connection can be terminated by the controller or by a user at the R&S FSW:

1. On the controller, close the "Remote Desktop" window at any time.
   The connection to the R&S FSW is terminated.

2. On the R&S FSW, a user logs on.
   The connection to the controller is terminated as a result. A message is displayed on the controller display indicating that another user has assumed control of the instrument.

Restoring the connection to the R&S FSW

Follow the instructions above for setting up a connection to the R&S FSW. If the connection is terminated and then restored, the R&S FSW remains in the same state.

9.5.5.5 How to Shut Down the R&S FSW via Remote Operation

1. Select the R&S FSW softfrontpanel and close the application with the key combination ALT + F4.
2. Select the desktop and press the key combination ALT + F4.
   A safety query is displayed to warn you that the instrument cannot be reactivated via remote operation and asks you whether you want to continue the shutdown process.
3. Respond to the safety query with "Yes".
   The connection with the controller is terminated and the R&S FSW is shut down.

9.5.6 How to Start a Remote Control Session from a PC

When you switch on the instrument, it is always in manual operation state ("local" state) and can be operated via the front panel.

To start remote control

1. Send an addressed command (`GTR` - Go to Remote) from a controller to the instrument.

   The instrument is switched to remote control ("remote" state). Operation via the front panel is disabled. Only the "Local" softkey is displayed to return to manual operation. The instrument remains in the remote state until it is reset to the manual state via the instrument or via remote control interfaces. Switching from manual operation to remote control and vice versa does not affect the other instrument settings.
2. During program execution, send the `SYSTem:DISPlay:UPDate ON` command to activate the display of results (see `SYSTem:DISPlay:UPDate` on page 796).

   The changes in the device settings and the recorded measurement values are displayed on the instrument screen.
3. To obtain optimum performance during remote control, send the `SYSTem:DISPlay:UPDate OFF` command to hide the display of results and diagrams again (default setting in remote control).
4. To prevent unintentional return to manual operation, disable the keys of the instrument using the universal command `LLO`.

   Switching to manual mode is only possible via remote control then. This function is only available for the GPIB interface.
5. To enable the keys of the R&S FSW again, switch the instrument to local mode (`GTL` - Go to Local), i.e. deactivate the `REN` line of the remote control interface.

If the instrument is operated exclusively in remote control, it is recommended that you switch on the power-save mode for the display. For more details on this mode refer to the "Overview".

9.5.7 How to Return to Manual Operation

Before you switch back to manual operation, all remote command processing must be completed. Otherwise, the instrument will switch back to remote control immediately.

► Select the "Local" softkey or the PRESET key, or use the following GPIB command:
`status = viGpibControlREN(vi, VI_GPIB_REN_ADDRESS_GTL)`

10 Remote Commands

The commands required to perform measurements in the Spectrum application in a remote environment are described here. It is assumed that the R&S FSW has already been set up for remote operation in a network as described in chapter 9.5, "How to Set Up a Network and Remote Control", on page 474.

Common Suffixes

In the Spectrum application, the following common suffixes are used in remote commands:

Suffix	Value range	Description
<ch>	1..18 (TX channel) 1..11 (ALT channel)	Channel
<k>	1..8 (Limit line) 1 | 2 (Display line)	Line
<m>	1..16	Marker
<n>	1..16	Window
<t>	1..6	Trace

Compatibility with former R&S signal and spectrum analyzers

As a rule, the R&S FSW supports most commands from previous R&S signal and spectrum analyzers such as the FSQ, FSP, FSU, or FSV. However, the default values, in particular the number of sweep points or particular bandwidths, may vary. Therefore, the R&S FSW can emulate these other devices, including their default values, in order to repeat previous measurements or support existing control applications as in legacy systems.

10.1 Common Commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

***CAL?**

Calibration Query

Initiates a calibration of the instrument and subsequently queries the calibration status. Responses > 0 indicate errors.

Usage: Query only

Manual control: See "Starting a Self-alignment" on page 398

***CLS**

CLear Status

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Usage: Setting only

***ESE** <Value>

Event Status Enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

Parameters:

<Value> Range: 0 to 255

***ESR?**

Event Status Read

Returns the contents of the event status register in decimal form and subsequently sets the register to zero.

Return values:

<Contents> Range: 0 to 255

Usage: Query only

***IDN?**

IDeNtification: returns the instrument identification.

Return values:

<ID> "Rohde&Schwarz,<device type>,<serial number>,<firmware version>"

Example: `Rohde&Schwarz,FSW-26,1312.8000K26/100005,1.30`

Usage: Query only

Manual control: See "*IDN Format" on page 469

***IST?**

Individual STatus query

Returns the contents of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

Return values:

<ISTflag> 0 | 1

Usage: Query only

***OPC**

OPeration Complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query form writes a "1" into the output buffer as soon as all preceding commands have been executed. This is used for command synchronization.

***OPT?**

OPTion identification query

Queries the options included in the instrument. For a list of all available options and their description refer to the CD-ROM.

Return values:

<Options>	The query returns a list of all installed and activated options, separated by commas, where: B<number> describes hardware options K<number> describes software options For PSA89600 emulation, the option is indicated as "B7J" for the `*OPT?` query ("B7J, 140" if `SYST:PSA:WIDeband` is activated).
Usage:	Query only

***PCB** <Address>

Pass Control Back

Indicates the controller address to which remote control is returned after termination of the triggered action.

Setting parameters:

<Address>	Range:	0 to 30
Usage:	Setting only	

***PRE** <Value>

Parallel poll Register Enable

Sets parallel poll enable register to the indicated value. The query returns the contents of the parallel poll enable register in decimal form.

Parameters:

<Value>	Range:	0 to 255

***PSC** <Action>

Power on Status Clear

Determines whether the contents of the `ENABle` registers are preserved or reset when the instrument is switched on. Thus a service request can be triggered when the instrument is switched on, if the status registers ESE and SRE are suitably configured. The query reads out the contents of the "power-on-status-clear" flag.

Parameters:

<Action> 0 | 1

0
The contents of the status registers are preserved.

1
Resets the status registers.

***RST**

ReSeT

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

Note that the factory set default values can be modified to user-defined settings (see `MMEMory:LOAD:STATe` on page 766). For more details on default values see chapter 7.1, "Restoring the Default Instrument Configuration (Preset)", on page 364.

Usage: Setting only

***SRE** <Contents>

Service Request Enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

Parameters:

<Contents> Contents of the service request enable register in decimal form. Bit 6 (MSS mask bit) is always 0.

Range: 0 to 255

***STB?**

STatus Byte query

Reads the contents of the status byte in decimal form.

Usage: Query only

***TRG**

TRiGger

Triggers all actions waiting for a trigger event. In particular, *TRG generates a manual trigger signal (Manual Trigger). This common command complements the commands of the `TRIGger` subsystem.

`*TRG` corresponds to the `INITiate:IMMediate` command (see `INITiate[:IMMediate]` on page 510).

Usage: Event

***TST?**

self TeST query

Triggers selftests of the instrument and returns an error code in decimal form (see Service Manual supplied with the instrument). "0" indicates no errors occured.

Usage: Query only

***WAI**

WAIt to continue

Prevents servicing of the subsequent commands until all preceding commands have been executed and all signals have settled (see also command synchronization and `*OPC`).

Usage: Event

10.2 Selecting the Operating Mode and Application

The following commands are required to select the operating mode or the application and to configure a Sequencer in a remote environment. The tasks for manual operation are described in chapter 3, "Applications and Operating Modes", on page 18.

10.2.1 Selecting the Mode and Applications

DISPlay:ATAB <State>

This command switches between the MultiView tab and the most recently displayed measurement channel.

Parameters:

<State> ON | OFF

ON
The MultiView tab is displayed.

OFF
The most recently displayed measurement channel is displayed.

*RST: OFF

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e starts 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. "Spectrum" -> "Spectrum 2").

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 'Spectrum'
INST:CRE:DUPL
```
Duplicates the channel named 'Spectrum' and creates a new measurement channel named 'Spectrum 2'.

Usage: Event

Manual control: See "Duplicate Current Channel" on page 26

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.

See also

- `INSTrument[:SELect]` on page 502
- `INSTrument:DELete` on page 500

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 10-1.

<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 table 10-1).

Example:
```
INST:CRE SAN, 'Spectrum 2'
```
Adds an additional spectrum display named "Spectrum 2".

Manual control: See "New Channel" on page 26

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

This command replaces a measurement channel with another one.

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 table 10-1.

<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 table 10-1).

Example:
```
INST:CRE:REPL 'Spectrum2',IQ,'IQAnalyzer'
```
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

Manual control: See "Replace Current Channel" on page 26

INSTrument:DELete <ChannelName>

This command deletes a measurement channel. If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example:
```
INST:DEL 'Spectrum4'
```
Deletes the spectrum channel with the name 'Spectrum4'.

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 table 10-1).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example:
```
INST:LIST?
```
Result for 3 measurement channels:
```
'ADEM','Analog Demod','IQ','IQ
Analyzer','SANALYZER','Spectrum'
```

Usage: Query only

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

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
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 FSW 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.

For details on operating modes and applications see chapter 3, "Applications and Operating Modes", on page 18.

Parameters:

<OpMode>	SANalyzer | MSRanalyzer
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 'Spectrum2','Spectrum3'` Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

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 499
- chapter 10.2.3, "Programming Example: Performing a Sequence of Measurements", on page 505

Parameters:

<ChannelType>	Channel type of the new channel. For a list of available channel types see table 10-1.
<ChannelName>	String containing the name of the channel.

Example:	`INST SAN`
	Activates a measurement channel for the Spectrum application.
	`INST 'MySpectrum'`
	Selects the measurement channel named 'MySpectrum' (for example before executing further commands for that channel).

Usage:	SCPI confirmed

Manual control: See "Spectrum" on page 20
See "1xEV-DO BTS" on page 20
See "1xEV-DO MS" on page 21
See "3G FDD BTS" on page 21
See "3G FDD UE" on page 21
See "Analog Demodulation" on page 21
See "cdma2000 BTS" on page 21
See "cdma2000 MS" on page 21
See "(Multi-Carrier) Group Delay" on page 22
See "GSM" on page 22
See "I/Q Analyzer" on page 22
See "LTE" on page 22
See "Noise Figure" on page 22
See "Phase Noise" on page 22
See "Pulse Measurements" on page 23
See "TD-SCDMA BTS" on page 23
See "TD-SCDMA UE" on page 23
See "Vector Signal Analysis (VSA)" on page 23
See "WLAN" on page 23
See "New Channel" on page 26

10.2.2 Performing a Sequence of Measurements

The following commands control the sequencer.

For details on the Sequencer see chapter 3.5.1, "The Sequencer Concept", on page 26.

INITiate: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:SEQuencer:IMMediate` on page 503.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 505.

Usage: Event

Manual control: See "Sequencer State" on page 28

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer. Its effect is similar to the `INITiate[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 505).

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.

Usage: Event

Manual control: See "Sequencer State" on page 28

INITiate:SEQuencer:MODE <Mode>

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

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 505).

A detailed programming example is provided in chapter 10.2.3, "Programming Example: Performing a Sequence of Measurements", on page 505.

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

For details on synchronization see chapter 9.1.6, "Command Sequence and Synchronization", on page 443

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 Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Manual control: See "Sequencer Mode" on page 29

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 chapter 10.2.3, "Programming Example: Performing a Sequence of Measurements", on page 505.

Parameters:

<State> ON | OFF

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

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

*RST: OFF

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 control: See "Sequencer State" on page 28

10.2.3 Programming Example: Performing a Sequence of Measurements

This example demonstrates how to perform several measurements in a sequence in a remote environment.

```
//2xSpectrumanalyzer + 2xIQ, start Sequencer at the end, test OPC?
// ------------------------------------------------------------------------


//------Preparing the instrument and first channel -----------
*RST
//Activate new IQ channel
INSTrument:CREate:NEW IQ,'IQ 1'
//Set sweep count for new IQ channel
SENS:SWEEP:COUNT 6
//Change trace modes for IQ channel
DISP:TRAC1:MODE BLANK
DISP:TRAC2:MODE MAXH
```

```
DISP:TRAC3:MODE MINH
//Switch to single sweep mode
INIT:CONT OFF
//switch back to first (default) analyzer channel
INST:SEL 'Spectrum';*WAI
//Switch into SEM
SENSe:SWEep:MODE ESPectrum
//Load Sem standard file for WCDMA
SENSe:ESPectrum:PRESet:STANdard 'WCDMA\3GPP\DL\3GPP_DL.xml'
//Set sweep count in Spectrum channel
SENS:SWEEP:COUNT 5

//----------Creating a second measurement channel ----------------

//Create second IQ channel
INSTrument:CREate:NEW IQ,'IQ 2'
//Set sweep count
SENS:SWEEP:COUNT 2
//Change trace modes
DISP:TRAC1:MODE MAXH
DISP:TRAC2:MODE MINH
//Create new analyzer channel
INSTrument:CREate:NEW SANalyzer,'Spectrum 2'
//Activate ACLR measurement in channel 'Spectrum 2'
CALCulate:MARKer:FUNCtion:POWer:SELect ACPower
//Load WCDMA Standard
CALCulate:MARKer:FUNCtion:POWer:PRESet FW3Gppcdma
//Change trace modes
DISP:TRAC2:MODE MAXH
DISP:TRAC1:MODE MINH

//--------Performing a sweep and retrieving results----------------

//Change sweep count
SENS:SWEep:COUNt 7
//Single Sweep mode
INIT:CONT OFF
//Switch back to first IQ channel
INST:SEL 'IQ 1';*WAI
//Perform a measurement
INIT:IMM;*OPC?
//Retrieve results
CALC:MARK:Y?
//Activate Multiview
DISPlay:ATAB     ON

//---------Performing a sequence of measurements with the Sequencer------------
//Activate Sequencer
SYSTem:SEQuencer ON
//Start sweep in Sequencer
```

```
INITiate:SEQuencer:IMMediate;*OPC?
//Switch into first IQ channel to get results
INST:SEL 'IQ 1';*WAI
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Change sweep time in IQ
SENS:SWE:TIME 300us
//Switch to single Sequencer mode
INITiate:SEQuencer:MODE SINGle
//Sweep all channels once, taking the sweep count in each channel into account
INITiate:SEQuencer:IMMediate;*OPC?
//Set marker to maximum in IQ1 and query result
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Switch to second IQ channel and retrieve results
INST:SEL 'IQ 2';*WAI
CALCulate:MARKer:MIN
CALC:MARK:Y?
//Switch to first Spectrum channel
INST:SEL 'Spectrum';*WAI
//Query one of the SEM results
CALCulate:MARKer:FUNCtion:POWer:RESult? CPOWer
//Switch to second Spectrum channel
INST:SEL 'Spectrum 2';*WAI
//Query channel power result
CALCulate:MARKer:FUNCtion:POWer:RESult? ACPower
```

10.3 Configuring and Performing Measurements

The following commands are required to configure measurements in a remote environment. The tasks for manual operation are described in chapter 4, "Measurements", on page 31.

10.3.1 Performing Measurements

10.3.1.1 Commands

Useful commands for performing measurements described elsewhere

- INITiate:ESPectrum on page 549
- INITiate:SPURious on page 574

Remote commands exclusive for performing measurements

ABORt

This command aborts a current measurement 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 chapter 9.1.6.1, "Preventing Overlapping Execution", on page 444.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` on page 503 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 (GPIB, LAN or other interface) to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

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

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

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

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

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

Usage: SCPI confirmed

Manual control: See "Aborting the Self-alignment" on page 398

INITiate:CONMeas

This command restarts a (single) measurement that has been stopped (using `INIT:CONT OFF`) or finished in single sweep mode.

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

As opposed to `INITiate[: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.

Example: (for Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Setting the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.
`INIT:CONM;*WAI`
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual control: See "Continue Single Sweep" on page 249

INITiate:CONTinuous <State>

This command controls the sweep mode.

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

For details on synchronization see chapter 9.1.6, "Command Sequence and Synchronization", on page 443

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 503) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: ON

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

Manual control: See "Frequency Sweep" on page 32
See "Zero Span" on page 32
See "Continuous Sweep/RUN CONT" on page 249

INITiate[:IMMediate]

This command starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

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

For details on synchronization see chapter 9.1.6, "Command Sequence and Synchronization", on page 443

Example: (For Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

Manual control: See "Frequency Sweep" on page 32
See "Zero Span" on page 32
See "Single Sweep/ RUN SINGLE" on page 248

[SENSe:]SWEep:COUNt:CURRent?

This query returns the current number of started sweeps or measurements. This command is only available if a sweep count value is defined and the instrument is in single sweep mode.

Example:

`SWE:COUNt 64`
Sets sweep count to 64
`INIT:CONT OFF`
Switches to single sweep mode
`INIT`
Starts a sweep (without waiting for the sweep end!)
`SWE:COUN:CURR?`
Queries the number of started sweeps

Usage: Query only

10.3.1.2 Programming Example: Performing a Basic Frequency Sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

```
//--------------Preparing the measurement ---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//--------------Configuring the Frequency and Span-------------
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.

//Activate signal tracking to keep the center frequency on the signal peak:
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
//After each sweep the maximum on trace 1 is searched within a range of 20 MHz
//around the center frequency. It must have a minimum power of -90dBm.

//--------------Configuring the Bandwidth----------------------
BAND:AUTO OFF
BAND 1MHz
BAND:TYPE RRC
//Defines the RBW as 1 MHz using an RRC filter

BAND:VID:AUTO OFF
BAND:VID 500kHz
//Decouples the VBW from the RBW and decreases it to smooth the trace.
```

```
//--------------Configuring the Sweep--------------------------
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
SENS:SWE:POIN 500
//During each sweep, 500 trace points will be measured.
SENS:SWE:TIME:AUTO OFF
SENS:SWE:TIME 50ms
//Decouples the sweep time from the RBW,VBW and span and increases it to
//make the measurement more precise.

//--------------Configuring Attenuation------------------------
//Only if electronic attenuator is available:
//INP:EATT:STAT ON
//Switches on the electronic attenuator.
//INP:EATT 30dB
//Sets the electronic attenuation to 30 dB.
INP:ATT 10dB
//Sets the mechanical attenuation to 10 dB and couples the reference level
//to the attenuation instead of vice versa.

//--------------Configuring the Amplitude and Scaling----------
DISP:TRAC1:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
DISP:TRAC1:Y:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10dB.
CALC:UNIT:POW V
//Sets the unit of the y-axis to Volt. The reference level is now 70.711 mV.
DISP:TRAC1:Y:SPAC LOG
//Uses logarithmic scaling with absolute values (V).
DISP:TRAC1:Y 110dB
//Increases the displayed range of the y-axis to 110 dB.
DISP:TRAC1:Y:RPOS 80PCT
//Shifts the display of the reference level down, it is no longer the top line
//in the diagram. The reference level is displayed as a red line.

//--------------Triggering-------------------------------------
TRIG:SOUR IFP
TRIG:LEV:IFP -10dBm
TRIG:SLOP POS
TRIG:DTIM 50ms
TRIG:IFP:HYST 5dB
TRIG:HOLD 10ms
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm, with a dropout time of 50 ms, a hysteresis of 5 dB and a delay
//of 10 ms.


SWE:EGAT ON
SWE:EGAT:TYPE EDGE
```

```
SWE:EGAT:LENG 5ms
//Defines gating. Values are measured for 5 ms after triggering.

OUTP:TRIG2:DIR OUTP
OUTP:TRIG2:OTYP UDEF
OUTP:TRIG2:LEV HIGH
OUTP:TRIG2:PULS:LENG 100us
OUTP:TRIG2:PULS:IMM
//Configures a high trigger signal with a pulse length of 100 us to be output at
//the front TRIGGER INPUT/OUTPUT connector once.

//--------------Configuring the Trace--------------------------
DISP:TRAC2 ON
DISP:TRAC2:MODE AVER
DISP:TRAC3 ON
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

SENS:DET1 POS
SENS:DET2 RMS
SENS:DET3 POS
//Configures traces 1 and 3 to use the positive peak detector; trace 2 uses
//the RMS detector.

TRAC:COPY TRACE4,TRACE1
//Copies trace 1 to a new trace 4 which will then be averaged.

SENS:AVER:STAT4 ON
SENS:AVER:COUN 10
SENS:AVER:TYPE LIN
//Configures trace 4 to be averaged linearly over 10 sweeps.

CALC:MATH:STAT ON
CALC:MATH:MODE LIN
CALC:MATH (TRACE1-TRACE2)
CALC:MATH:POS 100
//Calculates the linear difference between the measured and average values.
//The resulting trace is displayed at the top of the diagram.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//---------------Retrieving Results----------------------------
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
TRAC:DATA? TRACE4
//Returns one power and one frequency value per sweep point for each trace.
```

10.3.2 Configuring Power Measurements

The following commands work for several power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE <Mode>

This command selects the trace display mode for power measurements.

Parameters:

<Mode> **WRITe**
The power is calculated from the current trace.
MAXHold
The power is calculated from the current trace and compared with the previous power value using a maximum algorithm.

Manual control: See "Power Mode" on page 55

CALCulate:MARKer:FUNCtion:POWer:RESult? <Measurement>

This command queries the results of power measurements.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Query parameters:

<Measurement>

ACPower | MCACpower
ACLR measurements (also known as adjacent channel power or multi-carrier adjacent channel measurements).
Returns the power for every active transmission and adjacent channel. The order is:
• power of the transmission channels
• power of adjacent channel (lower,upper)
• power of alternate channels (lower,upper)
MSR ACLR results:
For MSR ACLR measurements, the order of the returned results is slightly different:
• power of the transmission channels
• total power of the transmission channels for each subblock
• power of adjacent channels (lower, upper)
• power of alternate channels (lower, upper)
• power of gap channels (lower1, upper1, lower2, upper2)
The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W

CN
Carrier-to-noise measurements.
Returns the C/N ratio in dB.

CN0
Carrier-to-noise measurements.
Returns the C/N ratio referenced to a 1 Hz bandwidth in dBm/Hz.

CPOWer
Channel power measurements.
Returns the channel power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W
For SEM measurements, the return value is the channel power of the reference range.

PPOWer
Peak power measurements.
Returns the peak power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W
For SEM measurements, the return value is the peak power of the reference range.

OBANdwidth | OBWidth
Occupied bandwidth.
Returns the occupied bandwidth in Hz.

Usage: Query only

Manual control: See "Ch Power ACLR" on page 33
See "C/N, C/No" on page 33
See "OBW" on page 33
See "Spectrum Emission Mask" on page 34
See "C/N" on page 88
See "C/No" on page 88

CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect <MeasType>

This command selects a power measurement and turns the measurement on.

Parameters:

<MeasType>

ACPower | MCACpower
Adjacent channel leakage ratio (ACLR) aka adjacent channel power or multi carrier adjacent channel.
The R&S FSW performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

CPOWer
Channel power measurement with a single carrier.
The R&S FSW performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

OBANdwidth | OBWidth
Occupied bandwidth measurement.
The R&S FSW performs the measurement on the trace that marker 1 is positioned on.

CN
Carrier-to-noise ratio measurement.

CN0
Carrier-to-noise ratio measurement referenced to 1 Hz bandwidth

Manual control: See "Ch Power ACLR" on page 33
See "C/N, C/No" on page 33
See "OBW" on page 33
See "C/N" on page 88
See "C/No" on page 88

CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] <State>

This command turns a power measurement on and off.

You can select a particular power measurement with `CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect`.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "C/N" on page 88
See "C/No" on page 88

[SENSe:]POWer:ACHannel:PRESet <Measurement>

This command determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<Measurement>

ACPower | MCACpower
ACLR measurement

CPOWer
channel power measurement

OBANdwidth | OBWidth
Occupied bandwidth measurement

CN
Carrier to noise ratio

CN0
Carrier to noise ration referenced to a 1 Hz bandwidth

Manual control:
See "Optimized Settings (Adjust Settings)" on page 55
See "Adjust Settings" on page 88
See "Adjust Settings" on page 93

[SENSe:]POWer:ACHannel:PRESet:RLEVel

This command determines the ideal reference level for the current measurement.

This automatic routine makes sure that the that the signal power level does not overload the R&S FSW or limit the dynamic range by too small a S/N ratio.

To determine the best reference level, the R&S FSW aborts current measurements and performs a series of test sweeps. After it has finished the test, it continues with the actual measurement.

To get a valid result, you have to perform a complete sweep with synchronization to the sweep end. This is only possible in single sweep mode.

Usage: Event

[SENSe:]POWer:TRACe <TraceNumber>

This command selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

Parameters:

<TraceNumber>
Range: 1 to 6
*RST: 1

Example:
`POW:TRAC 2`
Assigns the measurement to trace 2.

Manual control: See "Selected Trace" on page 54

10.3.3 Measuring the Channel Power and ACLR

All remote control commands specific to channel power or ACLR measurements are described here.

See also chapter 10.3.2, "Configuring Power Measurements", on page 514.

10.3.3.1 Managing Measurement Configurations

The following commands control measurement configurations for ACLR measurements.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet <Standard>

This command loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

If the "Multi-Standard Radio" standard is selected (see "Standard" on page 51), different commands are required to configure ACLR measurements (see chapter 10.3.3.7, "Configuring MSR ACLR Measurements", on page 531.

Parameters:

<Standard> For more information see chapter 4.2.8, "Reference: Predefined CP/ACLR Standards", on page 84.
If you want to load a customized configuration, the parameter is a string containing the file name.

Manual control: See "Standard" on page 51
See "Predefined Standards" on page 51
See "User-Defined Standards" on page 51

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:CATalog?

This command queries all files containing ACLR standards.

Return values:
<Standards> List of standard files.

Usage: Query only

Manual control: See "Standard" on page 51
See "User-Defined Standards" on page 51

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:DELete <Standard>

This command deletes a file containing an ACLR standard.

Parameters:
<Standard> String containing the file name of the standard.

Usage: Event

Manual control: See "Standard" on page 51
See "User-Defined Standards" on page 51

CALCulate<n>:MARKer<m>:FUNCtion:POWer:STANdard:SAVE <Standard>

This command saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Parameters:
<Standard> String containing the file name. The file format is xml.

Manual control: See "Standard" on page 51
See "User-Defined Standards" on page 51

10.3.3.2 Configuring the Channels

The following commands configure channels for channel power and ACLR measurements.

[SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

This command defines the number of pairs of adjacent and alternate channels.

Parameters:

<ChannelPairs>	Range:	0 to 12
	*RST:	1

Manual control: See "Number of Channels (TX, ADJ)" on page 53
See "Number of Adjacent Channels (ADJ Count)" on page 69

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel <Bandwidth>

This command defines the channel bandwidth of the adjacent channel.

The adjacent channel is the first pair of channels next to the transmission channels. If you set the channel bandwidth for these channels, the R&S FSW sets the bandwidth of the alternate channels to the same value.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth>	Range:	100 Hz to 1000 MHz
	*RST:	14 kHz

Manual control: See "Channel Bandwidths" on page 57
See "Adjacent Channel Definition" on page 70
See "Adjacent Channel Bandwidths" on page 70

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTernate<ch> <Bandwidth>

This command defines the channel bandwidth of the alternate channels.

If you set the channel bandwidth for the first alternate channel, the R&S FSW sets the bandwidth of the other alternate channels to the same value, but not the other way round. The command works hierarchically: to set a bandwidth of the 3rd and 4th channel, you have to set the bandwidth of the 3rd channel first.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth>	Range:	100 Hz to 1000 MHz
	*RST:	14 kHz

Manual control: See "Channel Bandwidths" on page 57
See "Adjacent Channel Definition" on page 70
See "Adjacent Channel Bandwidths" on page 70

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>] <Bandwidth>

This command defines the channel bandwidth of the transmission channels.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual control: See "Channel Bandwidths" on page 57
See "Channel Bandwidth" on page 88
See "Channel Bandwidth" on page 93

[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>

This command defines a name for the adjacent channel.

For MSR ACLR measurements, the channel names cannot be defined manually. In this case, this command is for query only.

Parameters:

<Name> String containing the name of the channel
*RST: ADJ

Manual control: See "Channel Names" on page 59

[SENSe:]POWer:ACHannel:NAME:ALTernate<ch> <Name>

This command defines a name for an alternate channel.

For MSR ACLR measurements, the channel names cannot be defined manually. In this case, this command is for query only.

Parameters:

<Name> String containing the name of the channel
*RST: ALT<1...11>

Manual control: See "Channel Names" on page 59

[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> <Name>

This command defines a name for a transmission channel.

Parameters:

<Name> String containing the name of the channel
*RST: TX<1...12>

Manual control: See "Channel Names" on page 59

[SENSe:]POWer:ACHannel:SPACing[:ACHannel] <Spacing>

This command defines the distance from transmission channel to adjacent channel.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first subblock to the lower adjacent channel, and the distance from the CF of the last Tx channel in the last subblock to the upper adjacent channel.

A change of the adjacent channel spacing causes a change in the spacing of all alternate channels below the adjacent channel.

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz

Usage: SCPI confirmed

Manual control: See "Channel Spacings" on page 57
See "Adjacent Channel Definition" on page 70
See "Adjacent Channel Spacings" on page 70

[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch> <Spacing>

This command defines the distance from transmission channel to alternate channels.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first subblock to the lower alternate channel, and the distance from the CF of the last Tx channel in the last subblock to the upper alternate channel.

If you set the channel spacing for the first alternate channel, the R&S FSW adjusts the spacing of alternate channels of a lower order, but not the other way round. The command works hierarchically: to set a distance from the transmission channel to the 2nd and 3rd alternate channel, you have to define a spacing for the 2nd alternate channel first.

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
*RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...

Manual control: See "Channel Spacings" on page 57
See "Adjacent Channel Definition" on page 70
See "Adjacent Channel Spacings" on page 70

[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>

This command defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the R&S FSW sets the spacing of the lower transmission channels to the same value, but not the other way round. The command works hierarchically: to set a distance between the 2nd and 3rd and 3rd and 4th channel, you have to set the spacing between the 2nd and 3rd channel first.

Parameters:

<Spacing> Range: 14 kHz to 2000 MHz
*RST: 20 kHz

Manual control: See "Channel Spacings" on page 57

[SENSe:]POWer:ACHannel:TXCHannel:COUNt <Number>

This command defines the number of transmission channels.

The command works for measurements in the frequency domain.

Parameters:

<Number>	Range:	1 to 18
	*RST:	1

Manual control: See "Number of Channels (TX, ADJ)" on page 53

10.3.3.3 Defining Weighting Filters

The following commands define weighting filters for ACLR measurements.

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>

This command defines the roll-off factor for the adjacent channel weighting filter.

Parameters:

<Alpha>	Roll-off factor	
	Range:	0 to 1
	*RST:	0.22

Manual control: See "Weighting Filters" on page 59
See "Adjacent Channel Definition" on page 70
See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] <Value>

This command defines the alpha value for the weighting filter for all channels.

Parameters:

<Value>	<numeric value>	
	*RST:	0,22

Example: `POW:ACH:FILT:ALPH:ALL 0,35`

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> <Alpha>

This command defines the roll-off factor for the alternate channel weighting filter.

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual control: See "Weighting Filters" on page 59
See "Adjacent Channel Definition" on page 70
See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the transmission channel weighting filter.

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual control: See "Weighting Filters" on page 59

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel <State>

This command turns the weighting filter for the adjacent channel on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Weighting Filters" on page 59
See "Adjacent Channel Definition" on page 70
See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALL <State>

This command turns the weighting filters for all channels on and off.

Parameters:

<State> ON | OFF

*RST: OFF

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> <State>

This command turns the weighting filter for an alternate channel on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Weighting Filters" on page 59
See "Adjacent Channel Definition" on page 70
See "Weighting Filters" on page 71

[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> <State>

This command turns the weighting filter for a transmission channel on and off.

Parameters:

<State>	ON | OFF *RST: OFF
Manual control:	See "Weighting Filters" on page 59

10.3.3.4 Selecting the Reference Channel

The following commands define the reference channel for relative ACLR measurements.

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE

This command sets the channel power as the reference for relative ACLR measurements.

Example:	`POW:ACH:REF:AUTO ONCE`
Usage:	Event
Manual control:	See "Setting a Fixed Reference for Channel Power Measurements (Set CP Reference)" on page 55

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO <RefChannel>

This command selects the reference channel for relative measurements.

You need at least one channel for the command to work.

Parameters:

<RefChannel>	**MINimum** Transmission channel with the lowest power **MAXimum** Transmission channel with the highest power **LHIGhest** Lowest transmission channel for lower adjacent channels and highest transmission channel for upper adjacent channels
Example:	`POW:ACH:REF:TXCH:AUTO MAX` Selects the channel with the peak power as reference channel.
Manual control:	See "Reference Channel" on page 53

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual <ChannelNumber>

This command defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Note that this command is not available for MSR ACLR measurements (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518).

Parameters:

<ChannelNumber>	Range:	1 to 18
	*RST:	1

Manual control: See "Reference Channel" on page 53

10.3.3.5 Checking Limits

The following commands configure and query limit checks for channel power and ACLR measurements.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit Register" on page 453).

CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the adjacent channels.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Parameters:

<LowerLimit>, <UpperLimit> — The first value defines the limit of the lower adjacent channel, the second value the limit of the upper adjacent channel.

Range:	-200 dBm to 200 dBm
*RST:	-200 dBm

Manual control: See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe <State>

This command turns the absolute limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Parameters:

<LowerLimit>, <UpperLimit> The first value defines the limit of the lower adjacent channel, the second value the limit of the upper adjacent channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Manual control: See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?

This command queries the state of the limit check for the adjacent channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<LowerACH>, <UpperACH>
text value

The command returns two results. The first is the result for the lower, the second for the upper adjacent channel.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

Manual control:
See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe <State>

This command turns the relative limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:

<State>
ON | OFF
*RST: OFF

Manual control:
See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the alternate channels.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Parameters:

<LowerLimit>, <UpperLimit>
The first value defines the limit of the lower alternate channel, the second value the limit of the upper alternate channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm

Manual control:
See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:ABSolute:STATe <State>

This command turns the absolute limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Parameters:

<LowerLimit>, <UpperLimit> The first value defines the limit of the lower alternate channel, the second value the limit of the upper alternate channel.

Range: 0 dB to 100 dB
*RST: 0 DB
Default unit: dB

Manual control: See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>:RESult?

This command queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:
<LowerChan>, <UpperChan>

text value

The command returns two results. The first is the result for the lower, the second for the upper adjacent or alternate channel.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe <State>

This command turns the relative limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Parameters:
<State> ON | OFF

*RST: OFF

Manual control:
See "Limit Checking" on page 58
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71

CALCulate<n>:LIMit<k>:ACPower[:STATe] <State>

This command turns the limit check for ACLR measurements on and off.

In addition, limits must be defined and activated individually for each channel (see `CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe`, `CALCulate<n>:LIMit<k>:ACPower:ALTernate<ch>[:RELative]:STATe`, `CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe` and `CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RELative:STATe`).

Parameters:
<State> ON | OFF

*RST: OFF

Manual control:
See "Limit Checking" on page 58
See "Limit Checking" on page 69
See "Adjacent Channel Definition" on page 70
See "Limit Checking" on page 71
See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

10.3.3.6 General ACLR Measurement Settings

The following commands control the measurement algorithm.

Useful commands for the ACLR measurement described elsewhere:

- `[SENSe:]POWer:NCORrection` on page 640
- `[SENSe:]POWer:ACHannel:PRESet` on page 517
- `[SENSe:]POWer:ACHannel:PRESet:RLEVel` on page 517
- `[SENSe:]POWer:TRACe` on page 517
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 514

Remote commands exclusive to ACLR measurement

[SENSe:]POWer:HSPeed <State>

This command turns high speed ACLR and channel power measurements on and off.

If on, the R&S FSW performs a measurement on each channel in the time domain. It returns to the frequency domain when the measurement is done.

In some telecommunications standards, high speed measurements use weighting filters with characteristic or steep-edged channel filters for band limitation.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `POW:HSP ON`

Manual control: See "Fast ACLR" on page 54

10.3.3.7 Configuring MSR ACLR Measurements

If the "Multi-Standard Radio" standard is selected (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518), the channels for the ACLR measurement are configured differently. (For more information see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.)

In this case, use the following commands.

Useful commands for configuring MSR ACLR measurements described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ` on page 540
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer:MODE` on page 514
- `CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 530
- `[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 525

- [SENSe:]POWer:NCORrection on page 640
- [SENSe:]POWer:TRACe on page 517
- [SENSe:]POWer:ACHannel:MODE on page 540
- [SENSe:]POWer:ACHannel:PRESet on page 517

Remote commands exclusive to configuring MSR ACLR measurements

---

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute <Limit>, <Reserved>

This command defines the absolute limit of the specified gap (CACLR) channel.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Limit> Defines the absolute limit of the specified gap channel in dBm.

<Reserved> Ignored.

Example: `CALC:LIM:ACP:GAP2:ABS 44.2dBm,0`

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe <State>

This command turns the absolute limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:

<gap>	1 | 2 Gap (CACLR) channel number

Parameters:

<State>	ON | OFF *RST: OFF

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RELative <Limit>, <Reserved>

This command defines the relative limit of the specified gap (CACLR) channel. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S FSW uses the lower value for the limit check.

Suffix:

<gap>	1 | 2 Gap (CACLR) channel number

Parameters:

<Limit>	Defines the relative limit of the specified gap channel in dB.
<Reserved>	Ignored.

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RELative:STATe <State>

This command turns the relative limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:

<gap>	1 | 2 Gap (CACLR) channel number

Parameters:

<State>	ON | OFF *RST: OFF

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?

This command queries the state of the limit check for *all* gap (CACLR) channels in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit Register" on page 453).

Suffix:

<gap> 1 | 2
irrelevant

Return values:

<LowerGap1>, <UpperGap1>, <LowerGap2>, <UpperGap2>
The command returns the results for the four gap channels for each gap (max. 4).

PASSED
Limit check has passed.

FAIL
Limit check has failed.

NONE
No results available, e.g. because limit checking was deactivated

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED,
```

Usage: Query only

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Limit Checking" on page 73

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:GAP<gap> <Bandwidth>

This command defines the bandwidth of the specified MSR gap (CACLR) channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518).

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Bandwidth> numeric value in Hz

*RST: 3.84 MHz

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Gap (CACLR) Channel Bandwidths" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap> <Alpha>

This command defines the roll-off factor for the specified gap (CACLR) channel's weighting filter.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the specified transmission channel's weighting filter.

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:

<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual control: See "Tx Channel Definition" on page 67
See "Weighting Filters" on page 68

[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap> <State>

This command turns the weighting filter for the specified gap (CACLR) channel on and off.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF
*RST: OFF

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Weighting Filters" on page 73

[SENSe:]POWer:ACHannel:FILTer:STATe:SBLock<sb>:CHANnel<ch> <State>

This command turns the weighting filter for the specified transmission channel on and off.

Suffix:

<sb>	1 | 2 | 3 | 4 | 5 Subblock number

Parameters:

<State>	ON | OFF *RST: WCDMA: ON, other technologies: OFF

Manual control: See "Tx Channel Definition" on page 67
See "Weighting Filters" on page 68

[SENSe:]POWer:ACHannel:SBCount <Number>

This command defines the number of subblocks, i.e. groups of transmission channels in an MSR signal.

For more information see chapter 4.2.3.4, "Measurement on Multi-Standard Radio (MSR) Signals", on page 46.

Parameters:

<Number>	Range: 1 to 5 *RST: 1

Manual control: See "Number of Subblocks" on page 63

[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>] <Bandwidth>

This command defines the bandwidth of the specified MSR Tx channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518).

Suffix:

<sb>	1 | 2 | 3 | 4 | 5 Subblock number

Parameters:

<Bandwidth>	Bandwidth in Hz

Manual control: See "Tx Channel Definition" on page 67
See "Tx Channel Bandwidth" on page 68

[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] <Frequency>

This command defines the (absolute) center frequency of the specified MSR Tx channel.

Note that the position of the first Tx channel in the first subblock and the last Tx channel in the last subblock also affect the position of the adjacent channels.

This command is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet on page 518).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:
<Frequency> absolute frequency in Hz

Manual control: See "Tx Channel Definition" on page 67
See "Tx Center Frequency" on page 67

[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer <Frequency>

This command defines the center of the specified MSR subblock. Note that the position of the subblock also affects the position of the adjacent gap (CACLR) channels.

This command is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet on page 518).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:
<Frequency> absolute frequency in Hz

Manual control: See "Subblock Definition" on page 66
See "Subblock Center Frequency" on page 67

[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]? <Name>

This command queries the name of the specified MSR Tx channel.

In MSR ACLR measurements, TX channel names correspond to the specified technology, followed by a consecutive number. The assigned subblock (A,B,C,D,E) is indicated as a prefix (e.g. A: WCDMA1). Channel names cannot be defined manually.

This command is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet on page 518).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:
<Name> String containing the name of the channel

Example: `POW:ACH:SBL2:NAME:CHAN2?`
Result:
'B:WCDMA'

Usage: Query only

Manual control: See "Tx Channel Definition" on page 67

[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth <Bandwidth>

This command defines the bandwidth of the individual MSR subblock. Note that subblock ranges also affect the position of the adjacent gap channels (CACLR).

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:
<Bandwidth> Bandwidth in Hz

Manual control: See "Subblock Definition" on page 66
See "RF Bandwidth" on page 67

[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>] <Standard>

This command defines the technology used for transmission by the specified MSR Tx channel.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet` on page 518).

Suffix:
<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:
<Standard> GSM | WCDMa | LTE_1_40 | LTE_3_00 | LTE_5_00 | LTE_10_00 | LTE_15_00 | LTE_20_00 | USER

Technology used for transmission

GSM
Transmission according to GSM standard

WCDMA
Transmission according to WCDMA standard

LTE_1_40 | LTE_3_00 | LTE_5_00 | LTE_10_00 | LTE_15_00 | LTE_20_00
Transmission according to LTE standard for different channel bandwidths

USER
User-defined transmission; no automatic preconfiguration possible

Manual control: See "Tx Channel Definition" on page 67
See "Technology Used for Transmission" on page 68

[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt <Number>

This command defines the number of transmission channels the specific subblock contains.

This command is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer:PRESet on page 518).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
Subblock number

Parameters:

<Number> Range: 1 to 18
*RST: 1

Manual control: See "Subblock Definition" on page 66
See "Number of Tx Channels (Tx Count)" on page 67

[SENSe:]POWer:ACHannel:SPACing:GAP<gap> <Spacing>

This command defines the distance from subblock to the specified gap channel.

The channels in the upper gap are identical to those in the lower gap. Thus, in the R&S FSW MSR ACLR measurement, only 2 gap channels are configured.

The spacing for gap channels is defined in relation to the outer edges of the surrounding subblocks, i.e.

Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)

(See also figure 4-5 and figure 4-6.)

Suffix:

<gap> 1 | 2
Gap channel number

Parameters:

<Spacing> numeric value in Hz
*RST: 2.5 MHz

Usage: SCPI confirmed

Manual control: See "Gap (CACLR) Channel Definition" on page 72
See "Gap (CACLR) Channel Spacings" on page 72

10.3.3.8 Performing an ACLR Measurement

The following commands are required to perform an ACLR measurement:

`CALC:MARK:FUNC:POW:SEL ACP`, see CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516

CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] on page 516

INITiate[:IMMediate] on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.3.9 Analyzing Measurement Results

The following commands analyze and retrieve measurement results for ACLR measurements.

Useful commands for channel power measurements described elsewhere

- CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514
- TRACe<n>[:DATA] on page 702

Remote commands exclusive to channel power measurements

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult:PHZ <State>

This command selects the way the R&S FSW returns results for power measurements.

You can query results with CALCulate:MARKer:FUNCtion:POWer:RESult?.

Parameters:

<State> ON | OFF

ON
Channel power density in dBm/Hz

OFF
Channel power in dBm

*RST: OFF

Example: `CALC:MARK:FUNC:POW:RES:PHZ ON`
Output of results referred to the channel bandwidth.

Manual control: See "Channel Power Levels and Density (Power Unit)" on page 55

[SENSe:]POWer:ACHannel:MODE <Mode>

This command selects the way the R&S FSW displays the power of adjacent channels.

You need at least one adjacent channel for the command to work.

Parameters:

<Mode>

ABSolute
Shows the absolute power of all channels

RELative
Shows the power of adjacent and alternate channels in relation to the transmission channel

*RST: RELative

Manual control: See "Absolute and Relative Values (ACLR Mode)" on page 54

10.3.3.10 Programming Examples for Channel Power Measurements

The following programming examples are meant to demonstrate the most important commands to perform channel power measurements in a remote environment.

Example: Configuring and Performing an ACLR Measurement

In this example we will configure and perform an adjacent-channel power measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S FSW performs the measurement optimally with the predefined settings, without further configuration.

```
//-------------Preparing the measurement---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:POW:SEL ACP
//Activates adjacent-channel power measurement.
CALC:MARK:FUNC:POW:PRES GSM
//Selects the user standard "GSM"

//---------------Setting Up Channels------------
POW:ACH:TXCH:COUN 1
//Creates one transmission channel.
POW:ACH:NAME:CHAN1 'TX Channel'
//Names the first transmission channel 'TX Channel'.
POW:ACH:ACP 2
//Creates two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:NAME:ACH 'ABC'
//Names the adjacent channel 'ABC'
POW:ACH:NAME:ALT1 'XYZ'
//Names the first alternate channel 'XYZ'.
POW:ACH:BWID:CHAN1 30kHz
//Defines a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:ACH 30kHz
//Defines a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ALT1 30kHz
//Defines a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:SPAC 33kHz
//Defines a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjusts the distance to the alternate channels (66 kHz).
POW:ACH:SPAC:ALT1 100kHz
```

```
//Defines a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.

//---------------Selecting a Reference Channel--
POW:ACH:MODE REL
//Selects relative display of the channel power.
POW:ACH:REF:TXCH:MAN 1
//Defines transmission channel 1 as the reference channel.

//-----------Saving the settings as a user standard--------------
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'
//Saves the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.

//---------------Defining Weighting Filters-----
POW:ACH:FILT:ALPH:CHAN1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:CHAN1 ON
//Turns the weighting filter for the first transmission channel on.
POW:ACH:FILT:ALPH:ACH 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the adjacent
//channel.
POW:ACH:FILT:ACH ON
//Turns the weighting filter for the adjacent channel on.
POW:ACH:FILT:ALPH:ALT1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALT1 ON
//Turns the weighting filter for the first alternate channel on.

//---------------Working with Limits------------
CALC:LIM:ACP:ACH 30DB,30DB
//Defines a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Defines a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Defines an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP ON
//Turns the ACLR limit check on.
CALC:LIM:ACP:ACH:STAT ON
//Turns the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turns the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ALT1:ABS:STAT ON
//Turns the absolute limit check for the first alternate channel on.

//--------------Performing the Measurement-----
```

```
POW:ACH:PRES ACP;*WAI
//Determines the ideal ACLR measurement configuration.
POW:ACH:PRES:RLEV;*WAI
//Determines the ideal reference level for the measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Limit Check--------------------
CALC:LIM:ACP:ACH:RES?
//Queries the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ALT1:RES?
//Queries the results of the limit check for the first alternate channels.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? ACP
//Returns the results for the ACLR measurement.
```

Example: Configuring and Performing an MSR ACLR Measurement

This example demonstrates how to configure and perform an ACLR measurement on a multi-standard radio signal in a remote environment.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST

// Select ACLR measurement
:CALCulate:MARKer:FUNCtion:POWer:SELect ACPower

// Select MSR Standard :CALCulate:MARKer:FUNCtion:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----------------- Configuring SUBBLOCK A

:SENSe:POWer:ACHannel:SBLock1:TXCHannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENTer 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM
```

```
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

//----------------- Configuring SUBBLOCK B

:SENSe:POWer:ACHannel:SBLock2:TXCHannel:COUNt 1
:SENSe:POWer:ACHannel:SBLock2:FREQuency:CENTer 1.255GHZ
:SENSe:POWer:ACHannel:SBLock2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLock2:CENTer:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLock2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLock2:BANDwidth:CHANnel1 3.25MHZ

//----------------- Configuring SUBBLOCK C

:SENSe:POWer:ACHannel:SBLock3:TXCHannel:COUNt 2
:SENSe:POWer:ACHannel:SBLock3:FREQuency:CENTer 1.268GHZ
:SENSe:POWer:ACHannel:SBLock3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel2 1.270GHZ


:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel2 2.75MHZ

//----------------- Configuring ADJ channels

:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALTernate1 1.60MHZ

:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALTernate1 5MHZ

//----------------- Configuring gap (CACLR) channels

:SENSe:POWer:ACHannel:SPACing:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2 5.0MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2 2.0MHZ

//--------------Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
```

```
INIT;*WAI

//---------------Retrieving Results-------------

//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in subblock A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in subblock B
//-17.0863336597,
//Transmission channels in subblock C
//-13.2390127767,-13.2390134744,
//Totals for each subblock
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACLR channels
//-0.52933512766,-64.9990115835,-64.5012521492,-0.33507330922,
//-64.4924159646,-0.52932552499,-0.52932552495,-64.4934163414
```

10.3.4 Measuring the Carrier-to-Noise Ratio

The following commands are necessary to perform carrier-to-noise measurements.

- CALC:MARK:FUNC:POW:SEL CN | CN0, see CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect
- CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]
- CALCulate:MARKer:FUNCtion:POWer:RESult?
- [SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]
- [SENSe:]POWer:ACHannel:PRESet

Programming example

This programming example demonstrates how to perform a Carrier-to-noise measurement in a remote environment.

```
//----------Preparing the measurement------------
*RST
//Reset the instrument
FREQ:CENT 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PRES CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.
```

```
//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

10.3.5 Measuring the Occupied Bandwidth

All remote control commands specific to occupied bandwidth measurements are described here.

10.3.5.1 Configuring the Measurement

The following commands configure measurements of the occupied bandwidth.

Useful commands for occupied bandwidth measurements described elsewhere

Configuring the channel:

- [SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]
- [SENSe:]POWer:ACHannel:PRESet
- [SENSe:]POWer:ACHannel:PRESet:RLEVel

Defining search limits:

- CALCulate:MARKer:X:SLIMits[:STATe] on page 712
- CALCulate:MARKer:X:SLIMits:LEFT on page 712
- CALCulate:MARKer:X:SLIMits:RIGHT on page 713

Performing the measurement:

- CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516
- CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] on page 516

Retrieving results:

- CALCulate:MARKer:FUNCtion:POWer:RESult? on page 514
- CALCulate<n>:MARKer<m>:FUNCtion:POWer:SELect on page 516
- CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe] on page 516

Remote commands exclusive to occupied bandwidth measurements

[SENSe:]POWer:BANDwidth|BWIDth <Percentage>

This command selects the percentage of the total power that defines the occupied bandwidth.

Parameters:

<Percentage> Range: 10 PCT to 99.9 PCT
*RST: 99 PCT

Example: `POW:BWID 95PCT`

Manual control: See "% Power Bandwidth" on page 92

10.3.5.2 Programming Example: OBW Measurement

This programming example demonstrates the measurement example described in chapter 4.4.5, "Measurement Example", on page 94 in a remote environment.

```
//-------------Configuring the Measurement-----------------------
*RST
//Resets the instrument
FREQ:CENT 800MHz
//Sets the center frequency to 800 MHz.
DISP:TRAC:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
CALC:MARK:FUNC:POW:SEL OBW
//Activates occupied bandwidth measurement.
POW:BWID 99PCT
//Sets the percentage of power to 99%.
POW:ACH:BAND 21kHz
//Sets the channel bandwidth to 21 kHz.
POW:ACH:PRES OBW
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.
DET APE
//Sets the trace detector to positive peak.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? OBW
//Returns the occupied bandwidth.
```

10.3.6 Measuring the Spectrum Emission Mask

All remote control commands specific to spectrum emission mask measurements are described here.

See also chapter 10.3.2, "Configuring Power Measurements", on page 514.

10.3.6.1 Managing Measurement Configurations

The following commands control measurement configurations for SEM measurements.

CALCulate<n>:LIMit:ESPectrum:RESTore

This command restores the predefined limit lines for the selected Spectrum Emission Mask standard.

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

Example: `CALC:LIM:ESP:REST`
Resets the limit lines for the current Spectrum Emission Mask standard to the default setting.

[SENSe:]ESPectrum:PRESet[:STANdard] <Standard>

This command loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\r_s\instr\sem_std`.

Parameters:

<Standard> String containing the file name.
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Return values:

<Standard> The query returns the name of the currently loaded standard.

[SENSe:]ESPectrum:PRESet:RESTore

This command restores the default configurations of predefined SEM standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

Usage: Event

Manual control: See "Restore Standard Files" on page 114

[SENSe:]ESPectrum:PRESet:STORe <Standard>

This command saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\r_s\instr\sem_std`.

Parameters:

<Standard> String containing the file name.
You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

10.3.6.2 Controlling the Measurement

The following commands control the measurement itself.

INITiate:ESPectrum

This command initiates a Spectrum Emission Mask measurement.

Usage: Event

[SENSe:]SWEep:MODE <Mode>

This command selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer[:STATe]`

Parameters:

<Mode> **AUTO**
Turns on basic spectrum measurements.

ESPectrum
Turns on spectrum emission mask measurements.

LIST
Turns on spurious emission measurements.

*RST: AUTO

Usage: SCPI confirmed

Manual control: See "Spectrum Emission Mask" on page 34
See "Spurious Emissions" on page 34

10.3.6.3 Configuring a Sweep List

The following commands define a sweep list for SEM measurements.

See also:

- `CALCulate:LIMit:ESPectrum:PCLass<class>:LIMit[:STATe]` on page 566

[SENSe:]ESPectrum:HighSPeed <State>

This command turns high speed mode for SEM measurements on and off.

For more information including restrictions see chapter 4.5.4.3, "Fast SEM Measurements", on page 102.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `ESP:HSP ON`

Manual control: See "Fast SEM" on page 105

[SENSe:]ESPectrum:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

Suffix:

<range> 1...30
Selects the measurement range.

Parameters:

<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
*RST: 30.0 kHz
Default unit: Hz

Manual control: See "RBW" on page 106

[SENSe:]ESPectrum:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

Suffix:

<range> 1...30
Selects the measurement range.

Parameters:

<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
*RST: 10.0 MHz
Default unit: Hz

Manual control: See "VBW" on page 106

[SENSe:]ESPectrum:RANGe:COUNt? <Ranges>

This command queries the number of ranges in the sweep list.

Return values:

<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]ESPectrum:RANGe<range>:DELete

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<range> 1...30
Selects the measurement range.

Usage: Event

Manual control: See "Delete Range" on page 108

[SENSe:]ESPectrum:RANGe<range>:FILTer:TYPE <FilterType>

This command selects the filter type for a SEM range.

In case of high speed measurements, the filter has to be identical for all ranges.

Suffix:

<range> 1...30
Selects the measurement range.

Parameters:

<FilterType> **NORMal**
Gaussian filters

CFILter
channel filters

RRC
RRC filters

P5
5 Pole filters

*RST: NORM
Refer to the datasheet for available filter bandwidths.

Manual control: See "Filter Type" on page 105

[SENSe:]ESPectrum:RANGe<range>[:FREQuency]:STARt <Frequency>

This command defines the start frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S FSW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S FSW will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see chapter 4.5.4.1, "Ranges and Range Settings", on page 98.

Suffix:
<range> 1...30
Selects the measurement range.

Parameters:
<Frequency> Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.
*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Manual control: See "Range Start / Range Stop" on page 105

[SENSe:]ESPectrum:RANGe<range>[:FREQuency]:STOP <Frequency>

This command defines the stop frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S FSW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S FSW will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see chapter 4.5.4.1, "Ranges and Range Settings", on page 98.

Suffix:
<range> 1...30
Selects the measurement range.

Parameters:
<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual control: See "Range Start / Range Stop" on page 105

[SENSe:]ESPectrum:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<range> 1...20
Selects the measurement range.

Parameters:

<Attenuation> Numeric value.
Refer to the data sheet for the attenuation range.
*RST: 10 dB
Default unit: dB

Manual control: See "RF Attenuator" on page 107

[SENSe:]ESPectrum:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a SEM range on and off.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF
*RST: ON

Example: `ESP:RANG2:INP:ATT:AUTO OFF`
Deactivates the RF attenuation auto mode for range 2.

Manual control: See "RF Att. Mode" on page 106

[SENSe:]ESPectrum:RANGe<range>:INPut:GAIN <Gain>

This command selects the level of preamplification for a SEM range.

In case of high speed measurements, the level of the preamplifier has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.
- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

[SENSe:]ESPectrum:RANGe<range>:INPut:GAIN:STATe <State>

This command turns the preamplifier for a SEM range on and off.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Preamp" on page 107

[SENSe:]ESPectrum:RANGe<range>:INSert <Mode>

This command inserts a new SEM range and updates the range numbers accordingly.

Suffix:

<range> 1..30
Selects the SEM range.

Parameters:

<Mode>

AFTer
Inserts a range after the selected range.

BEFore
Inserts a range before the selected range.

Manual control: See "Insert before/after Range" on page 108

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:ABSolute:STARt <Level>

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<range> 1..30
Selects the measurement range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STARt -10`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Abs Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:ABSolute:STOP <Level>

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<range> 1..30
Selects the measurement range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STOP -15`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Abs Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

Suffix:

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STARt -10`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS <Limit>

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 101.

Suffix:

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion` on page 558).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:ABSolute -10`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCtion <Function>

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<range>	1..30 Selects the SEM range.
<PClass>	1..4 Power class for which the limit is defined.

Parameters:

<Function>
Defines the function to be used to determine the relative limit line start value

MAX
The maximum of the relative *and* the absolute level is used as the limit start value. Use the `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt` and `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative start value. Use the `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STARt` command to define this value.

*RST: OFF

Example:
`SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:FUNCtion MAX`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

Suffix:

<range>	1..30 Selects the SEM range.
<PClass>	1..4 Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP -15`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute <Limit>

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 101.

Suffix:

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion` on page 559).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:ABSolute -15`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCtion <Function>

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Function> Defines the function to be used to determine the relative limit line stop value

MAX
The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP` and `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESPectrum:RANGe<range>:LIMit<PClass>:RELative:STOP` command to define this value.

*RST: OFF

Example:
`SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:FUNCtion MAX`
For a detailed example see chapter 10.3.6.10, "Example: SEM Measurement", on page 571.

Manual control: See "Rel Limit Start/Stop" on page 107

[SENSe:]ESPectrum:RANGe:LIMit<PClass>:STATe <State>

This command selects the limit check mode for all SEM ranges.

Suffix:

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<State> ABSolute | RELative | AND | OR

ABSolute
Checks only the absolute limits defined.

RELative
Checks only the relative limits. Relative limits are defined as relative to the measured power in the reference range.

AND
Combines the absolute and relative limit. The limit check fails when both limits are violated.

OR
Combines the absolute and relative limit. The limit check fails when one of the limits is violated.

*RST: RELative

Manual control: See "Limit Check 1-4" on page 107

[SENSe:]ESPectrum:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.
*RST: 0 dBm

Manual control: See "Ref. Level" on page 106

[SENSe:]ESPectrum:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual control: See "Sweep Time" on page 106

[SENSe:]ESPectrum:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a SEM range on and off.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF
*RST: ON

Example: `ESP:RANG3:SWE:TIME:AUTO OFF`
Deactivates the sweep time auto mode for range 3.

Manual control: See "Sweep Time Mode" on page 106

[SENSe:]ESPectrum:RANGe<range>:TRANsducer <Transducer>

This command selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name, including the path information.

Manual control: See "Transd. Factor" on page 107

10.3.6.4 Configuring the Reference Range

The following commands define the reference range for the SEM sweep list.

[SENSe:]ESPectrum:BWID <Bandwidth>

This command defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

Parameters:

<Bandwidth> minimum span ≤ value ≤ span of reference range
*RST: 3.84 MHz

Manual control: See "Channel Power Settings" on page 110
See "Tx Bandwidth" on page 110

[SENSe:]ESPectrum:FILTer[:RRC]:ALPHa <Alpha>

This command defines the roll-off factor for the RRC filter.

The RRC filter is available if the power reference is the channel power.

Parameters:

<Alpha> Range: 0 to 1
*RST: 0.22

Manual control: See "Channel Power Settings" on page 110
See "Alpha" on page 110

[SENSe:]ESPectrum:FILTer[:RRC][:STATe] <State>

This command turns the RRC filter in the reference range on and off.

The RRC filter is available if the power reference is the channel power.

Parameters:

<State> ON | OFF

*RST: ON

Manual control: See "Channel Power Settings" on page 110
See "RRC Filter State" on page 110

[SENSe:]ESPectrum:RRANge? <RefRange>

This command queries the reference range.

Return values:

<RefRange> Number of the current reference range.

Range: 1 to 30

Usage: Query only

[SENSe:]ESPectrum:RTYPe <Type>

This command defines the type of the power reference.

Parameters:

<Type> **PEAK**
Measures the highest peak within the reference range.

CPOWer
Measures the channel power within the reference range (integral bandwidth method).

*RST: CPOWer

Manual control: See "Power Reference Type" on page 109

10.3.6.5 Configuring the Power Classes

The following commands define the power classes for SEM measurements.

CALCulate:LIMit:ESPectrum:LIMits <Max1>,<Max2>,<Max3>

This command sets or queries up to 4 power classes in one step. You can only define values for the number of power classes defined by `CALCulate:LIMit:ESPectrum:PCLass:COUNt` on page 565.

Setting parameters:

<Max1> Defines the value range for power class 1 as `-200 to <Max1>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=2`
If only 2 power classes are defined, the value range for power class 2 is defined as `<Max1> to 200`.
Range: -199 to + 199

<Max2> Defines the value range for power class 2 as `<Max1> to <Max2>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=3`
If only 3 power classes are defined, the value range for power class 3 is defined as `<Max2> to 200`.
Range: -199 to + 199, <Max2> must be higher than <Max1>

<Max3> Defines the value range for power class 3 as `<Max2> to <Max3>`.
The value range for power class 4 is defined as `<Max3> to 200`.
Only available for `CALC:LIM:ESP:PCL:COUNT = 4`
Range: -199 to + 199, <Max3> must be higher than <Max2>

Return values:

<RangeLimits> As a result of the query, the range limits including the beginning of the first power class (-200) and the end of the last power class (+200) are indicated.

Example:

```
CALC:LIM:ESP:LIM -50,50,70
```
Defines the following power classes:
```
<-200, -50>
<-50, 50>
<50, 70>
<70, 200>
```
Query:
```
CALC:LIM:ESP:LIM?
```
Response:
```
-200,-50,50,70,200
```

Mode: A, CDMA, EVDO, TDS, WCDMA

CALCulate:LIMit:ESPectrum:MODE <Mode>

Which limit line is to be used for an SEM measurement depends on the power class the input signal power belongs to. This command defines wether the power class is determined automatically or manually.

Parameters:

<Mode>

AUTO
The power class (and thus the limit line) is assigned dynamically according to the currently measured channel power.

MANUAL
One of the specified power classes is selected manually for the entire measurement. The selection is made with the `CALCulate:LIMit:ESPectrum:PCLass<class>[:EXCLusive]` command.

*RST: AUTO

Example:

`CALC:LIM:ESP:MODE AUTO`
Activates automatic selection of the limit line.

CALCulate:LIMit:ESPectrum:VALue <Power>

This command activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

This command has the same effect as a combination of the CALC:LIM:ESP:MODE MAN and the `CALCulate:LIMit:ESPectrum:PCLass<class>[:EXCLusive]` commands; however, the power class to be used is not defined directly, but via the expected power. As opposed to `CALC:LIM:ESP:MODE AUTO`, the power class is not reassigned to the input signal power dynamically, but only once when the command is executed.

Parameters:

<Power>

integer

Range: -200 to 199
*RST: 0

Example:

`CALC:LIM:ESP:VAL 33`
Activates manual selection of the limit line and selects the limit line for P = 33.

CALCulate:LIMit:ESPectrum:PCLass:COUNt <NoPowerClasses>

This command sets the number of power classes to be defined. This command must be executed before any new power class values can be defined using `CALCulate:LIMit:ESPectrum:PCLass<class>:MAXimum` and `CALCulate:LIMit:ESPectrum:PCLass<class>:MINimum`.

Parameters:

<NoPowerClasses> 1 to 4

*RST: 1

Example: `CALC:LIM:ESP:PCL:COUN 2`
Two power classes can be defined.

CALCulate:LIMit:ESPectrum:PCLass<class>[:EXCLusive] <State>

This command selects the power class used by the measurement if `CALCulate:LIMit:ESPectrum:MODE` is set to manual.

Note that:

- You can only use power classes for which limits are defined.

Suffix:

<class> 1...4
power class

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:LIM:ESP:PCL1 ON`
Activates the first defined power class.

Manual control: See "Used Power Classes" on page 111
See "Adding or Removing a Power Class" on page 111

CALCulate:LIMit:ESPectrum:PCLass<class>:LIMit[:STATe] <State>

This command selects the limit check mode for each power class.

Suffix:

<class> 1...4
power class

Parameters:

<State>

ABSolute
Evaluates only limit lines with absolute power values

RELative
Evaluates only limit lines with relative power values

AND
Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

OR
Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

*RST: REL

Example: `CALC:LIM:ESP:PCL:LIM ABS`

Manual control: See "Used Power Classes" on page 111

CALCulate:LIMit:ESPectrum:PCLass<class>:MAXimum <Level>

This command defines the upper limit of a particular power class.

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see `CALCulate:LIMit:ESPectrum:PCLass:COUNt` on page 565).

Suffix:
<class> 1...4
power class

Parameters:
<Level> Range: -199.9 dBm to 200 dBm

Example: `CALC:LIM:ESP:PCL1:MAX -40 dBm`
Sets the maximum power value of the first power class to -40 dBm.

Manual control: See "PMin/PMax" on page 111

CALCulate:LIMit:ESPectrum:PCLass<class>:MINimum <Level>

This command defines the lower limit of a particular power class.

Note:

- The first power class always has a lower limit of -200 dBm.
- The lower limit of a power class must always be the same as the upper limit of the previous power class.
- The power class must already exist (see `CALCulate:LIMit:ESPectrum:PCLass:COUNt` on page 565).

Suffix:
<class> 1...4
power class

Parameters:
<Level> Range: -200 dBm to 199.9 dBm

Example: `CALC:LIM:ESP:PCL2:MIN -40 dBm`
Sets the minimum power value of the second power class to -40 dBm.

Manual control: See "PMin/PMax" on page 111

10.3.6.6 Configuring MSR SEM Measurements

The following commands configure MSR SEM measurements. For details see chapter 4.5.4.4, "Multi-Standard Radio (MSR) SEM Measurements", on page 103.

For manual operation see chapter 4.5.5.4, "MSR Settings", on page 111.

[SENSe:]ESPectrum:MSR:APPLy

This command configures the SEM sweep list according to the MSR settings defined by previous commands.

Usage: Event

Manual control: See "Apply to SEM" on page 113

[SENSe:]ESPectrum:MSR:BCATegory <Category>

This command defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

Parameters:

<Category> 1 | 2 | 3

1
2 carriers: LTE FDD and WCDMA

2
3 carriers: LTE FDD, WCDMA and GSM/EDGE

3
2 carriers: LTE TDD and TD-SCDMA

*RST: 1

Manual control: See "Band Category" on page 112

[SENSe:]ESPectrum:MSR:GSM:CPResent <State>

This command defines whether a GSM/Edge carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see `[SENSe:]ESPectrum:MSR:BCATegory` on page 568).

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Carrier Adjacent to RF Bandwidth Edge" on page 112

[SENSe:]ESPectrum:MSR:LTE:CPResent <State>

This command defines whether an LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see `[SENSe:]ESPectrum:MSR:BCATegory` on page 568).

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Carrier Adjacent to RF Bandwidth Edge" on page 112

[SENSe:]ESPectrum:MSR:RFBWidth <Bandwidth>

This command defines the RF bandwidth of the base station for MSR measurements.

Parameters:

<Bandwidth> Bandwidth in Hz

*RST: 10.0 MHz

Manual control: See "Base Station RF Bandwidth" on page 112

10.3.6.7 Configuring the List Evaluation

The following commands configure the list evaluation.

Useful commands for SEM measurements described elsewhere

- `MMEMory:STORe:LIST` on page 775

Remote commands exclusive to SEM measurements

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:AUTO <State>

This command turns the list evaluation on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example:

```
CALC:ESP:PSE:AUTO OFF
```

Deactivates the list evaluation.

Manual control: See "List Evaluation State" on page 115
See "List Evaluation State" on page 135

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch[:IMMediate]

This command initiates a list evaluation.

Usage: Event

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Parameters:

<Margin>
Range: -200 to 200
*RST: 200
Default unit: dB

Example: `CALC:ESP:PSE:MARG 100`
Sets the margin to 100 dB.

Manual control: See "Margin" on page 115
See "Margin" on page 136

CALCulate<n>:ESPectrum:PSEarch|PEAKsearch:PSHow

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:ESP:PSE:PSH ON`
Marks all peaks with blue squares.

Manual control: See "Show Peaks" on page 115
See "Show Peaks" on page 135

10.3.6.8 Performing an SEM Measurement

The following commands are required to perform an SEM measurement:

`SENS:SWE:MODE ESP`, see `[SENSe:]SWEep:MODE` on page 549

`INITiate[:IMMediate]` on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.6.9 Retrieving Results

The following commands analyze and retrieve measurement results for SEM measurements.

- `CALCulate<n>:LIMit<k>:FAIL` on page 754
- `CALCulate:MARKer:FUNCtion:POWer:RESult?` on page 514

- TRACe<n>[:DATA] on page 702
- TRACe<n>[:DATA]:MEMory? on page 704
- TRACe<n>[:DATA]:X? on page 704

10.3.6.10 Example: SEM Measurement

In this example we will configure and perform an SEM measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S FSW performs the measurement optimally with the predefined settings, without further configuration.

```
//------------ Preparing the measurement------------
*RST
//Resets the instrument
SWE:MODE ESP
//Activates SEM Measurement
//SEM has to be in single sweep mode to be configured

INIT:CONT OFF
//Turns on the SEM measurement.

//------------ Managing Measurement Configurations----------
ESP:PRES 'WCDMA\3GPP\UL\3GPP_UL.xml'
//Loads the 3GPP configuration stored in the file '3GPP_UL.xml'

//------------ Defining the Reference Range-----------------
ESP:RRAN?
//Queries the current reference range.
ESP:RTYP CPOW
//Selects the channel power as the power reference.
ESP:BWID 4 MHZ
//Defines a channel bandwidth of 4 MHz for the power reference.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5
//Uses an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.

//------------ Configuring Power Classes--------------------
CALC:LIM:ESP:PCL:COUN 3
//Defines 3 power classes.
CALC:LIM:ESP:LIM -100,0
//Defines the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:PCL1:LIM ABS
//Defines an absolute limit check for class 1.
CALC:LIM:ESP:PCL2:LIM REL
```

```
//Defines a relative limit check for class 2.
CALC:LIM:ESP:MODE MAN
//Defines a manual selection of the power class.
CALC:LIM:ESP:PCL2 ON
//Activates the use of the second power class for the entire measurement.

//------------ Configuring a Sweep List---------------------
ESP:RANG2:INS AFT
//Inserts a range after range 2.
ESP:RANG1:INS BEF
//Inserts a range before range 1.
ESP:RANG:COUNt?
//Returns the number of measurement ranges in the sweep list (currently 11).
ESP:RANG5:DEL

//Deletes the 11th range.
ESP:RANG1:STOP -10000000

//Defines a stop frequency of -9 MHz for range 1.
ESP:RANG2:STAR -9000000
//Defines a start frequency of -10 MHz for range 2.

ESP:HSP OFF
//Switches off Fast SEM mode so the ranges can be configured individually.

ESP:RANG2:BAND:RES 1000000
//Defines a resolution bandwidth of 1 MHz for range 2.

ESP:RANG2:FILT:TYPE RRC
//Selects an RRC filter for range 2.
ESP:RANG2:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 2.
ESP:RANG2:SWE:TIME 1
//Defines a sweep time of 1 second for range 2.
ESP:RANG2:RLEV 0
//Defines a reference level of 0 dBm for range 2.
ESP:RANG2:INP:ATT 10
//Defines an input attenuation of 10 dB for range 2.


// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSe1:CORRection:TRANsducer:SELect 'Transducer'
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3
```

```
ESP:RANG2:TRAN 'Transducer'
//Includes a transducer called 'transducer' for range 2.

//------------ Configuring the limit check------------------

ESP:RANG:LIM1:STAT AND
//Checks the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are
//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
//Enables the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

ESP:RANG:LIM2:STAT OR
//Checks the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Defines an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20
//Defines a relative limit of -20 dBc for the entire range 2 for power class 2.

//------------ Configuring List Evaluation-----------------
CALC:ESP:PSE:AUTO ON
//Activates list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:MARG 10dB
//Defines a peak threshold of 10 dB.

//------------ Managing Measurement Configurations----------

ESP:PRES:STOR 'WCDMA\3GPP\UL\3GPP_UL_User.xml'
//Saves the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.

//------------ Performing the measurement-------------------
INIT:IMM
//One sweep

//------------ Checking the Results-------------------------
CALC:LIM:FAIL?
```

```
//Queries the result of the limit check for all ranges.
TRAC:DATA? LIST
//Returns the peak for each range of the SEM measurement as a list.
```

10.3.7 Measuring Spurious Emissions

All remote control commands specific to spurious emissions measurements are described here.

10.3.7.1 Initializing the Measurement

Note that with the R&S FSW, the spurious measurement must be initialized before you can start configuring the sweep list or list evaluation.

INITiate:SPURious

This command initiates a Spurious Emission measurement.

Usage: Event

10.3.7.2 Configuring a Sweep List

The following commands configure the sweep list for spurious emission measurements.

Useful commands for configuring the sweep described elsewhere:

- `[SENSe:]SWEep:MODE` on page 549

Remote commands exclusive to spurious measurements:

[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a spurious emission measurement range.

Suffix:

<range>	1..30 Selects the measurement range.

Parameters:

<RBW>	Resolution bandwidth. Refer to the data sheet for available resolution bandwidths. Default unit: Hz

Manual control: See "RBW" on page 132

[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a spurious emission measurement range.

Suffix:

<range>	1..30 Selects the measurement range.

Parameters:

<VBW>	Video bandwidth. Refer to the data sheet for available video bandwidths. Default unit: Hz

Manual control: See "VBW" on page 132

[SENSe:]LIST:RANGe:BREak <State>

This command controls the sweep.

Parameters:

<State> **ON**
The R&S FSW stops after measuring one range.
To continue with the next range, you have to use `INITiate:CONMeas`.

OFF
The R&S FSW sweeps all ranges in one go.

*RST: OFF

Manual control: See "Stop After Sweep" on page 133

[SENSe:]LIST:RANGe:COUNt?

This command queries the number of ranges in the sweep list.

Return values:

<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]LIST:RANGe<range>:DELete

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<range> 1..30
Selects the measurement range.

Usage: Event

[SENSe:]LIST:RANGe<range>:DETector <Detector>

This command selects the detector for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Detector> **NEGative**
minimum peak detector

POSitive
peak detector

SAMPle
sample detector

RMS
RMS detector

AVERage
average detector

*RST: RMS

Manual control: See "Detector" on page 133

[SENSe:]LIST:RANGe<range>:FILTer:TYPE <FilterType>

This command selects the filter type for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<FilterType> **NORMal**
Gaussian filters

CFILter
channel filters

RRC
RRC filters

P5
5 Pole filters

*RST: NORM
The available bandwidths of the filters are specified in the data sheet.

Manual control: See "Filter Type" on page 132

[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt <Frequency>

This command defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S FSW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S FSW will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information see chapter 4.6, "Spurious Emissions Measurement", on page 126.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Manual control: See "Range Start / Range Stop" on page 132

[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP <Frequency>

This command defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S FSW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S FSW will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information seechapter 4.6, "Spurious Emissions Measurement", on page 126 .

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual control: See "Range Start / Range Stop" on page 132

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Attenuation>	Numeric value. Refer to the data sheet for the attenuation range. *RST: 10 dB Default unit: dB
Manual control:	See "RF Attenuator" on page 133

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

Suffix:

<range>	1..30 Selects the measurement range.

Parameters:

<State>	ON | OFF *RST: ON
Manual control:	See "RF Att. Mode" on page 133

[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe <State>

This command turns the preamplifier for a spurious emission measurement range on and off.

The preamplification is defined by `[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue]` on page 579.

Suffix:

<range>	1..30 Selects the measurement range.

Parameters:

<State>	ON | OFF *RST: OFF
Manual control:	See "Preamp" on page 133

[SENSe:]LIST:RANGe<range>:INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level for the range.

The command requires option R&S FSW-B24.

Suffix:

<range>	1..30 Selects the measurement range.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.

• R&S FSW8: 15dB and 30 dB
• R&S FSW13: 15dB and 30 dB
• R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

[SENSe:]LIST:RANGe<range>:LIMit:STARt <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: 13
Default unit: dBm

Manual control: See "Abs Limit Start/Stop" on page 134

[SENSe:]LIST:RANGe:LIMit:STATe

This command turns the limit check for all spurious emission measurement ranges on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Limit Check" on page 134

[SENSe:]LIST:RANGe<range>:LIMit:STOP <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: 13
Default unit: dBm

Manual control: See "Abs Limit Start/Stop" on page 134

[SENSe:]LIST:RANGe<range>:POINts <Points>

This command defines the number of sweep points in a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Points> For more information on sweep points see chapter 5.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 242.

*RST: 691

Manual control: See "Sweep Points" on page 133

[SENSe:]LIST:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.

*RST: 0 dBm

Manual control: See "Ref. Level" on page 133

[SENSe:]LIST:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual control: See "Sweep Time" on page 132

[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a spurious emission measurement range on and off.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF
*RST: ON

Manual control: See "Sweep Time Mode" on page 132

[SENSe:]LIST:RANGe<range>:TRANsducer <Transducer>

This command selects a transducer factor for a spurious emission measurement range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name, including the path information.

Manual control: See "Transducer" on page 134

10.3.7.3 Configuring the List Evaluation

The following commands configure the list evaluation.

Useful commands for spurious emission measurements described elsewhere

- `MMEMory:STORe:LIST` on page 775

Remote commands exclusive to spurious emission measurements

CALCulate<n>:PSEarch|PEAKsearch:AUTO <State>

This command turns the list evaluation on and off.

Parameters:

<State>	ON | OFF	
	*RST:	ON

Example: `CALC:PSE:AUTO OFF`
Deactivates the list evaluation.

CALCulate<n>:PSEarch|PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Parameters:

<Margin>	Range:	-200 to 200
	*RST:	200
	Default unit:	dB

Example: `CALC:PSE:MARG 100`
Sets the threshold to 100 dB.

CALCulate<n>:PSEarch|PEAKsearch:PSHow

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

Example: `CALC:PSE:PSH ON`
Marks all peaks with blue squares.

CALCulate<n>:PSEarch|PEAKsearch:SUBRanges <NumberPeaks>

This command defines the number of peaks included in the peak list.

After this number of peaks has been found, the R&S FSW stops the peak search and continues the search in the next measurement range.

Parameters:

<NumberPeaks>	Range:	1 to 50
	*RST:	25

Example: `CALC:PSE:SUBR 10`
Sets 10 peaks per range to be stored in the list.

Manual control: See "Peaks per Range" on page 136

10.3.7.4 Performing a Spurious Measurement

The following commands are required to perform a Spurious measurement:

`SENS:SWE:MODE LIST`, see `[SENSe:]SWEep:MODE` on page 549

INITiate[:IMMediate] on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.7.5 Retrieving and Saving Settings and Results

The following commands analyze and retrieve measurement results for Spurious measurements.

Useful commands for spurious emission measurements described elsewhere

- CALCulate<n>:LIMit<k>:FAIL on page 754
- TRACe<n>[:DATA] on page 702
- TRACe<n>[:DATA]:MEMory? on page 704
- TRACe<n>[:DATA]:X? on page 704

10.3.7.6 Programming Example: Spurious Emissions Measurement

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.

Spurious Emissions

	Range 1	Range 2	Range 3
Range Start	10 MHz	100 MHz	100.0000...
Range Stop	100 MHz	100.0000...	1 GHz
Filter Type	RRC	Normal(3...	Normal(3...
Res BW	24.3 kHz	10 kHz	100 kHz
Video BW	5 MHz	30 kHz	300 kHz
Sweep Time Mode	Manual	Auto	Auto
Sweep Time	1 s	4.01 ms	32.1 ms
Detector	Sample	RMS	RMS
Ref. Level	-20 dBm	0 dBm	0 dBm
RF Att. Mode	Manual	Auto	Auto
RF Attenuator	10 dB	10 dB	10 dB
Preamp	On	Off	Off
Sweep Points	601	4001	32001
Stop After Sweep	Off	Off	Off
Transducer	None	None	None
Limit Check	Absolute	Absolute	Absolute
Abs Limit Start	10 dBm	-13 dBm	-13 dBm
Abs Limit Stop	10 dBm	-13 dBm	-13 dBm

Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

```
//------------Preparing the measurement-------------
*RST
//Resets the instrument

SWE:MODE LIST
//Activates spurious emissions measurement
//Spurious measurement has to be in single sweep mode to be configured

INIT:CONT OFF
//Selects single sweep mode.

//---------------Configuring a Sweep List----------

LIST:RANG:COUNt?
//Returns the number of measurement ranges in the sweep list.
LIST:RANG4:DEL
//Deletes the fourth range.
LIST:RANG1:STAR 10000000
//Defines a start frequency of 10 MHz for range 1.
LIST:RANG1:STOP 100000000
//Defines a stop frequency of 100 MHz for range 1.
LIST:RANG1:BAND 500000
//Defines a resolution bandwidth of 500 kHz in range 1.
LIST:RANG1:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 1.
LIST:RANG1:INP:ATT:AUTO OFF
//Turns automatic selection of the input attenuation in range 1 off.

LIST:RANG1:INP:ATT 10
//Defines a input attenuation of 10 dBm for range 1.


LIST:RANG1:FILT:TYPE CFILter
//Selects an Channel filter for range 1.
LIST:RANG1:DET SAMP
//Selects a sample detector for range 1.
LIST:RANG1:POIN 601
//Defines 601 sweep points for range 1.
LIST:RANG1:RLEV -20
//Defines a reference level of -20 dBm for range 1.
LIST:RANG1:SWE:TIME 5
//Defines a manual sweep time of 5 second for range 1.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range
//
SENSe1:CORRection:TRANsducer:SELect 'Test'
```

```
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz to 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3

SENS:LIST:RANG1:TRAN 'Test'
//Includes a transducer called 'Test' for range 1.

LIST:RANG1:LIM:STAR 10
LIST:RANG1:LIM:STOP 10
//Defines an absolute limit of 10 dBm at the start and stop frequencies of range 1.
LIST:RANG:LIM:STAT ON
//Turns the limit check for all ranges on.

//---------------Configuring the List Evaluation----------
CALC:PSE:MARG 100
//Sets the threshold to 100 dB.
CALC:PSE:PSH ON
//Marks all peaks in the diagram with blue squares.
CALC:PSE:SUBR 10
//Sets 10 peaks per range to be stored in the list.

//--------------Performing the Measurement-----

INIT:SPUR; *WAI
//Performs a spurious emission measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:LIM1:FAIL?
//Queries the result of the check for limit line 1.
TRAC? SPUR
//Queries the peak list of the spurious emission measurement.
```

10.3.8 Analyzing Statistics (APD, CCDF)

All remote control commands specific to statistical measurements are described here.

10.3.8.1 Activating Statistical Measurements

The following commands activate statistical measurements.

CALCulate<n>:STATistics:APD[:STATe] <State>

This command turns the APD measurement on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:STAT:APD ON`

Switches on the APD measurement.

Manual control: See "APD" on page 34

CALCulate<n>:STATistics:CCDF[:STATe] <State>

This command turns the CCDF on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:STAT:CCDF ON`

Switches on the CCDF measurement.

Manual control: See "CCDF" on page 35

10.3.8.2 Configuring Statistical Measurements

The following commands configure the measurement.

Useful commands for configuring statistical measurements described elsewhere:

- `[SENSe:]BANDwidth|BWIDth[:RESolution]` on page 632

Remote commands exclusive to statistical measurements:

CALCulate<n>:MARKer<m>:Y:PERCent <Probability>

This command sets a marker to a particular probability value. You can query the corresponding level with `CALCulate<n>:MARKer<m>:X`.

Using the command turns delta markers into normal markers.

This command is available for CCDF measurements.

Parameters:

<Probability>	Range:	0 % to 100 %

Example: `CALC1:MARK:Y:PERC 95PCT`
Positions marker 1 to a probability of 95 %.

Manual control: See "Percent Marker (CCDF only)" on page 145

CALCulate<n>:STATistics:NSAMples <Samples>

This command defines the number of samples included in the analysis of statistical measurement functions.

Parameters:

<Samples>	Range:	Min: 100, Max: depends on the RBW filter
	*RST:	100000

Example: `CALC:STAT:NSAM 500`
Sets the number of measurement points to be acquired to 500.

Manual control: See "Number of Samples" on page 145

10.3.8.3 Using Gate Ranges for Statistical Measurements

The following commands control gated statistical measurements.

[SENSe:]SWEep:EGATe:TRACe<k>:COMMent <Comment>

This command defines a comment for the gate of a particular trace.

Parameters:

<Comment>	String containing the comment.

Example: `SWE:EGAT:TRAC1:COMM 'MyComment'`
Defines a comment for the gate in trace 1.

Manual control: See "Comment" on page 147

[SENSe:]SWEep:EGATe:TRACe:PERiod <Length>

This command defines the length of the gate for all traces.

The gate length applies to all traces.

Parameters:

<Length>	Range:	100 ns to 1000 s
	*RST:	2 ms

Example: `SWE:EGAT:TRAC1:PER 5ms`
Defines the period for gated triggering to 5 ms.

Manual control: See "Period" on page 147

[SENSe:]SWEep:EGATe:TRACe<k>:STARt<range> <Time>

This command defines the start time for a gate range.

Suffix:
<range> 1...3
gate range

Parameters:
<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe:PERiod`.
The following rules apply:
• the start time may not be higher than the length of the gate
• the start time may not be lower than the stop time of the gate range of a lower order
The reset values depend on the gate range.
• for gate range 1, the start time is 0 ms
• for gate range 3, the start time is 2 ms
• for gate range 5, the start time is 4 ms

Example: `SWE:EGAT:TRAC1:STAR1 3ms`
Sets the Starting point for range 1 on trace 1 at 3 ms.

Manual control: See "Range <x> Start/Stop" on page 147

[SENSe:]SWEep:EGATe:TRACe<k>[:STATe<range>] <State>

This command includes or excludes a gate range for a particular trace.

Suffix:
<range> 1...3
gate range

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

Example: `SWE:EGAT:TRAC1:STAT1 ON`
Activates gate range 1 for trace 1.

Manual control: See "Gated Trigger" on page 146
See "Range <x> Use" on page 147

[SENSe:]SWEep:EGATe:TRACe<k>:STOP<range> <Time>

This command defines the stop time for a gate range.

Suffix:
<range> 1...3
gate range

Parameters:
<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe:PERiod`.
The following rules apply:
• the stop time may not be higher than the length of the gate
• the stop time may not be lower than the start time
The reset values depend on the gate range.
• for gate range 1, the stop time is 1 ms
• for gate range 3, the stop time is 3 ms
• for gate range 5, the stop time is 5 ms

Example: `SWE:EGAT:TRAC1:STOP1 5ms`
Sets the stopping point for range 1 on trace 1 at 5 ms.

Manual control: See "Range <x> Start/Stop" on page 147

10.3.8.4 Scaling the Diagram

The following commands set up the diagram for statistical measurements.

CALCulate<n>:STATistics:PRESet

This command resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)
  0.0 dBm
- Display range (x-axis) for APD measurements
  100 dB
- Display range (x-axis) for CCDF measurements
  20 dB
- Upper limit of the y-axis
  1.0
- Lower limit of the y-axis
  1E-6

Example: `CALC:STAT:PRES`
Resets the scaling for statistical functions

Usage: Event

Manual control: See "Default Settings" on page 149

CALCulate<n>:STATistics:SCALe:AUTO ONCE

This command initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

Parameters:
ONCE

Example: `CALC:STAT:SCAL:AUTO ONCE;*WAI`
Adapts the level setting for statistical measurements.

Usage: Event

Manual control: See "Adjust Settings" on page 146

CALCulate<n>:STATistics:SCALe:X:RANGe <Range>

This command defines the display range of the x-axis for statistical measurements. The effects are identical to `DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]`.

Parameters:
<Range> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `CALC:STAT:SCAL:X:RANG 20dB`

Manual control: See "X-Axis" on page 149
See "Range" on page 149

CALCulate<n>:STATistics:SCALe:X:RLEVel <RefLevel>

This command sets the reference level for statistical measurements. The effects are identical to `DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel`.

Note that in case of statistical measurements the reference level applies to the x-axis.

Parameters:
<RefLevel> The unit is variable.
If a reference level offset is included, the range is adjusted by that offset.
Range: -130 dBm to 30 dBm
*RST: 0 dBm

Example: `CALC:STAT:SCAL:X:RLEV -60dBm`

Manual control: See "X-Axis" on page 149
See "Ref Level" on page 149

CALCulate<n>:STATistics:SCALe:Y:LOWer <Magnitude>

This command defines the lower vertical limit of the diagram.

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.
Range: 1E-9 to 0.1
*RST: 1E-6

Example: `CALC:STAT:SCAL:Y:LOW 0.001`

Manual control: See "Y-Axis" on page 149
See "Y-Max / Y-Min" on page 149

CALCulate<n>:STATistics:SCALe:Y:UNIT <Unit>

This command selects the unit of the y-axis.

Parameters:

<Unit> PCT | ABS
*RST: ABS

Example: `CALC:STAT:SCAL:Y:UNIT PCT`
Sets the percentage scale.

Manual control: See "Y-Axis" on page 149
See "Y-Unit" on page 149

CALCulate<n>:STATistics:SCALe:Y:UPPer <Magnitude>

This command defines the upper vertical limit of the diagram.

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.
Range: 1E-5 to 1.0
*RST: 1.0

Example: `CALC:STAT:SCAL:Y:UPP 0.01`

Manual control: See "Y-Axis" on page 149
See "Y-Max / Y-Min" on page 149

10.3.8.5 Performing a Statistical Measurement

The following commands are required to perform a statistical measurement:

`INITiate[:IMMediate]` on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.8.6 Retrieving Results

The following commands are required to retrieve the measurement results.

Useful commands for retrieving results described elsewhere:

- `CALCulate<n>:MARKer<m>:X` on page 709

Remote commands exclusive to statistical results

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

This command queries the results of the CCDF.

Query parameters:

<Probability>

P0_01
Level value for 0.01 % probability

P0_1
Level value for 0.1 % probability

P1
P1: Level value for 1 % probability

P10
Level value for 10 % probability

Example: `CALC:STAT:CCDF:X1? P10`
Returns the level values that are over 10 % above the mean value.

Usage: Query only

Manual control: See "CCDF" on page 35

CALCulate:STATistics:RESult<t>? <ResultType>

This command queries the results of a CCDF or ADP measurement for a specific trace.

Parameters:

<ResultType>

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

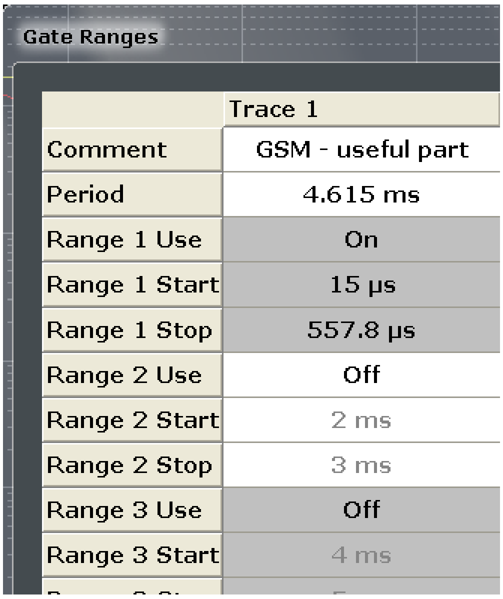
Example: `CALC:STAT:RES2? ALL`
Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage: Query only

Manual control: See "APD" on page 34
See "CCDF" on page 35

10.3.8.7 Programming Example: Measuring Statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in chapter 4.7.4, "APD and CCDF Basics - Gated Triggering", on page 143.




```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
TRIG:SOUR EXT
//Defines the use of an external trigger.
TRIG:HOLD 25us
//Defines a trigger offset of 25 µs.
CALC:STAT:APD ON
//Activates APD measurement.
CALC:STAT:NSAM 1000
//Sets the number of samples to be included in the statistical evaluation to 1000.

//-------------Defining Gate ranges -----------------

SWE:EGAT:TRAC1:COMM 'GSM - useful part'
//Defines a comment for the gate
SWE:EGAT:TRAC1:PER 4.61536ms
```

```
//Sets the gate period to 4.61536ms.
SWE:EGAT:TRAC1:STAR1 15us
//Sets the start of range 1 to 15 µs.
SWE:EGAT:TRAC1:STOP1 557.8us
//Sets the end of range 1 to 15 µs (start time) + 542.77 µs (useful part) = 557.8 µs.
SWE:EGAT:TRAC1:STAT1 ON
//Activates the use of range 1.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:STAT:RES1? MEAN
//Returns the mean average power for the useful part of the GSM signal.

//------------- Determining the CCDF values-------------------

CALC:STAT:CCDF ON
//Activates CCDF measurement.
CALC:MARK2:Y:PERC 95PCT
//Sets marker 2 to the 95% probability value.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
CALC:STAT:CCDF:X? P1
//Returns the level value for 10% probability for the CCDF.
CALC:MARK2:X?
//Returns the level for a probability of 95%.
```

10.3.9 Measuring the Time Domain Power

All remote control commands specific to time domain power measurements are described here.

10.3.9.1 Configuring the Measurement

The following remote commands measure the time domain power.

Useful commands for time domain power measurements described elsewhere

- CALCulate:MARKer:X:SLIMits:LEFT
- CALCulate:MARKer:X:SLIMits:RIGHT

- `CALCulate:MARKer:X:SLIMits[:STATe]`

Remote commands exclusive to time domain power measurements

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF

This command turns all time domain power evaluation modes off.

Usage: Event

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage <State>

This command switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with `[SENSe:]AVERage:COUNt`.

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

`INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:SUMM:AVER ON`
Switches on the calculation of average.
`AVER:COUN 200`
Sets the measurement counter to 200.
`INIT;*WAI`
Starts a sweep and waits for the end.

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd <State>

This command switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

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

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] <State>

This command turns time domain power measurements on and off. This measurement in only available in zero span.

When you turn the measurement on, the R&S FSW activates a marker and positions it on the peak power level in the marker search range.

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

Manual control: See "Time Domain Power" on page 35

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] <State>

This command turns the evaluation to determine the mean time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

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

Manual control: See "Results" on page 155

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] <State>

This command turns the evaluation to determine the positive peak time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

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

Manual control: See "Results" on page 155

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] <State>

This command turns the evaluation to determine the RMS time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

Manual control: See "Results" on page 155

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] <State>

This command turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S FSW performs the measurement on the trace marker 1 is positioned on.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

10.3.9.2 Performing a Time Domain Power Measurement

The following commands are required to perform a Time Domain Power measurement:

INITiate[:IMMediate] on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.9.3 Retrieving Measurement Results

The following commands query the results for time domain measurements.

Measuring the Mean Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

This command queries the average mean time domain power. The query is only possible if averaging has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage on page 596.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 509.

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

This command queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?

This command queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

Manual control: See "Results" on page 155

Measuring the Peak Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

This command queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 596.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

This command queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?

This command queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

Manual control: See "Results" on page 155

Measuring the RMS Power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult?

This command queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 596.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

This command queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?

This command queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 509.

Return values:

<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

Manual control: See "Results" on page 155

Measuring the Standard Deviation

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

This command queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage on page 596.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 509.

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

This command queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 509.

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult?

This command queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

10.3.9.4 Programming Example: Time Domain Power

This programming example demonstrates the measurement example described in chapter 4.8.6, "Measurement Example", on page 157 in a remote environment.

```
//-------------Configuring the Measurement-----------------------
*RST
//Resets the instrument

INIT:CONT OFF
//Turns on single sweep mode.

FREQ:CENT 1.8GHz
//Sets the center frequency to 1.8 GHz.

BAND:RES 100kHz
//Sets the bandwidth to 100 kHz.

SWE:TIME 10ms
//Sets the sweep time to 640 µs.

FREQ:SPAN 0
//Sets the instrument to zero span.


CALC:MARK:FUNC:SUMM:STAT ON
//Turns on time domain power measurements.

CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:RMS ON
//Turns the evalution of the mean, peak and RMS time domain power.

CALC:MARK:X:SLIM ON
//Activates limit lines for evaluation.

CALC:MARK:X:SLIM:LEFT 1ms
//Sets the left limit line to 326 µs.

CALC:MARK:X:SLIM:RIGH 6ms
//Sets the right limit line to 538 µs.
```

```
//--------------Performing the Measurement------------------------

INIT;*WAI
//Initiates the measurement and waits until the measurement is finished.

//-------------Retrieving the Results-------------------------------
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:PPE:RES?
CALC:MARK:FUNC:SUMM:RMS:RES?
//Queries the mean, peak and RMS time domain power.
```

10.3.10 Measuring the Harmonic Distortion

All remote control commands specific to harmonic distortion measurements are described here.

10.3.10.1 Activating the Measurement

The following command activates harmonic distortion measurement.

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe] <State>

This command turns the harmonic distortion measurement on and off.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.
- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:FUNC:HARM ON`

Activates the harmonic distortion measurement.

Manual control: See "Harmonic Distortion" on page 35

10.3.10.2 Configuring the Measurement

The following commands control the harmonic distortion measurement.

Useful commands for harmonic distortion measurements described elsewhere

- `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 627
- `[SENSe:]SWEep:TIME:AUTO` on page 637

Remote commands exclusive to harmonic distortion measurements

---

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO <State>

This command selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

Parameters:

<State> OFF | ON

OFF
identical

ON
a multiple

*RST: ON

Manual control: See "Harmonic RBW Auto" on page 163

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics <NoHarmonics>

This command selects the number of harmonics that the R&S FSW looks for.

Parameters:

<NoHarmonics> Range: 1 to 26
*RST: 10

Manual control: See "No. of Harmonics" on page 162

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet

This command initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)
  Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)

The level of the first harmonic is determined. The frequency remains unchanged.

Usage: Event

Manual control: See "Adjust Settings" on page 163

10.3.10.3 Performing the Measurement

The following commands are required to perform a harmonic distortion measurement:

`INITiate[:IMMediate]` on page 510, see chapter 10.3.1, "Performing Measurements", on page 508

10.3.10.4 Retrieving Results

The following commands retrieve the results of the harmonic distortion measurement.

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? TOTal

This command queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Result> <Distortion_%>,<Distortion_dB>

Pair of values, one showing the THD in %, one in dB.

Usage: Query only

Manual control: See "Harmonic Distortion" on page 35

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST?

This command queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Harmonics> Returns one value for every harmonic.
The first value is the absolute power of the first harmonic. The unit is variable.
The other values are power levels relative to the first harmonic.
The unit for these is dB.

Usage: Query only

Manual control: See "Harmonic Distortion" on page 35

10.3.10.5 Example: Measuring the Harmonic Distortion

```
//-------------Configuring the Measurement-------------
*RST
//Resets the instrument.

INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.

//-------------Performing the Measurement-------------------

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-------------Retrieving the Results-----------------------
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.
```

10.3.11 Measuring the Third Order Intercept Point

10.3.11.1 Determining the TOI

All remote control commands specific to TOI measurements are described here.

Useful commands for TOI measurements described elsewhere

- CALCulate<n>:DELTamarker<m>:X on page 708
- CALCulate<n>:DELTamarker<m>:X:RELative? on page 720
- CALCulate<n>:DELTamarker<m>:Y? on page 720
- CALCulate<n>:MARKer<m>:X on page 709
- CALCulate<n>:MARKer<m>:Y? on page 721

Remote commands exclusive to TOI measurements

CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe] <State>

This command initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the `CALCulate<n>:DELTamarker<m>:X` command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:FUNC:TOI ON`
Switches on the measurement of the third-order intercept.

Manual control: See "TOI" on page 35

CALCulate:MARKer:FUNCtion:TOI:SEARchsignal ONCE

This command initiates a search for signals in the current trace to determine the third intercept point.

Parameters:

ONCE

Example: `CALC:MARK:FUNC:TOI:SEAR ONCE`
Executes the search for 2 signals and their intermodulation product at the currently available trace.

Usage: Event

Manual control: See "Search Signals" on page 170

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?

This command queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<TOI> Third order intercept point.

Example:

`INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:TOI ON`
Switches the intercept measurement.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:TOI:RES?`
Outputs the measured value.

Usage: Query only

Manual control: See "TOI" on page 35

10.3.11.2 Programming Example: Measuring the TOI

This example demonstrates how to determine the TOI in a remote environment.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.

//-------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

10.3.12 Measuring the AM Modulation Depth

All remote control commands specific to AM modulation depth measurements are described here.

10.3.12.1 Configuring and Performing the Measurement

The following commands control the measurement.

Useful commands for AM modulation depth described elsewhere

- `CALCulate<n>:DELTamarker<m>:X` on page 708
- `CALCulate<n>:DELTamarker<m>:X:RELative?` on page 720

- CALCulate<n>:MARKer<m>:X on page 709

Remote commands exclusive to AM modulation depth measurements

---

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] <State>

This command turns the AM Modulation Depth measurement on and off.

To work correctly, the measurement requires an AM modulated signal.

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

Manual control: See "AM Mod Depth" on page 35

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE

This command initiates a search for the signals required for the AM depth measurement.

Note that the command does not perform a new measurement, but looks for the signals on the current trace.

Parameters:
ONCE

Example: `CALC:MARK:FUNC:MDEP:SEAR ONCE`
Executes the search of an AM modulated signal at the currently available trace.

Usage: Event

Manual control: See "Search Signals" on page 175

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult?

This command queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 509.

Return values:
<ModulationDepth> Modulation depth in %.

Usage: Query only

Manual control: See "AM Mod Depth" on page 35

10.3.12.2 Example: Measuring the AM Modulation Depth

This example demonstrates how to determine the AM modulation depth in a remote environment. Note that without a real input signal this measurement will not return useful results.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
FREQ:CENT 100MHz
//Set center frequency
FREQ:SPAN 10KHz
// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
//the temporary markers manually.

//----Changing the position of the temp markers-----
CALC:MARK:X 100MHZ
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHZ
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHZ
//Corrects the position of delta marker 3 by 1 kHz.

CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results for the repositioned markers.
```

10.3.13 List Evaluations

A list evaluation is a mutliple power measurement that measures the power at up to 200 frequencies. The measurement itself is a time domain measurement. Note that if you set a span greater than 0, the R&S FSW aborts the list evaluation.

Noise cancellation in list evaluations

As of R&S FSW firmware version 1.30, noise cancellation is also available in zero span and thus also for list evaluations. See "Noise cancellation" on page 54 for details.

List evaluations allow for a different instrument setup for each frequency you want to measure. You can define most of the settings with the commands described here. Settings not covered by the commands listed below can be controlled with the common commands (see chapter 10.5, "Setting Basic Measurement Parameters", on page 626. Note that these commands have to be sent prior to the commands that control the list evaluation.

In case of a triggered measurement, a separate trigger event is required for each frequency to initiate that measurement. Note that you have to make changes to the trigger level in the time domain in order for it to take effect for the List Evaluation commands.

The list evaluation is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S FSW aborts the list evaluation.

The R&S FSW also aborts the list evaluation if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. This method causes the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

10.3.13.1 Performing List Evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

Useful commands for list evaluation described elsewhere:

- `[SENSe:]POWer:NCORrection` on page 640

Remote commands exclusive to list evaluation

[SENSe:]LIST:POWer:RESult?

This command queries the results of the list evaluation.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PowerLevel> Power level for each frequency included in the measurement.
The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with `[SENSe:]LIST:POWer:SET`.
The result is a list of floating point values separated by commas.
The unit depends on `CALCulate<n>:UNIT:POWer`.

Usage: Query only

[SENSe:]LIST:POWer[:SEQuence] <Frequency>, <RefLevel>, <RFAttenuation>, <ElAttenuation>, <FilterType>, <RBW>, <VBW>, <MeasTime>, <TriggerLevel>

This command configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with `*OPC`, the R&S FSW produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see `[SENSe:]LIST:POWer:RESult?`.

Parameters:

<Frequency> Defines the receive frequency. Each frequency corresponds to one list entry.

Range: 0 to Fmax
Default unit: Hz

<RefLevel> Defines the reference level for a list entry.

Range: -130 to 30
Increment: 0.01
Default unit: dBm

<RFAttenuation> Defines the RF attenuation for a list entry.

Range: 0 to 70
Increment: 1
Default unit: dB

<ElAttenuation> Defines the electronic attenuation for a list entry.

Range: 0 to 30
Increment: 1
Default unit: dB

<FilterType>	Selects the filter type for a list entry. For more information see [SENSe:]BANDwidth|BWIDth[:RESolution]:TYPE.
<RBW>	Defines the resolution bandwidth for a list entry.
<VBW>	Defines the video bandwidth for a list entry.
<MeasTime>	Defines the measurement time for a list entry. Range: 1 µs to 16000 s
<TriggerLevel>	The trigger level must be 0.

Return values:

<PowerLevel>	Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with [SENSe:]LIST:POWer:SET. The result is a list of floating point values separated by commas. The unit depends on CALCulate<n>:UNIT:POWer.

[SENSe:]LIST:POWer:SET <PeakPower>, <RMSPower>, <AVGPower>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

This command defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVGPower>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

Parameters:

<PeakPower>	ON | OFF Turns peak power evaluation on and off. *RST: ON
<RMSPower>	ON | OFF Turns RMS power evaluation on and off. *RST: OFF
<AVGPower>	ON | OFF Turns average power evaluation on and off. *RST: OFF
<TriggerSource>	EXTernal | EXT2 | EXT3 | IMMediate | IFPower | RFPower | VIDeo Selects a trigger source. For more information see Configuring Triggered and Gated Measurements.
<TriggerSlope>	NEGative | POSitive Selects the trigger slop.

<TriggerOffset> Defines the trigger delay.

Range: negative measurement time to 30
*RST: 0
Default unit: s

<GateLength> Defines the gate length for gated measurements.
Setting 0 seconds turns gated measurements off.
To perform gated measurements, the trigger source must be different from `IMMediate`.

Range: 31.25 ns to 30 s
*RST: 0 s

[SENSe:]LIST:POWer:STATe <State>

This command turns the List Evaluation off.

Parameters:
<State> OFF

*RST: OFF

10.3.13.2 Example: Performing List Evaluation

The following example shows a list evaluation with the following configuration.

No	Freq [MHz]	Ref Level [dBm]	RF Attenuation [dB]	El Attenuation [dB]	Filter	RBW	VBW	Meas Time	Trigger Level
1	935.2	0	10	---	Normal	1 MHz	3 MHz	440 µs	0
2	935.4	0	10	10	Channel	30 kHz	100 kHz	440 µs	0
3	935.6	0	10	20	Channel	30 kHz	100 kHz	440 µs	0

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
LIST:POW:STAT ON
//Turns on the list evaluation.
LIST:POW:SET ON,ON,OFF,EXT,POS,10us,434us
//Configures the global list evaluation settings and evaluates the peak and RMS power.
LIST:POW
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0;
*OPC
//Defines a list with 3 entries and initiates the measurement with synchronization to the end
//Analyzer produces a service request
```

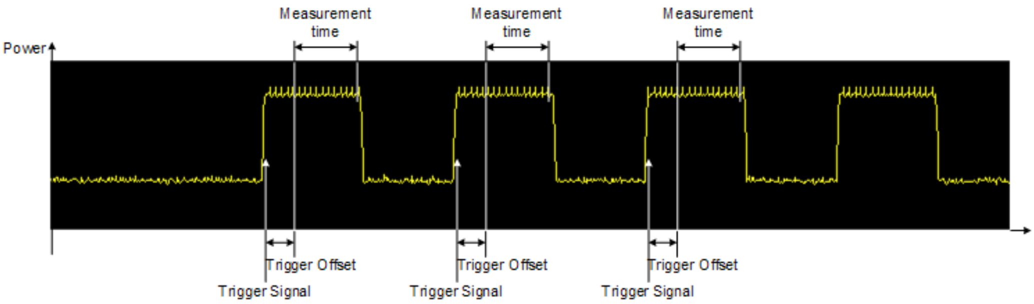
```
//On service request:
SENS:LIST:POW:RES?
//Returns the results of the measurements, two for each frequency (peak and RMS power).

-----Initiliazing the measurement and querying results simultaneously-----
LIST:POW?
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0
//Defines a list with 3 entries, initiates the measurement and queries the results.
//Result example:
-28.3,-30.6,-38.1
```

10.3.14 Measuring the Pulse Power

All remote control commands specific to measuring the mean or peak pulse power (e.g. bursts in various telecommunications standards) are described here. This measurement is available via remote control only.

The Pulse Power measurement is a gated measurement that determines the power over a particular number of pulses. The measurement is controlled by an external trigger or the video signal. A separate trigger event is required for each burst included in the measurement. In case of an external trigger source, the trigger level corresponds to the TTL level. In case of a video signal, you can define any threshold.

The figure below shows the relations between the available trigger settings.



The measurement is always on trace 1, either with the peak detector to determine the peak power or the RMS detector to determine the RMS power. Overall, you can configure the measurement independent of the instrument setup with the commands listed below only, which results in faster measurements.

The Pulse Power measurement is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S FSW aborts the Pulse Power measurement.

The R&S FSW also aborts the Pulse Power measurement if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. With this method, there is the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

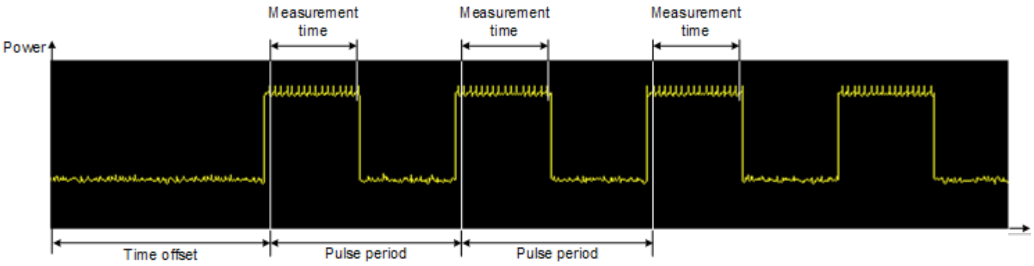
10.3.14.1 Performing Pulse Power Measurements

The following commands control pulse power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary <TimeOffset>,<MeasTime>,<PulsePeriod>,<#OfPulses>

This command configures power measurements on pulses in the time domain.

To evaluate the pulse power, the R&S FSW uses the data captured during a previous measurement. The data recorded during the set measurement time is combined to a measured value for each pulse according to the detector specified and the indicated number of results is output as a list.



To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<TimeOffset> Defines a time offset to start the measurement at the first pulse of a trace.

*RST: 0
Default unit: s

<MeasTime> Defines the measurement time.

Default unit: s

<PulsePeriod> Defines the pulse period

<#OfPulses> Defines the number of pulses to measure.

Example: `CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8`
Evaluates data that contains 8 pulses during a measurement time of 450 µs and a pulse period of 576.9 µs. The evaluation starts with an offset of 50 µs.

[SENSe:]MPOWer:FTYPe <FilterType>

This command selects the filter type for pulse power measurements.

Parameters:
<FilterType> **CFILter**
NORMal
P5
RRC

[SENSe:]MPOWer:RESult[:LIST]?

This command queries the results of the pulse power measurement.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:
<PulsePower> List of pulse powers.
The number of values depends on the number of pulses you have been measuring.
The unit is dBm.

Usage: Query only

[SENSe:]MPOWer:[:SEQuence] <Frequency>, <RBW>, <MeasTime>, <TriggerSource>, <TriggerLevel>, <TriggerOffset>, <Detector>, <#OfPulses>

This command configures and initiates the pulse power measurement.

The R&S FSW caches all measurement parameters that you can set with this command. If you use the command repeatedly, the R&S FSW only changes those settings that you have actually changed before initiating the measurement. Thus, measurement times are kept as low as possible.

If you synchronize the measurement with `*OPC`, the R&S FSW produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see `[SENSe:]LIST:POWer:RESult?`.

Parameters:

<Frequency> Defines the pulse frequency.
Range: 0 to Fmax
Default unit: Hz

<RBW> Defines the resolution bandwidth.

<MeasTime> Defines the measurement time.
Range: 1 µs to 30 s

<TriggerSource> EXTernal | EXT2 | EXT3 | VIDeo
Selects a trigger source.
For more information see Configuring Triggered and Gated Measurements.

<TriggerLevel> Defines a trigger level.
The trigger level is available for the video trigger. In that case, the level is a percentage of the diagram height.
In case of an external trigger, the R&S FSW uses a fix TTL level.
Range: 0 to 100
Default unit: PCT

<TriggerOffset> Defines the trigger delay.
Range: 0 s to 30 s
*RST: 0 s
Default unit: s

<Detector> Selects the detector and therefore the way the measurement is evaluated.

MEAN
Calculates the RMS pulse power.

PEAK
Calculates the peak pulse power.

<#OfPulses> Defines the number of pulses included in the measurement.
Range: 1 to 32001

Return values:

<PowerLevel> Pulse power level.
The result is a list of floating point values separated by commas.
The unit is dBm.

[SENSe:]MPOWer:RESult:MIN?

This command queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> Lowest power level of the pulse power measurement.
The unit is dBm.

Usage: Query only

10.3.14.2 Example: Performing a Pulse Power Measurement

The following example shows a pulse power measurement.

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333
```

10.4 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

The tasks for manual operation are described in chapter 6.1, "Result Display Configuration", on page 273.

10.4.1 General Window Commands

The following commands are required to configure general window layout, independant of the application.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 502).

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels (See chapter 3.1, "R&S MultiView", on page 19).

SINGle
Displays the measurement channel that was previously focused.

*RST: SPL

Example: `DISP:FORM SING`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 623).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:LARG`

10.4.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see `INSTrument[:SELect]` on page 502).

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual control: See "Diagram" on page 274
See "Marker Table" on page 274
See "Marker Peak List" on page 274
See "Result Summary" on page 275
See "Spectrogram" on page 275

Table 10-2: <WindowType> parameter values for the Spectrum application

Parameter value	Window type
DIAGram	Diagram
MTABle	Marker table
PEAKlist	Marker peak list
RSUMmary	Result summary
SGRam	Spectrogram

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 621 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

As opposed to the `DISPlay[:WINDow<n>]:SIZE` on page 620 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

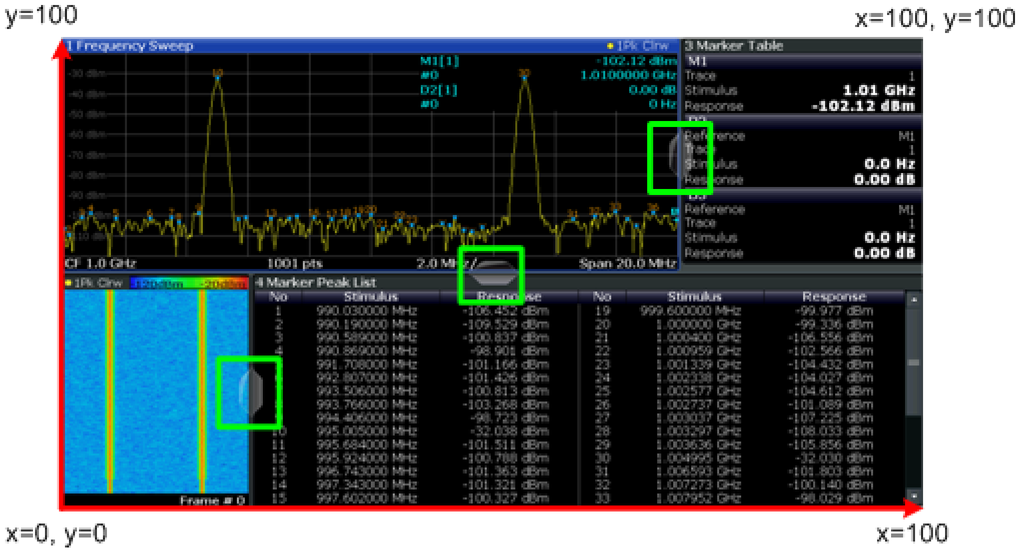


Fig. 10-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 10-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example:

```
LAY:SPL 1,3,50
```

Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example:

```
LAY:SPL 1,4,70
```

Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 621 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix).

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 621 for a list of available window types.

10.5 Setting Basic Measurement Parameters

All commands that set measurement-independant parameters are described here.

10.5.1 Defining the Frequency and Span

The commands required to configure the frequency and span settings in a remote environment are described here. The tasks for manual operation are described in chapter 5.3, "Frequency and Span Configuration", on page 222.

10.5.1.1 Defining the Frequency Range

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

This command matches the center frequency to the frequency of a marker.

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

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Usage: Event

Manual control: See "Harmonic Distortion" on page 35
See "Center Frequency = Marker Frequency" on page 333

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

This command matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

Usage: Event

[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 control: See "Center" on page 225
See "Preview" on page 260
See "Frequency" on page 260

[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 627.

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 control: See "Center Frequency Stepsize" on page 226

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

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

Parameters:

<State> ON | OFF

*RST: ON

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

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

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

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

RBW
Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

OFF
Decouples the step size.

*RST: SPAN

Example:
```
FREQ:CENT:STEP:LINK SPAN
```

Manual control: See "Center Frequency Stepsize" on page 226

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

This command defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

Parameters:

<Factor> 1 to 100 PCT

*RST: 10

Example: `FREQ:CENT:STEP:LINK:FACT 20PCT`

Manual control: See "Center Frequency Stepsize" on page 226

[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 226.

Parameters:

<Offset> Range: -100 GHz to 100 GHz

*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual control: See "Frequency Offset" on page 226

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

If you set a span of 0 Hz in the Spectrum application, the R&S FSW starts a measurement in the time domain.

Parameters:

<Span> The minimum span for measurements in the frequency domain is 10 Hz. For SEM and spurious emission measurements, the minimum span is 20 Hz.

Range: 0 Hz to fmax

*RST: Full span

Usage: SCPI confirmed

Manual control: See "Zero Span" on page 32
See "Span" on page 225

[SENSe:]FREQuency:SPAN:FULL

This command restores the full span.

Usage: Event
SCPI confirmed

Manual control: See "Full Span" on page 225
See "Zero Span" on page 225

[SENSe:]FREQuency:STARt <Frequency>

This command defines a start frequency for measurements in the frequency domain.

Parameters:
<Frequency> 0 to (fmax - min span)

*RST: 0

Example: `FREQ:STAR 20MHz`

Usage: SCPI confirmed

Manual control: See "Frequency Sweep" on page 32
See "Start / Stop" on page 225

[SENSe:]FREQuency:STOP <Frequency>

This command defines a stop frequency for measurements in the frequency domain.

Parameters:
<Frequency> min span to fmax

*RST: fmax

Example: `FREQ:STOP 2000 MHz`

Usage: SCPI confirmed

Manual control: See "Frequency Sweep" on page 32
See "Start / Stop" on page 225

10.5.1.2 Configuring Signal Tracking

When signal tracking is activated, the maximum signal is determined after each frequency sweep and the center frequency is set to the frequency of this signal. Thus with drifting signals the center frequency follows the signal.

For more details see chapter 5.3.1, "Impact of the Frequency and Span Settings", on page 222..

CALCulate:MARKer:FUNCtion:STRack[:STATe] <State>

This command turns signal tracking on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "Signal Tracking" on page 227
See "Signal Tracking State" on page 227

CALCulate:MARKer:FUNCtion:STRack:BANDwidth <Bandwidth>

This command defines the bandwidth around the center frequency that is included in the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Parameters:

<Bandwidth> Range: 10 Hz to Max span
*RST: (= span/10 on activating the function)
Default unit: Hz

Manual control: See "Signal Tracking" on page 227
See "Tracking Bandwidth" on page 227

CALCulate:MARKer:FUNCtion:STRack:THReshold <Level>

This command defines the threshold level for the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Parameters:

<Level> The unit depends on `CALCulate<n>:UNIT:POWer`.

Range: -130 dBm to 30 dBm
*RST: -120 dBm

Manual control: See "Signal Tracking" on page 227
See "Tracking Threshold" on page 227

CALCulate:MARKer:FUNCtion:STRack:TRACe <TraceNumber>

This command selects the trace on which the largest signal is searched for.

Parameters:

<TraceNumber> 1 to 6

Range: 1 to 6
*RST: 1

Manual control: See "Signal Tracking" on page 227
See "Signal Track Trace" on page 227

10.5.2 Configuring Bandwidth and Sweep Settings

The commands required to configure the bandwidth, sweep and filter settings in a remote environment are described here. The tasks for manual operation are described in chapter 5.5, "Bandwidth, Filter and Sweep Configuration", on page 237.

10.5.2.1 Configuring the Bandwidth and Filter

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

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

For measurements on I/Q data in the frequency domain, the maximum RBW is 1 MHz.

Parameters:

<Bandwidth> refer to data sheet

*RST: RBW: AUTO is set to ON; DBW: 3MHz

Example: `BAND 1 MHz`

Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual control: See "Analysis Bandwidth" on page 145
See "RBW" on page 245
See "Preview" on page 260
See "RBW" on page 260

[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO <State>

This command couples and decouples the resolution bandwidth to the span.

Parameters:

<State> ON | OFF

*RST: ON

Example: `BAND:AUTO OFF`

Switches off the coupling of the resolution bandwidth to the span.

Usage: SCPI confirmed

Manual control: See "RBW" on page 245
See "Default Coupling" on page 247

[SENSe:]BANDwidth|BWIDth[:RESolution]:RATio <Ratio>

This command defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with the remote command (RBW/span) is reciprocal to that of the manual operation (span/RBW).

Parameters:

<Ratio> Range: 0.0001 to 1
*RST: 0.01

Example: `BAND:RAT 0.1`

Manual control: See "Span/RBW" on page 246

[SENSe:]BANDwidth|BWIDth[:RESolution]:TYPE <FilterType>

This command selects the resolution filter type.

When you change the filter type, the command selects the next larger filter bandwidth if the same bandwidth is unavailable for that filter.

Parameters:

<FilterType>

CFILter
channel filters

NORMal
Gaussian filters

P5
5-pole filters
The 5-pole filter is not available for FFT sweeps.

RRC
RRC filters

*RST: NORMal

Example: `BAND:TYPE NORM`

Manual control: See "Filter Type" on page 247

[SENSe:]BANDwidth|BWIDth:VIDeo <Bandwidth>

This command defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

Parameters:

<Bandwidth> refer to data sheet
*RST: AUTO is set to ON

Example: `BAND:VID 10 kHz`

Manual control: See "VBW" on page 245

[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO <State>

This command couples and decouples the video bandwidth to the resolution bandwidth.

Parameters:

<State> ON | OFF

*RST: ON

Example: `BAND:VID:AUTO OFF`

Manual control: See "VBW" on page 245
See "RBW/VBW " on page 246
See "Default Coupling" on page 247

[SENSe:]BANDwidth|BWIDth:VIDeo:RATio <Ratio>

This command defines the coupling ratio of the video bandwidth to the resolution bandwidth (RBW/VBW).

Parameters:

<Ratio> Range: 0,001 to 1000
*RST: 1

Example: `BAND:VID:RAT 3`
Sets the coupling of video bandwidth to video bandwidth = 3*resolution bandwidth

Manual control: See "RBW/VBW " on page 246

[SENSe:]BANDwidth|BWIDth:VIDeo:TYPE <Mode>

This command selects the position of the video filter in the signal path.

Changing the video filter position is possible only if the resolution bandwidth is ≤ 100 kHz.

Parameters:

<Mode> **LINear**
The video filter is applied in front of the logarithmic amplifier.
In linear mode, measurements with a logarithmic level scale result in flatter falling edges compared to logarithmic mode. The reason is the conversion of linear power values into logarithmic level values: if you halve the linear power, the logarithmic level decreases by 3 dB.

LOGarithmic
The video filter is applied after the logarithmic amplifier

*RST: LINear

Example: `BAND:VID:TYPE LIN`
Video filter ahead of the logarithmic amplifier

10.5.2.2 Configuring the Sweep

Useful commands for configuring sweeps described elsewhere:

- `[SENSe:]AVERage:COUNt` on page 692
- `[SENSe:]AVERage<n>[:STATe<t>]` on page 693
- `[SENSe:]AVERage<n>:TYPE` on page 693

Remote commands exclusive to configuring sweeps:

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of sweeps that the application uses to average traces.

In case of continuous sweeps, the application calculates the moving average over the average count.

In case of single sweep measurements, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<SweepCount> If you set a sweep count of 0 or 1, the R&S FSW performs one single sweep in single sweep mode.
In continuous sweep mode, if the sweep count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000
*RST: 0

Example:
`SWE:COUN 64`
Sets the number of sweeps to 64.
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.

Usage: SCPI confirmed

Manual control: See "Sweep/Average Count" on page 247

[SENSe:]SWEep:OPTimize <Mode>

This command selects the sweep type optimization mode.

Parameters:

<Mode>

AUTO
Automatically applies the sweep optimization mode that is best for the current measurement.

DYNamic
Optimizes the sweep mode for a large dynamic range.

SPEed
Optimizes the sweep mode for high performance.

*RST: AUTO

Example: `SWE:OPT DYN`
Select dynamic sweep mode.

Manual control: See "Optimization" on page 248

[SENSe:]SWEep:POINts <SweepPoints>

This command defines the number of measurement points analyzed during a sweep.

Note that the number of sweep points is limited to 10001 when measuring spurious emissions.

Parameters:

<SweepPoints> Range: 101 to 200 000
*RST: 1001

Example: `SWE:POIN 251`

Usage: SCPI confirmed

Manual control: See "Sweep Points" on page 248

[SENSe:]SWEep:TIME <Time>

This command defines the sweep (or: data capture) time.

In the Spectrum application, the command decouples the sweep time from the span and resolution and video bandwidths.

Parameters:

<Time> refer to data sheet

*RST: (AUTO is set to ON)

Example: `SWE:TIME 10s`

Usage: SCPI confirmed

Manual control: See "Sweep Time" on page 56
See "Sweep Time" on page 246
See "Preview" on page 260
See "Sweep Time" on page 260

[SENSe:]SWEep:TIME:AUTO <State>

This command couples and decouples the sweep time to the span and the resolution and video bandwidths.

Parameters:

<State> ON | OFF

*RST: ON

Example: `SWE:TIME:AUTO ON`
Activates automatic sweep time.

Usage: SCPI confirmed

Manual control: See "Harmonic Sweep Time" on page 163
See "Sweep Time" on page 246
See "Default Coupling" on page 247

[SENSe:]SWEep:TYPE <Type>

This command selects the sweep type.

Parameters:

<Type> **AUTO**
Automatic selection of the sweep type between sweep mode and FFT.

FFT
FFT mode

*RST: AUTO

Example: `SWE:TYPE FFT`

Manual control: See "Sweep Type" on page 248

[SENSe:]SWEep:TYPE:USED

This command queries the sweep type if you have turned on automatic selection of the sweep type.

Return values:

<Type> **SWE**
Normal sweep

FFT
FFT mode

[SENSe:]BANDwidth|BWIDth[:RESolution]:FFT <FilterMode>

Defines the filter mode to be used for FFT filters by defining the partial span size. The partial span is the span which is covered by one FFT analysis.

This command is only available when using the sweep type "FFT".

Note: this command is maintained for compatibility reasons only. For new remote control programs, use the `[SENSe:]SWEep:OPTimize` command.

Parameters:

<FilterMode> WIDE | AUTO | NARRow

AUTO
Automatically applies the sweep optimization mode that is best for the current measurement.

NARRow
Optimizes the sweep mode for a large dynamic range.

WIDE
Optimizes the sweep mode for high performance.

*RST: AUTO

Example: `BAND:TYPE FFT`
Select FFT filter.

Example: `BAND:FFT NARR`
Select narrow partial span for FFT filter.

10.5.3 Configuring the Vertical Axis (Amplitude, Scaling)

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

10.5.3.1 Amplitude Settings

The tasks for manual configuration are described in chapter 5.4.2, "Amplitude Settings", on page 231.

Useful commands for amplitude configuration described elsewhere:

- `[SENSe:]ADJust:LEVel` on page 658

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

Manual control: See "Reference Level = Marker Level" on page 334

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all measurement windows.

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual control: See "Reference Level" on page 232
See "Unit" on page 233

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

This command defines the reference level.

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual control: See "Reference Level" on page 232

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

This command defines a reference level offset.

Parameters:

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

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual control: See "X-Axis" on page 149
See "Shifting the Display (Offset)" on page 149
See "Reference Level" on page 232
See "Shifting the Display (Offset)" on page 232

[SENSe:]POWer:NCORrection <State>

This command turns noise cancellation on and off.

If noise cancellation is on, the R&S FSW performs a reference measurement to determine its inherent noise and subtracts the result from the channel power measurement result (first active trace only).

For more information see "Noise cancellation" on page 54.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `POW:NCOR ON`

Manual control: See "Noise cancellation" on page 54

10.5.3.2 Configuring the Attenuation

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If an electronic attenuator is available and active, the command defines a mechanical attenuation (see `INPut:EATT:STATe` on page 642).

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 control: See "RF Attenuation" on page 233
See "Attenuation Mode / Value" on page 233

INPut:ATTenuation:AUTO <State>

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

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual control: See "RF Attenuation" on page 233
See "Attenuation Mode / Value" on page 233

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 641).

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

Parameters:

<Attenuation> attenuation in dB

Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)

Example:

```
INP:EATT:AUTO OFF
INP:EATT 10 dB
```

Manual control: See "Using Electronic Attenuation (Option B25)" on page 234

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> ON | OFF

*RST: ON

Example: `INP:EATT:AUTO OFF`

Manual control: See "Using Electronic Attenuation (Option B25)" on page 234

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

Parameters:

<State> ON | OFF

*RST: OFF

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

Manual control: See "Using Electronic Attenuation (Option B25)" on page 234

10.5.3.3 Configuring a Preamplifier

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

For R&S FSW 26 models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW 8 or 13 models, the preamplification is defined by `INPut:GAIN[:VALue]`.

Parameters:

<State> ON | OFF

*RST: OFF

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

Usage: SCPI confirmed

Manual control: See "Input Settings" on page 234
See "Preamplifier (option B24)" on page 234

INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 642).

The command requires option R&S FSW-B24.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.
- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

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

Usage: SCPI confirmed

Manual control: See "Input Settings" on page 234
See "Preamplifier (option B24)" on page 234

10.5.3.4 Scaling the Y-Axis

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

This command defines the display range of the y-axis.

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>]:TRACe:Y:SPACing`.

Parameters:

<Range> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

Manual control: See "Range" on page 236

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

Automatic scaling of the y-axis is performed once, then switched off again.

Usage: SCPI confirmed

Manual control: See "Auto Scale Once" on page 236

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

This command selects the type of scaling of the y-axis.

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 control: See "Scaling" on page 236

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

This command defines the vertical position of the reference level on the display grid.

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

Parameters:

<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.

*RST: 100 PCT = frequency display; 50 PCT = time display

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual control: See "Ref Level Position" on page 236

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

This command selects the scaling of the y-axis.

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 control: See "Scaling" on page 236

10.5.4 Configuring Triggered and Gated Measurements

The commands required to configure a triggered or gated measurement in a remote environment are described here. The tasks for manual operation are described in chapter 5.6, "Trigger and Gate Configuration", on page 252.

*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.

10.5.4.1 Configuring the Triggering Conditions

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 control: See "Trigger Settings" on page 260
See "Drop-Out Time" on page 263

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

Defines the time offset between the trigger event and the start of the sweep (data capturing).

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger offset as well.

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative sweep time to 30 s.
*RST: 0 s

Example: `TRIG:HOLD 500us`

Manual control: See "Trigger Settings" on page 260
See "Trigger Offset" on page 264

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

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

Note that this command is available for **any trigger source**, not just IF Power.

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Period> *RST: 150 ns

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual control: See "Trigger Settings" on page 260
See "Trigger Holdoff" on page 264

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

This command defines the trigger hysteresis.

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 control: See "Trigger Settings" on page 260
See "Hysteresis" on page 264

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

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

Note that the variable INPUT/OUTPUT connectors (ports 2+3) must be set for use as input using the `OUTPut:TRIGger<port>:DIRection` command.

Suffix:

<port> 1 | 2 | 3
Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:

<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Manual control: See "Trigger Settings" on page 260
See "Trigger Level" on page 263

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.

Parameters:

<TriggerLevel> Range: -50 dBm to 20 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IFP -30DBM`

Manual control: See "Trigger Settings" on page 260
See "Trigger Level" on page 263

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

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

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual control: See "Trigger Settings" on page 260
See "Trigger Level" on page 263

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.

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

Parameters:

<TriggerLevel> Range: -50 dBm to -10 dBm
*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

Manual control: See "Trigger Settings" on page 260
See "Trigger Level" on page 263

TRIGger[:SEQuence]:LEVel:VIDeo <Level>

This command defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<Level> Range: 0 PCT to 100 PCT
*RST: 50 PCT

Example: `TRIG:LEV:VID 50PCT`

Manual control: See "Trigger Settings" on page 260
See "Trigger Level" on page 263

TRIGger[:SEQuence]:SLOPe <Type>

For all trigger sources except time you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Type> POSitive | NEGative

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

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

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual control: See "Trigger Settings" on page 260
See "Slope" on page 264

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

For details on trigger sources see "Trigger Source" on page 260.

Using a trigger or gated measurements turns the squelch off (see `[SENSe:]DEMod:SQUelch[:STATe]` on page 743).

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.

For troubleshooting tips see "Uncompleted sequential commands - blocked remote channels" on page 855.

Parameters:

<Source>

IMMediate
Free Run

EXTern
Trigger signal from the TRIGGER INPUT connector.

EXT2
Trigger signal from the TRIGGER INPUT/OUTPUT connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

TIME
Time interval

VIDeo
Video mode is available in the time domain and only in the Spectrum application.

PSEN
External power sensor

*RST: IMMediate

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

Manual control: See "Using the power sensor as an external trigger" on page 193
See "Trigger Settings" on page 260
See "Trigger Source" on page 260
See "Free Run" on page 261
See "External Trigger 1/2/3" on page 261
See "Video" on page 261
See "IF Power" on page 262
See "RF Power" on page 262
See "Power Sensor" on page 262
See "Time" on page 263

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

This command defines the repetition interval for the time trigger.

Parameters:

<Interval> 2.0 ms to 5000

Range: 2 ms to 5000 s
*RST: 1.0 s

Example:

`TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 50`
The sweep starts every 50 s.

Manual control: See "Trigger Settings" on page 260
See "Repetition Interval" on page 263

10.5.4.2 Configuring Gated Measurements

[SENSe:]SWEep:EGATe <State>

This command turns gated measurements on and off.

In case of measurements with an external gate, the measured values are recorded as long as the gate is opened. During a sweep the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remain completely unaffected.

The measurement ends when a particular number of measurement points has been recorded (see `[SENSe:]SWEep:POINts` on page 636).

Performing gated measurements turns the squelch off.

Parameters:
<State> ON | OFF

*RST: OFF

Example: `SWE:EGAT ON`
Switches on the external gate mode.
`SWE:EGAT:TYPE EDGE`
Switches on the edge-triggered mode.
`SWE:EGAT:HOLD 100US`
Sets the gate delay to 100 µs.
`SWE:EGAT:LEN 500US`
Sets the gate opening time to 500 µs.
`INIT;*WAI`
Starts a sweep and waits for its end.

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

This command defines the length of the trigger delay.

The trigger delay has no effect on

- measurements using the "Level" gate mode
- frequency sweep, FFT sweep, zero span and I/Q mode measurements using an IF Power trigger.

Parameters:
<DelayTime> Range: 0 s to 30 s
*RST: 0 s

Example: `SWE:EGAT:HOLD 100us`

Manual control: See "Gate Settings" on page 266
See "Gate Delay" on page 266

[SENSe:]SWEep:EGATe:LENGth <GateLength>

This command defines the gate length.

Parameters:
<GateLength> Range: 125 ns to 30 s
*RST: 400µs

Example: `SWE:EGAT:LENG 10ms`

Manual control: See "Gate Settings" on page 266
See "Gate Length" on page 266

[SENSe:]SWEep:EGATe:POLarity <Polarity>

This command selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:

<Polarity> POSitive | NEGative

*RST: POSitive

Example: `SWE:EGAT:POL POS`

Manual control: See "Trigger Settings" on page 260
See "Slope" on page 264

[SENSe:]SWEep:EGATe:SOURce <Source>

This command selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see "Trigger Source" on page 260.

Parameters:

<Source> EXTernal | EXT2 | EXT3 | IFPower | IQPower | VIDeo | RFPower | PSEN

*RST: IFPower

Example: `SWE:EGAT:SOUR IFP`
Switches the gate source to IF power.

Manual control: See "Trigger Settings" on page 260
See "Trigger Source" on page 260
See "External Trigger 1/2/3" on page 261
See "Video" on page 261
See "IF Power" on page 262
See "RF Power" on page 262
See "Power Sensor" on page 262

[SENSe:]SWEep:EGATe:TYPE <Type>

This command selects the way gated measurements are triggered.

Parameters:

<Type>

LEVel
The trigger event for the gate to open is a particular power level. After the gate signal has been detected, the gate remains open until the signal disappears.
Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

EDGE
The trigger event for the gate to open is the detection of the signal edge.
After the gate signal has been detected, the gate remains open until the gate delay is over.

*RST: EDGE

Example: `SWE:EGAT:TYPE EDGE`

Manual control: See "Gate Settings" on page 266
See "Gate Mode" on page 266

10.5.4.3 Configuring the Trigger Output

The following commands are required to send the trigger signal to one of the variable TRIGGER INPUT/OUTPUT connectors. The tasks for manual operation are described in "Trigger 2/3" on page 220.

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction.

Suffix:

<port>

2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Direction>

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual control: See "Trigger 2/3" on page 220

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> — 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Level>

HIGH
TTL signal.

LOW
0 V

*RST: LOW

Manual control: See "Trigger 2/3" on page 220
See "Output Type" on page 221
See "Level" on page 221

OUTPut:TRIGger<port>:OTYPe <OutputType>

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

Suffix:

<port> — 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<OutputType>

DEVice
Sends a trigger signal when the R&S FSW has triggered internally.

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

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

*RST: DEVice

Manual control: See "Trigger 2/3" on page 220
See "Output Type" on page 221

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<port> 2 | 3

Selects the trigger port to which the output is sent.

2 = trigger port 2 (front)

3 = trigger port 3 (rear)

Usage: Event

Manual control: See "Trigger 2/3" on page 220

See "Output Type" on page 221

See "Send Trigger" on page 221

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

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

Suffix:

<port> 2 | 3

Selects the trigger port to which the output is sent.

2 = trigger port 2 (front)

3 = trigger port 3 (rear)

Parameters:

<Length> Pulse length in seconds.

Manual control: See "Trigger 2/3" on page 220

See "Output Type" on page 221

See "Pulse Length" on page 221

10.5.5 Adjusting Settings Automatically

The commands required to adjust settings automatically in a remote environment are described here. The tasks for manual operation are described in chapter 5.7, "Adjusting Settings Automatically", on page 270.

MSRA operating mode

In MSRA operating mode, settings related to data acquisition (measurement time, hysteresis) can only be adjusted automatically in the MSRA Master, not in the MSRA applications.

[SENSe:]ADJust:ALL

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

This includes:

- Center frequency
- Reference level

Example: `ADJ:ALL`

Usage: Event

Manual control: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 270

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

In order to determine the ideal reference level, the R&S FSW performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure: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 control: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 271

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

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

Parameters:

<Mode>

AUTO
The R&S FSW determines the measurement length automatically according to the current input data.

MANual
The R&S FSW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 656.

*RST: AUTO

Manual control: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 271
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 271

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

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 658 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

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

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

Manual control: See "Lower Level Hysteresis" on page 272

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

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 658 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

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

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual control: See "Upper Level Hysteresis" on page 271

[SENSe:]ADJust:CONFigure:TRIG <State>

Defines the behaviour of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example). See "Adjusting settings automatically during triggered measurements" on page 270.

Parameters:

<State>

ON

The measurement for automatic adjustment waits for the trigger.

OFF

The measurement for automatic adjustment is performed immediately, without waiting for a trigger.

*RST: ON

[SENSe:]ADJust:FREQuency

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

Example: `ADJ:FREQ`

Usage: Event

Manual control: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 271

[SENSe:]ADJust:LEVel

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

Example: `ADJ:LEV`

Usage: Event

Manual control: See "Reference Level" on page 232
See "Setting the Reference Level Automatically (Auto Level)" on page 233

10.5.6 Configuring the Data Input and Output

10.5.6.1 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.

(See `STATus:QUEStionable:POWer[:EVENt]?` on page 805 and "STATus:QUEStionable:POWer Register" on page 457).

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

For details on the protection mechanism see chapter 5.2.1.1, "RF Input Protection", on page 183.

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 control: See "Input Coupling" on page 186

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

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

This function requires option R&S FSW-B13.

(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

Usage: SCPI confirmed

Manual control: See "High-Pass Filter 1...3 GHz" on page 187

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-Preselector" on page 187.

Parameters:

<State> ON | OFF

*RST: ON (OFF for I/Q Analyzer, GSM, VSA and MC Group Delay measurements)

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

Manual control: See "YIG-Preselector" on page 187

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input.

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 control: See "Impedance" on page 186
See "Reference Level" on page 232
See "Unit" on page 233

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSW. If no additional options are installed, only RF input is supported.

Parameters:

<Source>

RF

Radio Frequency ("RF INPUT" connector)

DIQ

Digital IQ data (only available with optional Digital Baseband Interface R&S FSW-B17)

For details on I/Q input see the R&S FSW I/Q Analyzer User Manual.

*RST: RF

Manual control: See "Radio Frequency State" on page 186

INPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSW.

See the R&S FSW Getting Started manual for details.

Parameters:

<State>

ON

User port is switched to INPut

OFF

User port is switched to OUTPut

*RST: ON

INPut:UPORt[:VALue]?

This command queries the control lines of the user ports.

Example: `INP:UPOR?`

Usage: Query only

10.5.6.2 Using External Mixers

The commands required to work with external mixers in a remote environment are described here. Note that these commands require the R&S FSW-B21 option to be installed and an external mixer to be connected to the front panel of the R&S FSW. In MSRA mode, external mixers are not supported.

For details on working with external mixers see chapter 5.2.4.1, "Basics on External Mixers", on page 197.

Basic Settings

The basic settings concern general usage of an external mixer.

[SENSe:]MIXer[:STATe] <State>

Activates or deactivates the use of a connected external mixer as input for the measurement. This command is only available if the R&S FSW-B21 option is installed and an external mixer is connected.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

Example: `MIX ON`

Manual control: See "External Mixer State" on page 206

[SENSe:]MIXer:BIAS:HIGH <BiasSetting>

This command defines the bias current for the high (second) range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer[:STATe]` on page 662).

Parameters:

<BiasSetting>	*RST:	0.0 A
	Default unit:	A

Manual control: See "Bias Settings" on page 207

[SENSe:]MIXer:BIAS[:LOW] <BiasSetting>

This command defines the bias current for the low (first) range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer[:STATe]` on page 662).

Parameters:

<BiasSetting>	*RST:	0.0 A
	Default unit:	A

Manual control: See "Bias Settings" on page 207

[SENSe:]MIXer:LOPower <Level>

This command specifies the LO level of the external mixer's LO port.

Parameters:

<Level> numeric value

Range: 13.0 dBm to 17.0 dBm
Increment: 0.1 dB
*RST: 15.5 dBm

Example: `MIX:LOP 16.0dBm`

Manual control: See "LO Level" on page 206

[SENSe:]MIXer:SIGNal <State>

This command specifies whether automatic signal detection is active or not.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

Parameters:

<State> **OFF | ON | AUTO | ALL**

OFF
No automatic signal detection is active.

ON
Automatic signal detection (Signal ID) is active.

AUTO
Automatic signal detection (Auto ID) is active.

ALL
Both automatic signal detection functions (Signal ID+Auto ID) are active.

*RST: OFF

Manual control: See "Signal ID" on page 206
See "Auto ID" on page 206

[SENSe:]MIXer:THReshold <Value>

This command defines the maximum permissible level difference between test sweep and reference sweep to be corrected during automatic comparison (see `[SENSe:]MIXer:SIGNal` on page 663).

Parameters:

<Value> <numeric value>

Range: 0.1 dB to 100 dB
*RST: 10 dB

Example: `MIX:PORT 3`

Manual control: See "Auto ID Threshold" on page 207

Mixer Settings

The following commands are required to configure the band and specific mixer settings.

[SENSe:]MIXer:FREQuency:HANDover <Frequency>

This command defines the frequency at which the mixer switches from one range to the next (if two different ranges are selected). The handover frequency for each band can be selected freely within the overlapping frequency range.

This command is only available if the external mixer is active (see `[SENSe:]MIXer[:STATe]` on page 662).

Parameters:

<Frequency> numeric value

Example: `MIX ON`
Activates the external mixer.
`MIX:FREQ:HAND 78.0299GHz`
Sets the handover frequency to 78.0299 GHz.

Manual control: See "Handover Freq." on page 208

[SENSe:]MIXer:FREQuency:STARt?

This command queries the frequency at which the external mixer band starts.

Example: `MIX:FREQ:STAR?`
Queries the start frequency of the band.

Usage: Query only

Manual control: See "RF Start / RF Stop" on page 208

[SENSe:]MIXer:FREQuency:STOP?

This command queries the frequency at which the external mixer band stops.

Example: `MIX:FREQ:STOP?`
Queries the stop frequency of the band.

Usage: Query only

Manual control: See "RF Start / RF Stop" on page 208

[SENSe:]MIXer:HARMonic:BAND:PRESet

This command restores the preset frequency ranges for the selected standard waveguide band.

Note: Changes to the band and mixer settings are maintained even after using the PRESET function. Use this command to restore the predefined band ranges.

Example: `MIX:HARM:BAND:PRES`
Presets the selected waveguide band.

Usage: Event

Manual control: See "Preset Band" on page 209

[SENSe:]MIXer:HARMonic:BAND[:VALue] <Band>

This command selects the external mixer band. The query returns the currently selected band.

This command is only available if the external mixer is active (see `[SENSe:]MIXer[:STATe]` on page 662).

Parameters:
<Band> KA | Q | U | V | E | W | F | D | G | Y | J | USER
Standard waveguide band or user-defined band.

Manual control: See "Band" on page 208

Table 10-3: Frequency ranges for pre-defined bands

Band	Frequency start [GHz]	Frequency stop [GHz]
KA (A) *)	26.5	40.0
Q	33.0	50.0
U	40.0	60.0
V	50.0	75.0
E	60.0	90.0
W	75.0	110.0
F	90.0	140.0
D	110.0	170.0
G	140.0	220.0
*) The band formerly referred to as "A" is now named "KA".		

Band	Frequency start [GHz]	Frequency stop [GHz]
J	220.0	325.0
Y	325.0	500.0
USER	32.18 (default)	68.22 (default)
*) The band formerly referred to as "A" is now named "KA".		

[SENSe:]MIXer:HARMonic:HIGH:STATe <State>

This command specifies whether a second (high) harmonic is to be used to cover the band's frequency range.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `MIX:HARM:HIGH:STAT ON`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Range 1/2" on page 209

[SENSe:]MIXer:HARMonic:HIGH[:VALue] <HarmOrder>

This command specifies the harmonic order to be used for the high (second) range.

Parameters:

<HarmOrder numeric value

Range: 2 to 61 (USER band); for other bands: see band definition

Example: `MIX:HARM:HIGH 2`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Harmonic Order" on page 210

[SENSe:]MIXer:HARMonic:TYPE <OddEven>

This command specifies whether the harmonic order to be used should be odd, even, or both.

Which harmonics are supported depends on the mixer type.

Parameters:

<OddEven> **ODD | EVEN | EODD**

*RST: EVEN

Example: `MIX:HARM:TYPE ODD`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Harmonic Type" on page 209

[SENSe:]MIXer:HARMonic[:LOW] <HarmOrder>

This command specifies the harmonic order to be used for the low (first) range.

Parameters:
<HarmOrder> numeric value

Range: 2 to 61 (USER band); for other bands: see band definition
*RST: 2 (for band F)

Example: `MIX:HARM 3`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Harmonic Order" on page 210

[SENSe:]MIXer:LOSS:HIGH <Average>

This command defines the average conversion loss to be used for the entire high (second) range.

Parameters:
<Average> numeric value

Range: 0 to 100
*RST: 24.0 dB
Default unit: dB

Example: `MIX:LOSS:HIGH 20dB`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Conversion loss" on page 210

[SENSe:]MIXer:LOSS:TABLe:HIGH <FileName>

This command defines the file name of the conversion loss table to be used for the high (second) range.

Parameters:
<FileName> string ('<file name>')

Example: `MIX:LOSS:TABL:HIGH 'MyCVLTable'`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Conversion loss" on page 210

[SENSe:]MIXer:LOSS:TABLe[:LOW] <FileName>

This command defines the file name of the conversion loss table to be used for the low (first) range.

Parameters:
<FileName> string ('<file name>')

Example: `MIX:LOSS:TABL 'mix_1_4'`
Specifies the conversion loss table *mix_1_4*.

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Conversion loss" on page 210

[SENSe:]MIXer:LOSS[:LOW] <Average>

This command defines the average conversion loss to be used for the entire low (first) range.

Parameters:

<Average> numeric value

Range: 0 to 100
*RST: 24.0 dB
Default unit: dB

Example: `MIX:LOSS 20dB`

Manual control: See "Mixer Settings (Harmonics Configuration)" on page 209
See "Conversion loss" on page 210

[SENSe:]MIXer:PORTs <PortType>

This command specifies whether the mixer is a 2-port or 3-port type.

Parameters:

<PortType> **2 | 3**

*RST: 2

Example: `MIX:PORT 3`

Manual control: See "Mixer Type" on page 209

[SENSe:]MIXer:RFOVerrange[:STATe] <State>

If enabled, the band limits are extended beyond "RF Start" and "RF Stop" due to the capabilities of the used harmonics.

Parameters:

<State> ON | OFF

*RST: OFF

Manual control: See "RF Overrange" on page 209

Conversion Loss Table Settings

The following settings are required to configure and manage conversion loss tables.

[SENSe:]CORRection:CVL:BAND <Type>

This command defines the waveguide band for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Band> K | A | KA | Q | U | V | E | W | F | D | G | Y | J | USER

Standard waveguide band or user-defined band.
Note: The band formerly referred to as "A" is now named "KA"; the input parameter "A" is still available and refers to the same band as "KA".
For a definition of the frequency range for the pre-defined bands, see table 10-3).

*RST: F (90 GHz - 140 GHz)

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:BAND KA`
Sets the band to KA (26.5 GHz - 40 GHz).

Manual control: See "Band" on page 213

[SENSe:]CORRection:CVL:BIAS <BiasSetting>

This command defines the bias setting to be used with the conversion loss table.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<BiasSetting> numeric value

*RST: 0.0 A
Default unit: A

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:BIAS 3A`

Manual control: See "Bias Settings" on page 207
See "Write to <CVL table name>" on page 207
See "Bias" on page 213

[SENSe:]CORRection:CVL:CATAlog?

This command queries all available conversion loss tables saved in the `C:\r_s\instr\user\cvl\` directory on the instrument.

This command is only available with option B21 (External Mixer) installed.

Usage: Query only

[SENSe:]CORRection:CVL:CLEAr

This command deletes the selected conversion loss table. Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672).

This command is only available with option B21 (External Mixer) installed.

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:CLE`

Usage: Event

Manual control: See "Delete Table" on page 211

[SENSe:]CORRection:CVL:COMMent <Text>

This command defines a comment for the conversion loss table. Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:
<Text>

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:COMM 'Conversion loss table for FS_Z60'`

Manual control: See "Comment" on page 213

[SENSe:]CORRection:CVL:DATA <Freq>,<Level>

This command defines the reference values of the selected conversion loss tables. The values are entered as a set of frequency/level pairs. A maximum of 50 frequency/level pairs may be entered. Before this command can be performed, the conversion loss table must be selected (see [SENSe:]CORRection:CVL:SELect on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Freq> numeric value

The frequencies have to be sent in ascending order.

<Level>

Example:

`CORR:CVL:SEL 'LOSS_TAB_4'`

Selects the conversion loss table.

`CORR:CVL:DATA 1MHZ,-30DB,2MHZ,-40DB`

Manual control: See "Position/Value" on page 214

[SENSe:]CORRection:CVL:HARMonic <HarmOrder>

This command defines the harmonic order for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [SENSe:]CORRection:CVL:SELect on page 672.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<HarmOrder> numeric value

Range: 2 to 65

Example:

`CORR:CVL:SEL 'LOSS_TAB_4'`

Selects the conversion loss table.

`CORR:CVL:HARM 3`

Manual control: See "Harmonic Order" on page 213

[SENSe:]CORRection:CVL:MIXer <Type>

This command defines the mixer name in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [SENSe:]CORRection:CVL:SELect on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Type> string

Name of mixer with a maximum of 16 characters

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:MIX 'FS_Z60'`

Manual control: See "Mixer Name" on page 213

[SENSe:]CORRection:CVL:PORTs <PortNo>

This command defines the mixer type in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<PortType> 2 | 3

*RST: 2

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:PORT 3`

Manual control: See "Mixer Type" on page 214

[SENSe:]CORRection:CVL:SELect <FileName>

This command selects the conversion loss table with the specified file name. If <file_name> is not available, a new conversion loss table is created.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<FileName> '<File name>'

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`

Manual control: See "New Table" on page 211
See "Edit Table" on page 211
See "File Name" on page 213

[SENSe:]CORRection:CVL:SNUMber <SerialNo>

This command defines the serial number of the mixer for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see `[SENSe:]CORRection:CVL:SELect` on page 672).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<SerialNo> Serial number with a maximum of 16 characters

Example:
`CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:MIX '123.4567'`

Manual control: See "Mixer S/N" on page 214

Programming Example: Working with an External Mixer

This example demonstrates how to work with an external mixer in a remote environment. It is performed in the Spectrum application in the default layout configuration. Note that without a real input signal and connected mixer, this measurement will not return useful results.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//----------- Configuring basic mixer behavior -------------
//Set the LO level of the mixer's LO port to 15 dBm.
SENS:MIX:LOP 15dBm
//Set the bias current to -1 mA .
SENS:MIX:BIAS:LOW -1mA
//----------- Configuring the mixer and band settings -------------
//Use band "V" to full possible range extent for assigned harmonic (6).
SENS:MIX:HARM:BAND V
SENS:MIX:RFOV ON
//Query the possible range
SENS:MIX:FREQ:STAR?
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)
//Use a 3-port mixer type
SENS:MIX:PORT 3
//Split the frequency range into two ranges;
//range 1 covers 47.48 GHz GHz to 80 GHz; harmonic 6, average conv. loss of 20 dB
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:LOW  20dB
SENS:MIX:HARM:HIGH 8
SENS:MIX:LOSS:HIGH 30dB
//--------- Activating automatic signal identification functions -----------
//Activate both automatic signal identification functions.
SENS:MIX:SIGN ALL
```

```
//Use auto ID threshold of 8 dB.
SENS:MIX:THR 8dB

//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
//---------------Retrieving Results-------------
//Return the trace data for the input signal without distortions
//(default screen configuration)
TRAC:DATA? TRACE3
```

Configuring a conversion loss table for a user-defined band

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//--------------Configuring a new conversion loss table --------------
//Define cvl table for range 1 of band as described in previous example
// (extended V band)
SENS:CORR:CVL:SEL 'UserTable'
SENS:CORR:CVL:COMM 'User-defined conversion loss table for USER band'
SENS:CORR:CVL:BAND USER
SENS:CORR:CVL:HARM 6
SENS:CORR:CVL:BIAS -1mA
SENS:CORR:CVL:MIX 'FS_Z60'
SENS:CORR:CVL:SNUM '123.4567'
SENS:CORR:CVL:PORT 3
//Conversion loss is linear from 55 GHz to 75 GHz
SENS:CORR:CVL:DATA 55GHZ,-20DB,75GHZ,-30DB
//----------- Configuring the mixer and band settings -------------
//Use user-defined band and assign new cvl table.
SENS:MIX:HARM:BAND USER
//Define band by two ranges;
//range 1 covers 47.48 GHz to 80 GHz; harmonic 6, cvl table 'UserTable'
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:TABL:LOW 'UserTable'
SENS:MIX:HARM:HIGH 8

SENS:MIX:LOSS:HIGH 30dB
//Query the possible range
SENS:MIX:FREQ:STAR?
```

```
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)

//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
//---------------Retrieving Results-------------
//Return the trace data (default screen configuration)
TRAC:DATA? TRACe1
```

10.5.6.3 Working with Power Sensors

The following commands describe how to work with power sensors.

Configuring Power Sensors

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

This command turns automatic assignment of a power sensor to the power sensor index on and off.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<State> ON | OFF
*RST: ON

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

Manual control: See "Select" on page 191

SYSTem:COMMunicate:RDEVice:PMETer:COUNt?

This command queries the number of power sensors currently connected to the R&S FSW.

Parameters:

<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

Manual control: See "Select" on page 191

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

This command assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:

<p> 1...4
Power sensor index

Setting parameters:

<Placeholder> Currently not evaluated

<SerialNo> Serial number of a connected power sensor

Query parameters:

<Type> The power sensor type, e.g. "NRP-Z81".

<Interface> Currently not evaluated

Return values:

<Placeholder> Currently not used

<Type> Detected power sensor type, e.g. "NRP-Z81".

<Interface> Interface the power sensor is connected to; always "USB"

<SerialNo> Serial number of the power sensor assigned to the specified index

Example:

```
SYST:COMM:RDEV:PMET2:DEF '','NRP-Z81','',
'123456'
```

Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".

```
SYST:COMM:RDEV:PMET2:DEF?
```

Queries the sensor assigned to "Power Sensor 2".
Result:

```
'','NRP-Z81','USB','123456'
```

The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Manual control: See "Select" on page 191

Configuring Power Sensor Measurements

CALibration:PMETer<p>:ZERO:AUTO ONCE

This commands starts to zero the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, results are invalid.

Suffix:

<p>	1...4 Power sensor index

Parameters:

ONCE

Example:	`CAL:PMET2:ZERO:AUTO ONCE;*WAI` Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.
Usage:	Event
Manual control:	See "Zeroing Power Sensor" on page 191

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

This command defines the reference value for relative measurements.

Suffix:

<p>	1...4 Power sensor index

Parameters:

<RefValue>	Range: -200 dBm to 200 dBm *RST: 0
Example:	`CALC:PMET2:REL -30` Sets the reference value for relative measurements to -30 dBm for power sensor 2.
Manual control:	See "Reference Value" on page 193

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

This command sets the current measurement result as the reference level for relative measurements.

Suffix:

<p> 1...4
Power sensor index

Parameters:

ONCE

Example: `CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

Manual control: See "Setting the Reference Level from the Measurement (Meas->Ref)" on page 193

CALCulate<n>:PMETer<p>:RELative:STATe <State>

This command turns relative power sensor measurements on and off.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

FETCh:PMETer<p>?

This command queries the results of power sensor measurements.

Suffix:

<p> 1...4
Power sensor index

Return values:

<Level> Power level that has been measured by a power sensor.
The unit is either dBm (absolute measurements) or dB (relative measurements).

Usage: Query only

READ:PMETer<p>?

This command initiates a power sensor measurement and queries the results.

Suffix:

<p>	1...4 Power sensor index
Usage:	Query only

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

This command turns the duty cycle correction on and off.

Suffix:

<p>	1...4 Power sensor index

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`PMET2:DCYC:STAT ON`
Manual control:	See "Duty Cycle" on page 193

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

This command defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:

<p>	1...4 Power sensor

Parameters:

<Percentage>	Range: 0.001 to 99.999 *RST: 99.999 Default unit: %

Example:	`PMET2:DCYC:STAT ON`
	Activates the duty cycle correction.
	`PMET2:DCYC:VAL 0.5`
	Sets the correction value to 0.5%.

Manual control:	See "Duty Cycle" on page 193

[SENSe:]PMETer<p>:FREQuency <Frequency>

This command defines the frequency of the power sensor.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Frequency> The available value range is specified in the data sheet of the power sensor in use.

*RST: 50 MHz

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

Manual control: See "Frequency Manual" on page 192

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

This command selects the frequency coupling for power sensor measurements.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Coupling>

CENTer
Couples the frequency to the center frequency of the analyzer

MARKer1
Couples the frequency to the position of marker 1

OFF
Switches the frequency coupling off

*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

Manual control: See "Frequency Coupling" on page 192

[SENSe:]PMETer<p>:MTIMe <Duration>

This command selects the duration of power sensor measurements.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Duration> SHORt | NORMal | LONG

*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

Manual control: See "Meas Time/Average" on page 192

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

This command sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<NumberReadings> An average count of 0 or 1 performs one power reading.
Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example:
`PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

Manual control: See "Average Count (Number of Readings)" on page 193

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

This command turns averaging for power sensor measurements on and off.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<State> ON | OFF
*RST: OFF

Example:
`PMET2:MTIM:AVER ON`
Activates manual averaging.

Manual control: See "Meas Time/Average" on page 192

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

This command includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:

<p> 1...4
Power sensor index

Parameters:
<State> **ON**
Includes the reference level offset in the results.
OFF
Ignores the reference level offset.
*RST: ON

Example: `PMET2:ROFF OFF`
Takes no offset into account for the measured power.

Manual control: See "Use Ref Lev Offset" on page 193

[SENSe:]PMETer<p>[:STATe] <State>

This command turns a power sensor on and off.

Suffix:
<p> 1...4
Power sensor index

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

Example: `PMET1 ON`
Switches the power sensor measurements on.

Manual control: See "State" on page 191
See "Select" on page 191

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

This command turns continuous update of power sensor measurements on and off.

If on, the results are update even if a single sweep is complete.

Suffix:
<p> 1...4
Power sensor index

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

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

Manual control: See "Continuous Value Update" on page 191

UNIT<n>:PMETer<p>:POWer <Unit>

This command selects the unit for absolute power sensor measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Unit> DBM | WATT | W
*RST: DBM

Example: `UNIT:PMET:POW DBM`

Manual control: See "Unit/Scale" on page 192

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

This command selects the unit for relative power sensor measurements.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Unit> DB | PCT
*RST: DB

Example: `UNIT:PMET:POW:RAT DB`

Manual control: See "Unit/Scale" on page 192

Triggering with Power Sensors

[SENSe:]PMETer<p>:TRIGger:DTIMe <Time>

This command defines the time period that the input signal has to stay below the IF power trigger level before the measurement starts.

Suffix:
<p> 1...4
Power sensor index

Parameters:
<Time> Range: 0 s to 1 s
Increment: 100 ns
*RST: 100 µs

Example: `PMET2:TRIG:DTIMe 0.001`

[SENSe:]PMETer<p>:TRIGger:HOLDoff <Holdoff>

This command defines the trigger holdoff for external power triggers.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Holdoff> Time period that has to pass between the trigger event and the start of the measurement, in case another trigger event occurs.

Range: 0 s to 1 s
Increment: 100 ns
*RST: 0 s

Example: `PMET2:TRIG:HOLD 0.1`
Sets the holdoff time of the trigger to 100 ms

Manual control: See "Using the power sensor as an external trigger" on page 193
See "Trigger Holdoff" on page 194

[SENSe:]PMETer<p>:TRIGger:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis for external power triggers.

The hysteresis in dB is the value the input signal must stay below the IF power trigger level in order to allow a trigger to start the measurement.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
Increment: 1 dB
*RST: 0 dB

Example: `PMET2:TRIG:HYST 10`
Sets the hysteresis of the trigger to 10 dB.

Manual control: See "Using the power sensor as an external trigger" on page 193
See "Hysteresis" on page 194

[SENSe:]PMETer<p>:TRIGger:LEVel <Level>

This command defines the trigger level for external power triggers.

This command requires the use of an R&S NRP-Z81 power sensor.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Level> -20 to +20 dBm

Range: -20 dBm to 20 dBm
*RST: -10 dBm

Example: `PMET2:TRIG:LEV -10 dBm`
Sets the level of the trigger

Manual control: See "Using the power sensor as an external trigger" on page 193
See "External Trigger Level" on page 194

[SENSe:]PMETer<p>:TRIGger:SLOPe <Edge>

This command selects the trigger condition for external power triggers.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<Edge> **POSitive**
The measurement starts in case the trigger signal shows a positive edge.

NEGative
The measurement starts in case the trigger signal shows a negative edge.

*RST: POSitive

Example: `PMET2:TRIG:SLOP NEG`

Manual control: See "Using the power sensor as an external trigger" on page 193
See "Slope" on page 194

[SENSe:]PMETer<p>:TRIGger[:STATe] <State>

This command turns the external power trigger on and off.

This command requires the use of an R&S NRP-Z81 power sensor.

Suffix:

<p> 1...4
Power sensor index

Parameters:

<State> ON | OFF

*RST: OFF

Example: `PMET2:TRIG ON`
Switches the external power trigger on

Manual control: See "Using the power sensor as an external trigger" on page 193

10.5.6.4 Configuring the Outputs

Configuring trigger input/output is described in chapter 10.5.4.3, "Configuring the Trigger Output", on page 653.

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the front panel on and off.

For details see chapter 5.2.1.2, "Input from Noise Sources", on page 183.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DIAG:SERV:NSO ON`

Manual control: See "Noise Source" on page 220

OUTPut:IF[:SOURce] <Source>

Defines the type of signal sent to the IF/VIDEO/DEMOD connector on the rear panel of the R&S FSW.

The command is only available in the time domain.

For restrictions and more information see chapter 5.2.1.4, "IF and Video Signal Output", on page 184.

Parameters:

<Source>

IF
Sends the measured IF value at the frequency defined using OUTPut:IF:IFFRequency to the IF/VIDEO/DEMOD output connector.

VIDeo
Sends the displayed video signal (i.e. the filtered and detected IF signal, 200mV) to the IF/VIDEO/DEMOD output connector.
This setting is required to send demodulated audio frequencies to the output.

*RST: IF

Example: `OUTP:IF VID`
Selects the video signal for the IF output connector.

Manual control: See "IF/Video Output" on page 219

OUTPut:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

For more information see chapter 5.2.1.4, "IF and Video Signal Output", on page 184.

Parameters:

<Frequency> *RST: 50.0 MHz

Manual control: See "IF (Wide) Out Frequency" on page 220

OUTPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSW.

Parameters:

<State>

ON
User port is switched to OUTPut

OFF
User port is switched to INPut

*RST: OFF

OUTPut:UPORt[:VALue] <Value>

This command sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern. If the user port is programmed to input instead of output (see `INPut:UPORt:STATe` on page 661), the output value is temporarily stored.

Parameters:

<Value> bit values in hexadecimal format

TTL type voltage levels (max. 5V)

Range: #B00000000 to #B00111111

Example: `OUTP:UPOR #B00100100`

Sets pins 5 and 7 to 5 V.

10.6 Analyzing Measurements (Basics)

The commands for general analysis tasks are described here.

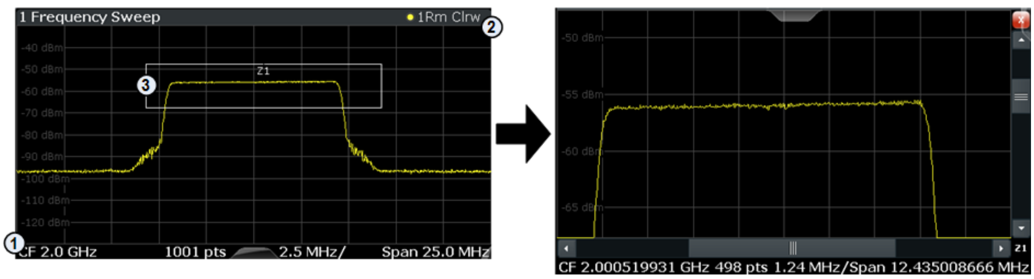
10.6.1 Zooming into the Display

10.6.1.1 Using the Single Zoom

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Parameters:

<x1>,<y1>, <x2>,<y2>	Diagram coordinates in % of the complete diagram that define the zoom area. The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system. Range: 0 to 100 Default unit: PCT

Manual control: See "Single Zoom" on page 278

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Parameters:

<State>	ON | OFF *RST: OFF

Example: `DISP:ZOOM ON`
Activates the zoom mode.

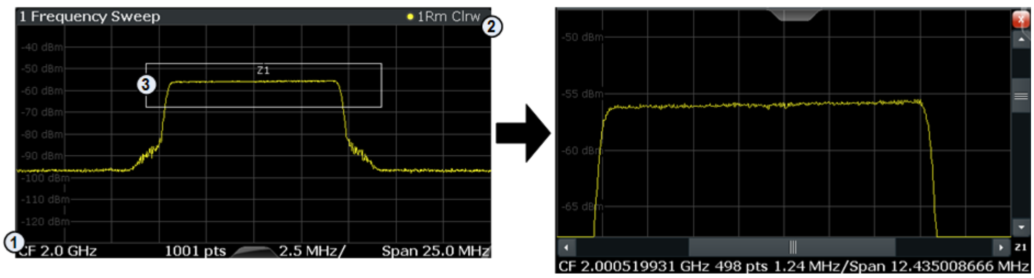
Manual control: See "Single Zoom" on page 278
See "Restore Original Display" on page 278
See "Deactivating Zoom (Selection mode)" on page 278

10.6.1.2 Using the Multiple Zoom

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:
<zoom> 1...4
Selects the zoom window.

Parameters:
<x1>,<y1>,
<x2>,<y2>
Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

Manual control: See "Multiple Zoom" on page 278

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the mutliple zoom on and off.

Suffix:
<zoom> 1...4
Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

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

Manual control: See "Multiple Zoom" on page 278
See "Restore Original Display" on page 278
See "Deactivating Zoom (Selection mode)" on page 278

10.6.2 Configuring the Trace Display and Retrieving Trace Data

The commands required to work with traces are described here.

Commands required to export traces (and other result data) are described in chapter 10.7.5, "Storing Measurement Results", on page 774.

10.6.2.1 Configuring Standard Traces

Useful commands for trace configuration described elsewhere

- DISPlay[:WINDow<n>]:TRACe:Y:SPACing on page 644
- DISPlay[:WINDow<n>]:TRACe:Y[:SCALe] on page 643

Remote commands exclusive to trace configuration

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

This command selects the trace mode.

In case of max hold, min hold or average trace mode, you can set the number of single measurements with [SENSe:]SWEep:COUNt. Note that synchronization to the end of the measurement is possible only in single sweep mode.

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example: `INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual control: See "Trace Mode" on page 294

DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous <State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Parameters:
<State> **ON**
The automatic reset is off.
OFF
The automatic reset is on.
*RST: OFF

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual control: See "Hold" on page 295

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Parameters:
<State> ON | OFF
*RST: ON for TRACe1, OFF for TRACe2 to 6

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

Manual control: See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 297

[SENSe:]AVERage:COUNt <AverageCount>

This command defines the number of sweeps that the application uses to average traces.

In case of continuous sweeps, the application calculates the moving average over the average count.

In case of single sweep measurements, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<AverageCount> If you set a average count of 0 or 1, the application performs one single sweep in single sweep mode.
In continuous sweep mode, if the average count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000
*RST: 0

Usage: SCPI confirmed

Manual control: See "Sweep/Average Count" on page 247
See "Average Count" on page 296

[SENSe:]AVERage<n>[:STATe<t>] <State>

This command turns averaging for a particular trace in a particular window on and off.

Parameters:

<State> ON | OFF

Usage: SCPI confirmed

[SENSe:]AVERage<n>:TYPE <Mode>

This command selects the trace averaging mode.

Parameters:

<Mode>

VIDeo
The logarithmic power values are averaged.

LINear
The power values are averaged before they are converted to logarithmic values.

POWer
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.

*RST: VIDeo

Example: `AVER:TYPE LIN`
Switches to linear average calculation.

Usage: SCPI confirmed

Manual control: See "Average Mode" on page 295

[SENSe:][WINDow:]DETector<trace>[:FUNCtion] <Detector>

This command selects the detector.

Parameters:

<Detector> APEak | NEGative | POSitive | SAMPle | RMS | AVERage

*RST: APEak

Example: `DET POS`

Sets the detector to "positive peak".

Manual control: See "Detector" on page 295

[SENSe:][WINDow:]DETector<trace>[:FUNCtion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DET:AUTO OFF`

The selection of the detector is not coupled to the trace mode.

Manual control: See "Detector" on page 295

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Parameters:

<TraceNumber>, <TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**

The first parameter is the destination trace, the second parameter is the source.

Example: `TRAC:COPY TRACe1,TRACe2`

Copies the data from trace 2 to trace 1.

Usage: SCPI confirmed

Manual control: See "Copy Trace" on page 297

10.6.2.2 Configuring Spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the R&S FSW also provides a spectrogram display of the measured data. A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. The commands required to configure spectrograms in a remote environment are described here. For details and manual operation see chapter 6.3.1.6, "Spectrograms", on page 287.

When configuring spectrograms, the window suffix is irrelevant. The settings are always applied to the spectrogram window, or to all spectrogram windows, if several are active for the same measurement channel.

For commands to set markers in spectrograms, see chapter 10.6.3.6, "Marker Search (Spectrograms)", on page 721.

Configuring a Spectrogram Measurement

CALCulate:SGRam:CLEar[:IMMediate]

This command resets the spectrogram and clears the history buffer.

Example: `CALC:SGR:CLE`
Resets the result display and clears the memory.

Usage: Event

Manual control: See "Spectrogram Frames" on page 249
See "Clear Spectrogram" on page 250

CALCulate:SGRam:CONT <State>

This command determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `INIT:CONT OFF`
Selects single sweep mode.
`INIT;*WAI`
Starts the sweep and waits for the end of the sweep.
`CALC:SGR:CONT ON`
Repeats the single sweep measurement without deleting the results of the last measurement.

Manual control: See "Spectrogram Frames" on page 249
See "Continue Frame" on page 250
See "State" on page 302

CALCulate:SGRam:FRAMe:COUNt <Frames>

This command defines the number of frames to be recorded in a single sweep.

Parameters:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1
*RST: 1

Example:
`INIT:CONT OFF`
Selects single sweep mode.
`CALC:SGR:FRAM:COUN 200`
Sets the number of frames to 200.

Manual control: See "Spectrogram Frames" on page 249
See "Frame Count" on page 250

CALCulate:SGRam:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:
`INIT:CONT OFF`
Stop the continuous sweep.
`CALC:SGR:FRAM:SEL -25`
Selects frame number -25.

Manual control: See "Spectrogram Frames" on page 249
See "Select frame" on page 249

CALCulate:SGRam:HDEPth <History>

This command defines the number of frames to be stored in the R&S FSW memory.

Parameters:

<History>	The maximum number of frames depends on the number of sweep points. Range: 781 to 20000 Increment: 1 *RST: 3000
Example:	`CALC:SGR:SPEC 1500` Sets the history depth to 1500.
Manual control:	See "History Depth" on page 302

CALCulate:SGRam:TSTamp:DATA? <Frames>

This command queries the time stamp of the frames.

The frame results themselves are returned with `TRACe<n>[:DATA]`.

Query parameters:

<Frames>	**CURRent** Returns the time stamp of the current frame. **ALL** Returns the time stamps of all frames. The results are sorted in descending order, beginning with the current frame.

Return values:

<Date>	The return values consist of four values for each frame. • date of the measurement in seconds that have passed since 01.01.1970 • milliseconds of the date for a higher resolution These numbers are appropriate for relative uses, but you can also calculate the absolute date and time as displayed on the screen. The third and fourth value are reserved for future uses. If the Spectrogram is empty, the command returns '0,0,0,0'

Example:	`CALC:SGR:TST ON`
	Activates the time stamp.
	`CALC:SGR:TST:DATA? ALL`
	Returns the time stamp of all frames sorted in a descending order.

Usage:	Query only
Manual control:	See "Time Stamp" on page 303

CALCulate:SGRam:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate:DELTamarker<m>:SGRam:FRAMe` on page 726
- `CALCulate:MARKer<m>:SGRam:FRAMe` on page 722

- CALCulate:SGRam:FRAMe:SELect on page 696

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:SGR:TST ON`

Activates the time stamp.

Manual control: See "Time Stamp" on page 303

CALCulate:SGRam[:STATe] <State>

This command turns the spectrogram on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:SGR ON`

Activates the Spectrogram result display.

Manual control: See "State" on page 302

Configuring the Color Map

DISPlay:WINDow:SGRam:COLor:DEFault

This command restores the original color map.

Usage: Event

Manual control: See "Set to Default" on page 305

DISPlay:WINDow:SGRam:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66

*RST: 0

Default unit: %

Example: `DISP:WIND:SGR:COL:LOW 10`

Sets the start of the color map to 10%.

Manual control: See "Start / Stop" on page 304

DISPlay:WINDow:SGRam:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Parameters:

<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Manual control: See "Shape" on page 304

DISPlay:WINDow:SGRam:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual control: See "Start / Stop" on page 304

DISPlay:WINDow:SGRam:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:

<ColorScheme>

HOT
Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example: `DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual control: See "Hot/Cold/Radar/Grayscale" on page 305

10.6.2.3 Using Trace Mathematics

The following commands control trace mathematics.

CALCulate<n>:MATH[:EXPression][:DEFine] <Expression>

This command selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

Parameters:

<Expression>

(TRACE1-TRACE2)
Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
Subtracts trace 4 from trace 1.

(TRACE1-TRACE5)
Subtracts trace 5 from trace 1.

(TRACE1-TRACE6)
Subtracts trace 6 from trace 1.

Example:

`CALC:MATH:STAT ON`
Turns trace mathematics on.
`CALC:MATH:EXPR:DEF (TRACE1-TRACE3)`
Subtracts trace 3 from trace 1.

Usage: SCPI confirmed

Manual control: See "Trace Math Function" on page 298

CALCulate<n>:MATH:MODE <Mode>

This command selects the way the R&S FSW calculates trace mathematics.

Parameters:

<Mode>

For more information on the way each mode works see Trace Math Mode.

LINear
Linear calculation.

LOGarithmic
Logarithmic calculation.

POWer
Linear power calculation.

*RST: LOGarithmic

Example: `CALC:MATH:MODE LIN`
Selects linear calculation.

Manual control: See "Trace Math Mode" on page 299

CALCulate<n>:MATH:POSition <Position>

This command defines the position of the trace resulting from the mathematical operation.

Parameters:

<Position> Vertical position of the trace in % of the height of the diagram area. 100 PCT corresponds to the upper diagram border.

Range: -100 to 200
*RST: 50
Default unit: PCT

Example: `CALC:MATH:POS 100`
Moves the trace to the top of the diagram area.

Manual control: See "Trace Math Position" on page 299

CALCulate<n>:MATH:STATe <State>

This command turns the trace mathematics on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MATH:STAT ON`
Turns on trace mathematics.

Usage: SCPI confirmed

Manual control: See "Trace Math Function" on page 298
See "Trace Math Off" on page 298

10.6.2.4 Retrieving Trace Results

This chapter describes how to retrieve data from standard traces.

For spectrograms see also chapter 10.6.3.6, "Marker Search (Spectrograms)", on page 721.

For details on the format of the retrieved trace data see also chapter 10.6.2.5, "Formats for Returned Values: ASCII Format and Binary Format", on page 704.

Commands required to export traces (and other result data) are described in chapter 10.7.5, "Storing Measurement Results", on page 774.

FORMat[:DATA] <Format>

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

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

For details on data formats see chapter 10.6.2.5, "Formats for Returned Values: ASCII Format and Binary Format", on page 704.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

TRACe<n>[:DATA] <Trace>,<Data> | <ResultType>

This command queries current trace data and measurement results.

If you use it as a setting command, it transfers trace data from an external source to the R&S FSW.

The data format depends on `FORMat[:DATA]`.

Parameters:

<Trace> Selects the trace to write the data to.

TRACE1 | ... | TRACE6

<Data> Contains the data to transfer.

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the trace data for the corresponding trace.
For details see table 10-4.

LIST
Returns the results of the peak list evaluation for Spurious Emission and Spectrum Emission Mask measurements.
For details see table 10-5.

SPURious
Returns the peak list of Spurious Emission measurements.

SPECtrogram | SGRam
Returns the results of the spectrogram result display.
For details see table 10-6.

Return values:

<TraceData> For more information see tables below.

Example: `TRAC TRACE1,+A$`
Transfers trace data ('+A$') to trace 1.

Example: `TRAC? TRACE3`
Queries the data of trace 3.

Usage: SCPI confirmed

Manual control:
See "Spectrum Emission Mask" on page 34
See "Spurious Emissions" on page 34
See "List Evaluation State" on page 115
See "List Evaluation State" on page 135

Table 10-4: Return values for TRACE1 to TRACE6 parameter

The trace data consists of a list of power levels that have been measured. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the unit you have currently set. If you are measuring with the auto peak detector, the command returns positive peak values only. For SEM or Spurious Emission measurement results, the x-values should be queried as well, as they are not equi-distant (see `TRACe<n>[:DATA]:X?` on page 704).

Table 10-5: Return values for LIST parameter

For every measurement range you have defined (range 1...n), the command returns eight values in the following order. <No>,<StartFreq>,<StopFreq>,<RBW>,<PeakFreq>,<PowerAbs>,<PowerRel>,<PowerDelta>,<LimitCheck>,<Unused1>,<Unused2> • <No>: range number • <StartFreq>,<StopFreq>: start and stop frequency of the range • <RBW>: resolution bandwidth • <PeakFreq>: frequency of the peak in a range • <PowerAbs>: absolute power of the peak in dBm • <PowerRel>: power of the peak in relation to the channel power in dBc • <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check • <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) • <Unused1>,<Unused2>: reserved (0.0)

Table 10-6: Return values for SPECtrogram parameter

For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command is identical to `TRAC:DATA? TRACE1`

For details on the returned values see the TRAC:DATA? <TRACE...> command.

Query parameters:

<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

<OffsSwPoint> The offset in sweep points related to the start of the measurement at which data retrieval is to start.

<NoOfSwPoints> Number of sweep points to be retrieved from the trace.

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

TRACe<n>[:DATA]:X? <TraceNumber>

This command queries the horizontal trace data. This is especially useful for traces with non-equidistant x-values, e.g. for SEM or Spurious Emissions measurements.

Query parameters:

<TraceNumber> Trace number.
TRACE1 | ... | TRACE6

Example: `TRAC:X? TRAC1`
Returns the x-values for trace 1.

Usage: Query only

Manual control: See "Spectrum Emission Mask" on page 34

10.6.2.5 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.

10.6.3 Working with Markers

The commands required to work with markers and marker functions in a remote environment are described here. The tasks for manual operation are described in chapter 6.4, "Marker Usage", on page 311.

In the Spectrum application, markers are identical in all windows. Thus, the suffix <n> for the window is generally irrelevant.

10.6.3.1 Setting Up Individual Markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker:AOFF

This command turns all delta markers off.

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (stimulus, x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTamarker<m1>:LINK:TO:MARKer<m2>` or `CALCulate<n>:MARKer<m1>:LINK:TO:MARKer<m2>` commands.

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

Example: `CALC:DELT2:LINK ON`

Manual control: See "Linking to Another Marker" on page 323

CALCulate<n>:DELTamarker<m1>:LINK:TO:MARKer<m2> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

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

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual control: See "Linking to Another Marker" on page 323

CALCulate<n>:DELTamarker:MODE <Mode>

This command selects the delta marker mode.

Parameters:

<Mode> **ABSolute**
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Parameters:

<Reference> **1 to 16**
Selects markers 1 to 16 as the reference.

FIXed
Selects the fixed reference as the reference.

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual control: See "Reference Marker" on page 323

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual control: See "Marker State" on page 322
See "Marker Type" on page 323

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The position is relative to the reference marker.
To select an absolute position you have to change the delta marker mode with `CALCulate<n>:DELTamarker:MODE` on page 707.
A query returns the absolute position of the delta marker.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the (absolute) x-value of delta marker 1.

Manual control: See "Marker 1/2/3/4" on page 170
See "Marker 1/2/3" on page 175
See "Marker Position (Stimulus)" on page 323

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual control: See "All Markers Off" on page 324

CALCulate<n>:MARKer<m1>:LINK:TO:MARKer<m2> <State>

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual control: See "Linking to Another Marker" on page 323

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual control: See "Marker State" on page 322
See "Marker Type" on page 323

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual control: See "Assigning the Marker to a Trace" on page 324

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit is either Hz (frequency domain) or s (time domain) or dB (statistics).

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual control: See "Marker 1/2/3/4" on page 170
See "Marker 1/2/3" on page 175
See "Marker Position (Stimulus)" on page 323

10.6.3.2 General Marker Settings

The following commands control general marker functionality.

Remote commands exclusive to general marker functionality

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode> **ON**
Turns the marker table on.

OFF
Turns the marker table off.

AUTO
Turns the marker table on if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual control: See "Marker Table Display" on page 325

CALCulate:MARKer:X:SSIZe <StepSize>

This command selects the marker step size mode.

The step size defines the distance the marker moves when you move it with the rotary knob. It therefore takes effect in manual operation only.

Parameters:

<StepSize>

STANdard
the marker moves from one pixel to the next

POINts
the marker moves from one sweep point to the next

*RST: POINts

Example: `CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual control: See "Marker Stepsize" on page 325

10.6.3.3 Configuring and Performing a Marker Search

The following commands control the marker search.

CALCulate:MARKer:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CALC:MARK:LOEX ON`

Manual control: See "Exclude LO" on page 327

CALCulate<n>:MARKer:PEXCursion <Excursion>

This command defines the peak excursion.

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB

Parameters:

<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized

*RST: 6 dB in the Spectrum application and RF displays

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual control: See "Peak Excursion" on page 328

CALCulate:MARKer:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual control: See "Search Limits (Left / Right)" on page 93
See "Deactivating All Search Limits" on page 93
See "Limit State" on page 156
See "Search Limits" on page 328
See "Search Limits" on page 332

CALCulate:MARKer:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<SearchLimit> The value range depends on the span or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual control: See "Search Limits (Left / Right)" on page 93
See "Left Limit / Right Limit" on page 156
See "Search Limits" on page 328
See "Search Limits" on page 332

CALCulate:MARKer:X:SLIMits:RIGHT <SearchLimit>

This command defines the right limit of the marker search range.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Parameters:

<Limit> The value range depends on the span or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual control: See "Search Limits (Left / Right)" on page 93
See "Left Limit / Right Limit" on page 156
See "Search Limits" on page 328
See "Search Limits" on page 332

CALCulate:MARKer:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual control: See "Search Limits" on page 328
See "Using Zoom Limits" on page 329
See "Search Limits" on page 332

CALCulate:THReshold <Level>

This command defines a threshold level for the marker peak search.

Parameters:

<Level> Numeric value. The value range and unit are variable.

*RST: -120 dBm

Example: `CALC:THR -82DBM`
Sets the threshold value to -82 dBm.

Manual control: See "Search Limits" on page 328
See "Search Threshold" on page 328
See "Search Limits" on page 332

CALCulate:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off.

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

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual control: See "Deactivating All Search Limits" on page 93
See "Search Limits" on page 328
See "Search Limits" on page 332

10.6.3.4 Positioning the Marker

This chapter contains remote commands necessary to position the marker on a trace.

Positioning Normal Markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S FSW performs the peak search after each sweep.

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

Example: `CALC:MARK:MAX:AUTO ON`
Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual control: See "Automatic Peak Search" on page 328

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330
See "Search Next Peak" on page 333

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the highest level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual control: See "Marker Search Type" on page 330
See "Peak Search" on page 333

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S FSW performs the peak search after each sweep.

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

Example: `CALC:MARK:MIN:AUTO ON`
Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual control: See "Automatic Peak Search" on page 328

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330
See "Search Next Minimum" on page 333

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual control: See "Marker Search Type" on page 330
See "Search Minimum" on page 333

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Mode for Next Peak in X Direction" on page 330

Positioning Delta Markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Next Peak" on page 333

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the highest level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual control: See "Marker Search Type" on page 330
See "Peak Search" on page 333

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327
See "Search Next Minimum" on page 333

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

In the spectrogram, the command moves a delta marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual control: See "Marker Search Type" on page 330
See "Search Minimum" on page 333

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the vertical marker position remains the same.

Usage: Event

Manual control: See "Search Mode for Next Peak" on page 327

10.6.3.5 Retrieving Marker Results

The following commands are used to retrieve the results of markers.

You can use the marker values to position the center frequency or reference level directly using the following commands:

- CALCulate<n>:MARKer<m>:FUNCtion:CENTer on page 627
- CALCulate<n>:MARKer<m>:FUNCtion:REFerence on page 638

Useful commands for retrieving results described elsewhere:

- CALCulate<n>:DELTamarker<m>:X on page 708
- CALCulate<n>:MARKer<m>:X on page 709
- CALCulate:MARKer:FUNCtion:FPEaks:COUNt? on page 730
- CALCulate:MARKer:FUNCtion:FPEeaks:X? on page 732
- CALCulate:MARKer:FUNCtion:FPEeaks:Y? on page 732
- CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? on page 733
- CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult? on page 734
- CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult? on page 737
- CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? on page 735
- CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? on page 738
- CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency? on page 738
- CALCulate:MARKer:FUNCtion:NDBDown:QFACtor? on page 738
- CALCulate<n>:MARKer<m>:COUNt:FREQuency? on page 740

Remote commands exclusive to retrieving marker results

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

Manual control: See "Marker 1/2/3/4" on page 170
See "Marker 1/2/3" on page 175

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

The unit depends on the application of the command.

Table 10-7: Base unit

Parameter, measuring function or result display	Output unit
DBM | DBPW | DBUV | DBMV | DBUA	dB (lin/log)
WATT | VOLT | AMPere	dB (lin), % (log)
statistics function (APD or CCDF) on	dimensionless output

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:

`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Result> Result at the marker position.
The unit is variable and depends on the one you have currently set.

Example:

`INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

10.6.3.6 Marker Search (Spectrograms)

The following commands automatically define the marker and delta marker position in the spectrogram.

Using Markers

The following commands control spectrogram markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the markers.

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 715
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 715

- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 715
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 715
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 716
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 716
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 716
- `CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 717

Remote commands exclusive to spectrogram markers

CALCulate:MARKer<m>:SGRam:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds. The range depends on the history depth.

Example:
`CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual control: See "Frame (Spectrogram only)" on page 323

CALCulate:MARKer:SGRam:SARea <SearchArea>

This command defines the marker search area for all markers.

Parameters:
<SearchArea>

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual control: See "Marker Search Area" on page 331

CALCulate:MARKer<m>:SGRam:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:MARKer<m>:SGRam:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:MARKer<m>:SGRam:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:MARKer<m>:SGRam:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:MARKer<m>:SGRam:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Usage: Event

Manual control: See "Marker Search Type" on page 330

Using Delta Markers

The following commands control spectrogram delta markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the delta markers.

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 717
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 717
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 718
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 718
- `CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 718
- `CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 718
- `CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 718
- `CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 719

Remote commands exclusive to spectrogram markers

CALCulate:DELTamarker<m>:SGRam:FRAMe <Frame> | <Time>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: `CALC:DELT4:SGR:FRAM -20`
Sets fourth deltamarker 20 frames below marker 1.
`CALC:DELT4:SGR:FRAM 2 s`
Sets fourth deltamarker 2 seconds above the position of marker 1.

CALCulate:DELTamarker<m>:SGRam:SARea <SearchArea>

This command defines the delta marker search area.

Parameters:

<SearchArea> **VISible**
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).
MEMory
Performs a search within all frames in the memory.
*RST: VISible

Manual control: See "Marker Search Area" on page 331

CALCulate:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Usage: Event

Manual control: See "Marker Search Type" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Usage: Event

Manual control: See "Search Mode for Next Peak in Y Direction" on page 330

CALCulate:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Usage: Event

Manual control: See "Marker Search Type" on page 330

10.6.3.7 Fixed Reference Marker Settings

The following commands configure a fixed reference marker.

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]

This command moves the fixed reference marker to the peak power.

Example: `CALC:DELT:FUNC:FIX:RPO:MAX`
Sets the reference point level for delta markers to the peak of the selected trace.

Usage: Event

Manual control: See "Defining a Fixed Reference" on page 325
See "Defining a Reference Point" on page 338

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X <RefPoint>

This command defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Parameters:
<RefPoint> Numeric value that defines the horizontal position of the reference.
For frequency domain measurements, it is a frequency in Hz.
For time domain measurements, it is a point in time in s.
*RST: Fixed Reference: OFF

Example: `CALC:DELT:FUNC:FIX:RPO:X 128 MHz`
Sets the frequency reference to 128 MHz.

Manual control: See "Defining a Fixed Reference" on page 325
See "Defining a Reference Point" on page 338

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y <RefPointLevel>

This command defines the vertical position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Parameters:
<RefPoint> Numeric value that defines the vertical position of the reference.
The unit and value range is variable.
*RST: Fixed Reference: OFF

Example: `CALC:DELT:FUNC:FIX:RPO:Y -10dBm`
Sets the reference point level for delta markers to -10 dBm.

Manual control: See "Defining a Fixed Reference" on page 325
See "Defining a Reference Point" on page 338

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet <Offset>

This command defines a level offset for the fixed delta marker reference point.

Parameters:

<Offset> Numeric value

*RST: 0

Default unit: dB

10.6.3.8 Marker Peak Lists

Useful commands for peak lists described elsewhere

- `CALCulate<n>:MARKer:PEXCursion` on page 711
- `MMEMory:STORe:LIST` on page 775

Remote commands exclusive to peak lists

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] <State>

This command turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`

Removes the peak labels from the diagram

Manual control: See "Displaying Marker Numbers" on page 345

CALCulate:MARKer:FUNCtion:FPEaks:COUNt?

This command queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

Return values:
<NumberOfPeaks>

Example: `CALC:MARK:FUNC:FPE:COUN?`
Queries the number of peaks.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] <Peaks>

This command initiates a peak search.

Parameters:
<Peaks> This parameter defines the number of peaks to find during the search.
Note that the actual number of peaks found during the search also depends on the peak excursion you have set with `CALCulate<n>:MARKer:PEXCursion`.
Range: 1 to 200

Example: `CALC:MARK:PEXC 5`
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
`CALC:MARK:FUNC:FPE 10`
Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE <MaxNoPeaks>

This command defines the maximum number of peaks that the R&S FSW looks for during a peak search.

Parameters:
<MaxNoPeaks> Maximum number of peaks to be determined.
Range: 1 to 200
*RST: 50

Example: `CALC:MARK:FUNC:FPE:LIST:SIZE 10`
The marker peak list will contain a maximum of 10 peaks.

Manual control: See "Maximum Number of Peaks" on page 345

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>

This command selects the order in which the results of a peak search are returned.

Parameters:
<SortMode> **X**
Sorts the peaks according to increasing position on the x-axis.
Y
Sorts the peaks according to decreasing position on the y-axis.
*RST: X

Example: `CALC:MARK:FUNC:FPE:SORT Y`
Sets the sort mode to decreasing y values

Manual control: See "Sort Mode" on page 345

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STAT <State>

This command turns a peak search on and off.

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

Example: `CALC:MARK:FUNC:FPE:STAT ON`
Activates marker peak search

Manual control: See "Peak List State" on page 344

CALCulate:MARKer:FUNCtion:FPEeaks:X?

This command queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Return values:
<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Usage: Query only

CALCulate:MARKer:FUNCtion:FPEeaks:Y?

This command queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Return values:
<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

10.6.3.9 Noise Measurement Marker

The following commands control the noise measurement marker function.

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?

This command queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<NoiseLevel>	Current noise level. The unit is the one currently active.

Example:	`INIT:CONT OFF`
	Switches to single sweep mode.
	`CALC:MARK2 ON`
	Switches on marker 2.
	`CALC:MARK:FUNC:NOIS ON`
	Switches on noise measurement.
	`INIT;*WAI`
	Starts a sweep and waits for the end.
	`CALC:MARK2:NOIS:RES?`
	Outputs the noise result of marker 2.

Usage:	Query only
Manual control:	See "Noise Measurement State" on page 337

CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] <State>

This command turns the noise measurement at the marker position on and off.

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`CALC:MARK:FUNC:NOIS ON` Switches on the noise measurement.
Manual control:	See "Noise Measurement State" on page 337 See "Switching All Noise Measurements Off" on page 337

10.6.3.10 Phase Noise Measurement Marker

The following commands control the phase noise measurement marker function.

Useful commands for phase noise markers described elsewhere

- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]`
- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X`
- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y`

Remote commands exclusive to phase noise markers

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO <State>

This command turns an automatic peak search for the fixed reference marker at the end of a sweep on and off.

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

Example: `CALC:DELT:FUNC:PNO:AUTO ON`
Activates an automatic peak search for the reference marker in a phase-noise measurement.

Manual control: See "Defining a Reference Point" on page 338

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?

This command queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Return values:
<PhaseNoise>

Example: `CALC:DELT2:FUNC:PNO:RES?`
Outputs the result of phase-noise measurement of the delta-marker 2.

Usage: Query only

Manual control: See "Phase Noise Measurement State" on page 338

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] <State>

This command turns the phase noise measurement at the delta marker position on and off.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are taken into account in the measurement.

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

Example: `CALC:DELT:FUNC:PNO ON`
Switches on the phase-noise measurement with all delta markers.
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm

Manual control: See "Phase Noise Measurement State" on page 338
See "Switching All Phase Noise Measurements Off" on page 339

10.6.3.11 Band Power Marker

The following commands control the marker for band power measurements.

Using Markers

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power marker are displayed.

Parameters:
<Mode> **POWer**
Result is displayed as a power in dBm.
DENSity
Result is displayed as a density in dBm/Hz.
*RST: POWer

Example: `CALC:MARK4:FUNC:BPOW:MODE DENS`
Configures marker 4 to show the measurement results in dBm/Hz.

Manual control: See "Power Mode" on page 342

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Return values:
<Power> Signal power over the marker bandwidth.

Example: Activate the band power marker:
`CALC:MARK:FUNC:BPOW:STAT ON`
Select the density mode for the result:
`CALC:MARK:FUNC:BPOW:MODE DENS`
Query the result:
`CALC:MARK:FUNC:BPOW:RES?`
Response:
`20dBm/Hz`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the marker position.

Parameters:

<Span> Frequency. The maximum span depends on the marker position and R&S FSW model.
*RST: 5% of current span
Default unit: Hz

Example: `CALC:MARK:FUNC:BPOW:SPAN 2MHz`
Measures the band power over 2 MHz around the marker.

Manual control: See "Span" on page 342

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns markers for band power measurements on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK4:FUNC:BPOW:STAT ON`
Activates or turns marker 4 into a band power marker.

Manual control: See "Band Power Measurement State" on page 341
See "Switching All Band Power Measurements Off" on page 342

Using Delta Markers

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power delta marker are displayed.

Parameters:

<Mode>	**POWer** Result is displayed as a power in dBm. **DENSity** Result is displayed as a density in dBm/Hz. *RST: POWer

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Return values:

<Power>	Signal power over the delta marker bandwidth.
Usage:	Query only

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the delta marker position.

Parameters:

<Span>	Frequency. The maximum span depends on the marker position and R&S FSW model. *RST: 5% of current span Default unit: Hz

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns delta markers for band power measurements on and off.

If neccessary, the command also turns on a reference marker.

Parameters:

<State>	ON | OFF *RST: OFF

10.6.3.12 n dB Down Marker

The following commands control the n dB down markers.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown <Distance>

This command defines the distance of the n dB down markers to the reference marker.

Parameters:

<Distance> Distance of the temporary markers to the reference marker in dB.

*RST: 6dB

Example: `CALC:MARK:FUNC:NDBD 3dB`

Sets the distance to the reference marker to 3 dB.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?

This command queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Frequency> **<frequency 1>**

absolute frequency of the n dB marker to the left of the reference marker in Hz

<frequency 2>

absolute frequency of the n dB marker to the right of the reference marker in Hz.

Example: `INIT:CONT OFF`

Switches to single sweep mode.

`CALC:MARK:FUNC:NDBD ON`

Switches on the n dB down function.

`INIT;*WAI`

Starts a sweep and waits for the end.

`CALC:MARK:FUNC:NDBD:FREQ?`

This command would return, for example, 100000000, 200000000, meaning that the first marker position is at 100 MHz, the second marker position is at 200 MHz

Usage: Query only

Manual control: See "n dB down Delta Value" on page 340

CALCulate:MARKer:FUNCtion:NDBDown:QFACtor?

This command queries the Q factor of n dB down measurements.

Return values:

<QFactor>

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?

This command queries the distance of the n dB down markers from each other.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Distance> The result depends on the span.
In case of frequency domain measurements, the command returns the bandwidth between the two n dB down markers in Hz.
In case of time domain measurements, the command returns the pulse width between the two n dB down markers in seconds.

Example:
`INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:RES?`
Outputs the measured value.

Usage: Query only

Manual control: See "n dB down Marker State" on page 339

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe <State>

This command turns the n dB Down marker function on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example:
`CALC:MARK:FUNC:NDBD:STAT ON`
Turns the n dB Down marker on.

Manual control: See "n dB down Marker State" on page 339

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME

This command queries the position of the n dB down markers on the x-axis when measuring in the time domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:

<Time>

<time 1>
absolute position in time of the n dB marker to the left of the reference marker in seconds

<time 2>
absolute position in time of the n dB marker to the right of the reference marker in seconds

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode
```
CALC:MARK:FUNC:NDBD ON
```
Switches on the n dB down function.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:FUNC:NDBD:TIME?
```
Outputs the time values of the temporary markers.

Manual control: See "n dB down Delta Value" on page 340

10.6.3.13 Signal Count Marker

The following commands control the frequency counter.

CALCulate<n>:MARKer<m>:COUNt <State>

This command turns the frequency counter at the marker position on and off.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the R&S FSW deactivates the frequency count of the first marker.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK ON
```
Switches on marker 1.
```
CALC:MARK:COUN ON
```
Switches on the frequency counter for marker 1.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:COUN:FREQ?
```
Outputs the measured value.

Manual control: See "Signal Count Marker State" on page 335

CALCulate<n>:MARKer<m>:COUNt:FREQuency?

This command queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Before you can use the command, you have to turn on the frequency counter.

Return values:

<Frequency>	Frequency at the marker position.

Example:	`INIT:CONT OFF`
	Switches to single sweep mode.
	`CALC:MARK ON`
	Switches on marker 2.
	`CALC:MARK:COUN ON`
	Activates the frequency counter for marker 1.
	`INIT;*WAI`
	Starts a sweep and waits for the end.
	`CALC:MARK:COUN:FREQ?`
	Outputs the measured value of marker 1.

Usage:	Query only
Manual control:	See "Signal Count Marker State" on page 335

CALCulate<n>:MARKer<m>:COUNt:RESolution <Resolution>

This command defines the resolution of the frequency counter.

Parameters:

<Resolution>	0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz *RST: 0.1 Hz
Example:	`CALC:MARK:COUN:RES 1kHz` Sets the resolution of the frequency counter to 1 kHz.
Manual control:	See "Resolution" on page 335

10.6.3.14 Marker Demodulation

The following commands control the demodulation of AM and FM signals at the marker position.

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous <State>

This command turns continuous demodulation of the signal at the marker position in the frequency domain on and off.

In the time domain continuous demodulation is always on.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC2:MARK3:FUNC:DEM:CONT ON`

Switches on the continuous demodulation.

Manual control: See "Continuous Demodulation" on page 343

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff <Duration>

This command defines for how long the the signal at the marker position is demodulated.

In the time domain continuous demodulation is always on.

Parameters:

<Duration> Range: 10 ms to 1000 s

*RST: Marker demodulation = OFF

Example: `CALC:MARK:FUNC:DEM:HOLD 3s`

Manual control: See "Marker Stop Time" on page 343

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect <DemodMode>

This command selects the demodulation mode at the marker position.

Parameters:

<DemodMode> **AM**

AM demodulation

FM

FM demodulation

*RST: AM

Example: `CALC:MARK:FUNC:DEM:SEL FM`

Manual control: See "Modulation" on page 343

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe] <State>

This command turns the audio demodulator on and off when the measurement reaches a marker position.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3:FUNC:DEM ON`

Switches on the demodulation for marker 3.

Manual control: See "Marker Demodulation State" on page 343

[SENSe:]DEMod:SQUelch:LEVel <Threshold>

This command defines the threshold for selective demodulation.

All signals below the threshold are not demodulated.

Parameters:

<Threshold> Percentage of the display height.

Range: 0 to 100
*RST: 50

Example: `DEM:SQU:LEV 80`
Sets the squelch level to 80% of the displayed signal.

Manual control: See "Squelch level" on page 344

[SENSe:]DEMod:SQUelch[:STATe] <State>

This command turns selective demodulation at the marker position on and off.

For selective demodulation, the R&S FSW turns on a video trigger whose level corresponds to the squelch level. Therefore it turns other triggers or gates off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DEM:SQU ON`
Signals below the level threshold are not sent to the audio output.

Manual control: See "Squelch" on page 343

10.6.4 Configuring Display and Limit Lines

The commands required to configure display and limit lines in a remote environment are described here. The tasks for manual operation are described in chapter 6.5.4, "How to Work with Display and Limit Lines", on page 360.

10.6.4.1 Configuring Display Lines

The following commands configure vertical and horizontal display lines.

CALCulate<n>:DLINe<k> <Position>

This command defines the (vertical) position of a display line.

Parameters:

<Position> The value range is variable.
You can use any unit you want, the R&S FSW then converts the unit to the currently selected unit. If you omit a unit, the R&S FSW uses the currently selected unit.

*RST: (state is OFF)

Example: `CALC:DLIN -20dBm`
Positions the display line at -20 dBm.

Manual control: See "Horizontal Line 1/2" on page 354

CALCulate<n>:DLINe<k>:STATe <State>

This command turns a display line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DLIN2:STAT ON`
Turns on display line 2.

CALCulate<n>:FLINe<k> <Frequency>

This command defines the position of a frequency line.

Parameters:

<Frequency> Note that you can not set a frequency line to a position that is outside the current span.

Range: 0 Hz to Fmax
*RST: (STATe to OFF)

Example: `CALC:FLIN2 120MHz`
Sets frequency line 2 to a frequency of 120 MHz.

Manual control: See "Vertical Line 1/2" on page 354

CALCulate<n>:FLINe<k>:STATe <State>

This command turns a frequency line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:FLIN2:STAT ON`
Turns frequency line 2 on.

CALCulate<n>:TLINe<Line> <Time>

This command defines the position of a time line.

Parameters:

<Time> Note that you can not set a time line to a position that is higher than the current sweep time.

Range: 0 s to 1600 s
*RST: (STATe to OFF)

Example: `CALC:TLIN 10ms`
Sets the first time line to 10 ms.

Manual control: See "Vertical Line 1/2" on page 354

CALCulate<n>:TLINe<Line>:STATe <State>

This command turns a time line on and off

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:TLIN:STAT ON`
Turns the first time line on.

10.6.4.2 Defining Limit Checks

Note that in remote control, upper and lower limit lines are configured using separate commands. Thus, you must decide in advance which you want to configure. The x-values for both upper and lower limit lines are defined as a common control line. This control line is the reference for the y-values for both upper and lower limit lines.

Configuring Limit Lines

CALCulate:LIMit:COMMent <Comment>

This command defines a comment for a limit line.

Parameters:

<Comment> String containing the description of the limit line. The comment may have up to 40 characters.

Manual control: See "Comment" on page 358

CALCulate:LIMit<k>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a lower limit line.

Parameters:

<LimitLinePoints> Variable number of x-axis values.
Note that the number of horizontal values has to be the same as the number of vertical values set with `CALCulate:LIMit<k>:LOWer[:DATA]` or `CALCulate:LIMit<k>:UPPer[:DATA]`. If not, the R&S FSW either adds missing values or ignores surplus values.
The unit is Hz or s.
*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 359

CALCulate:LIMit<k>:CONTrol:DOMain <SpanSetting>

This command selects the domain of the limit line.

Parameters:

<SpanSetting> FREQuency | TIME
*RST: FREQuency

Manual control: See "X-Axis" on page 359

CALCulate<n>:LIMit<k>:CONTrol:MODE <Mode>

This command selects the horizontal limit line scaling.

Parameters:

<Mode> **ABSolute**
Limit line is defined by absolute physical values (Hz or s).

RELative
Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

*RST: ABSolute

CALCulate:LIMit<k>:CONTrol:OFFSet <Offset>

This command defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Parameters:

<Offset> Numeric value.
The unit depends on the scale of the x-axis.

*RST: 0

Manual control: See "X-Offset" on page 356

CALCulate:LIMit<k>:CONTrol:SHIFt <Distance>

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Numeric value.
The unit depends on the scale of the x-axis.

Manual control: See "Shift x" on page 360

CALCulate:LIMit<k>:CONTrol:SPACing <InterpolMode>

This command selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Parameters:

<InterpolMode> LINear | LOGarithmic

*RST: LIN

Example: `CALC:LIM:CONT:SPAC LIN`

CALCulate:LIMit<k>:LOWer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of a lower limit line.

Parameters:

<LimitLinePoints> Variable number of level values.

Note that the number of vertical values has to be the same as the number of horizontal values set with CALCulate:LIMit<k>:CONTrol[:DATA]. If not, the R&S FSW either adds missing values or ignores surplus values.

The unit depends on CALCulate:LIMit<k>:UNIT on page 750.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 359

CALCulate:LIMit<k>:LOWer:MARGin <Margin>

This command defines an area around a lower limit line where limit check violations are still tolerated.

Parameters:

<Margin> **numeric value**

*RST: 0

Default unit: dB

Manual control: See "Margin" on page 359

CALCulate:LIMit<k>:LOWer:MODE <Mode>

This command selects the vertical limit line scaling.

Parameters:

<Mode> **ABSolute**

Limit line is defined by absolute physical values.

The unit is variable.

RELative

Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual control: See "X-Axis" on page 359

CALCulate:LIMit<k>:LOWer:OFFSet <Offset>

This command defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Parameters:

<Offset> Numeric value.

*RST: 0
Default unit: dB

Manual control: See "Y-Offset" on page 357

CALCulate:LIMit<k>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Defines the distance that the limit line moves.
The unit depends on `CALCulate:LIMit<k>:UNIT` on page 750.

Manual control: See "Shift y" on page 360

CALCulate:LIMit<k>:LOWer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Parameters:

<InterpolType> LINear | LOGarithmic

*RST: LIN

Manual control: See "X-Axis" on page 359
See "Y-Axis" on page 359

CALCulate:LIMit<k>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate:LIMit<k>:NAME` on page 750.

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual control: See "Visibility" on page 356

CALCulate:LIMit<k>:LOWer:THReshold <Threshold>

This command defines a threshold for relative limit lines.

The R&S FSW uses the threshold for the limit check, if the limit line violates the threshold.

Parameters:

<Threshold> Numeric value.
The unit depends on CALCulate:LIMit<k>:UNIT on page 750.
*RST: -200 dBm

Manual control: See "Threshold" on page 358

CALCulate:LIMit<k>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Parameters:

<Name> String containing the limit line name.
*RST: REM1 to REM8 for lines 1 to 8

Manual control: See "Name" on page 358

CALCulate:LIMit<k>:UNIT <Unit>

This command defines the unit of a limit line.

Parameters:

<Unit> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | (unitless)
If you select dB as the limit line unit, the command automatically turns the limit line into a relative limit line.
*RST: DBM

Manual control: See "Y-Axis" on page 359

CALCulate:LIMit<k>:UPPer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of an upper limit line.

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with CALCulate:LIMit<k>:CONTrol[:DATA]. If not, the R&S FSW either adds missing values or ignores surplus values.
The unit depends on CALCulate:LIMit<k>:UNIT on page 750.
*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 359

CALCulate:LIMit<k>:UPPer:MARGin <Margin>

This command defines an area around an upper limit line where limit check violations are still tolerated.

Parameters:

<Margin> **numeric value**

*RST: 0
Default unit: dB

Manual control: See "Margin" on page 359

CALCulate:LIMit<k>:UPPer:MODE <Mode>

This command selects the vertical limit line scaling.

Parameters:

<Mode> **ABSolute**
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual control: See "X-Axis" on page 359

CALCulate:LIMit<k>:UPPer:OFFSet <Offset>

This command defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Parameters:

<Offset> Numeric value.

*RST: 0
Default unit: dB

Manual control: See "Y-Offset" on page 357

CALCulate:LIMit<k>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Defines the distance that the limit line moves.
The unit depends on `CALCulate:LIMit<k>:UNIT` on page 750.

Usage: Event

Manual control: See "Shift y" on page 360

CALCulate:LIMit<k>:UPPer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Parameters:

<InterpolType> LINear | LOGarithmic

*RST: LIN

Manual control: See "X-Axis" on page 359
See "Y-Axis" on page 359

CALCulate:LIMit<k>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate:LIMit<k>:NAME` on page 750.

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual control: See "Visibility" on page 356

CALCulate:LIMit<k>:UPPer:THReshold <Limit>

This command defines an absolute limit for limit lines with a relative scale.

The R&S FSW uses the threshold for the limit check, if the limit line violates the threshold.

Parameters:

<Limit> Numeric value.
The unit depends on `CALCulate:LIMit<k>:UNIT` on page 750.

*RST: -200
Default unit: dBm

Manual control: See "Threshold" on page 358

Managing Limit Lines

CALCulate:LIMit:ACTive?

This command queries the names of all active limit lines.

Return values:

<LimitLines> String containing the names of all active limit lines in alphabetical order.

Example: `CALC:LIM:ACT?`
Queries the names of all active limit lines.

Usage: Query only

Manual control: See "Visibility" on page 356

CALCulate:LIMit<k>:COPY <Line>

This command copies a limit line.

Parameters:

<Line> **1 to 8**
number of the new limit line

<name>
String containing the name of the limit line.

Example: `CALC:LIM1:COPY 2`
Copies limit line 1 to line 2.
`CALC:LIM1:COPY 'FM2'`
Copies limit line 1 to a new line named FM2.

Manual control: See "Copy Line" on page 357

CALCulate:LIMit<k>:DELete

This command deletes a limit line.

Usage: Event

Manual control: See "Delete Line" on page 357

CALCulate:LIMit<k>:TRACe <TraceNumber>

This command links a limit line to one or more traces.

Parameters:

<TraceNumber> 1 to 6
*RST: 1

Example: `CALC:LIM2:TRAC 3`
Assigns limit line 2 to trace 3.

Manual control: See "Traces to be Checked" on page 356

Checking the Results of a Limit Check

CALCulate:LIMit:CLEar[:IMMediate]

This command deletes the result of the current limit check.

The command works on all limit lines in all measurement windows at the same time.

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

Usage: SCPI confirmed

CALCulate<n>:LIMit<k>:FAIL

This command queries the result of a limit check.

Note that for SEM measurements, the limit line suffix <k> is irrelevant, as only one specific SEM limit line is checked for the currently relevant power class.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 509.

Return values:
<Result>
0
PASS

1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC:LIM3:FAIL?`
Queries the result of the check for limit line 3.

Usage: SCPI confirmed

Manual control: See "Spectrum Emission Mask" on page 34
See "Limit Check 1-4" on page 107
See "Limit Check" on page 134

CALCulate:LIMit<k>:STATe <State>

This command turns the limit check on and off.

To query the limit check result, use `CALCulate<n>:LIMit<k>:FAIL`.

Parameters:
<State> ON | OFF

*RST: OFF

Example: `CALC:LIM:STAT ON`
Switches on the limit check for limit line 1.

Usage: SCPI confirmed

Manual control: See "Disable All Lines" on page 357

10.7 Managing Settings and Results

The commands required to store and load instrument settings and import and export measurement results in a remote environment are described here. The tasks for manual operation are described in chapter 7, "Data Management", on page 364.

Addressing drives

The various drives can be addressed via the "mass storage instrument specifier" <msis> using the conventional Windows syntax. The internal hard disk is addressed by "C:". For details on storage locations refer to chapter 7.2.2.2, "Storage Location and File Name", on page 369.

The file names (<FileName> parameter) are given as string parameters enclosed in quotation marks. They also comply with Windows conventions. Windows file names do not distinguish between uppercase and lowercase notation.

Wildcards

The two characters "*" and "?" can be used as "wildcards", i.e., they are variables for a selection of several files. The question mark "?" replaces exactly one character, the asterisk replaces any of the remaining characters in the file name. "*.*" thus means all files in a directory.

Path names

Storage locations can be specified either as absolute (including the entire path) or relative paths (including only subfolders of the current folder). Use the `MMEM:CDIR?` query to determine the current folder.

10.7.1 General Data Storage and Loading Commands

See also:

- `FORMat[:DATA]` on page 702

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual control: See "Saving the Evaluation List" on page 115
See "Saving the Evaluation List" on page 136
See "Decimal Separator" on page 300
See "Exporting the Peak List" on page 345

MMEMory:CATalog?

This command returns the contents of a particular directory.

Query parameters:

<Path> String containing the path and directory.
If you leave out the path, the command returns the contents of the directory selected with `MMEMory:CDIRectory`.
The path may be relative or absolute. Using wildcards ('*') is possible to query a certain type of files only.

Return values:

<FileNames> List of file and directory names, separated by commas

Example: `MMEM:CAT? 'C:\R_S\Instr\user\SPOOL?.PNG'`
Returns all files in C:\R_S\Instr\user whose names start with SPOOL, have 6 letters and the extension ".PNG", e.g.:
`SPOOL1.PNG,SPOOL2.PNG,SPOOL3.PNG`

Usage: Query only
SCPI confirmed

Manual control: See "Selecting the Storage Location - Drive/ Path/ Files" on page 113

MMEMory:CATalog:LONG? <Path>

This command returns the contents of a particular directory with additional information about the files.

Query parameters:

<Path> String containing the path and directory.
If you leave out the path, the command returns the contents of the directory selected with `MMEMory:CDIRectory`.
The path may be relative or absolute. Using wildcards ('*') is possible to query a certain type of files only.

Return values:

<UsedDiskSpace> Byte size of all files in the directory.

<FreeDiskSpace> Remaining disk space in bytes.

<FileInfo> <NameFileN>,<SuffixFileN>,<SizeFileN>
Describes the individual file.
<NameFileN>
Name of the file.
<SuffixFileN>
Type of the file. Possible suffixes are: ASCii, BINary, DIRectory, STAT
<SizeFileN>
Size of the file in bytes.

Usage: Query only

MMEMory:CDIRectory <Directory>

This command changes the current directory.

Parameters:

<Directory> String containing the path to another directory.
The path may be relative or absolute.

Usage: SCPI confirmed

MMEMory:COMMent <Comment>

This command defines a comment for the stored settings.

Parameters:

<Comment> String containing the comment.

Example:

```
MMEMory:COMMent "ACP measurement with Standard Tetra from 23.05."
MMEMory::MMEMory:STORe1:STATe 1, "ACP_T"
```

As a result, in the selection list for recall settings, the comment `"ACP measurement with Standard Tetra from 23.05."` is added to the ACP entry.

Manual control: See "Comment" on page 371

MMEMory:COPY <SourceFile>,<DestinationFile>

This command copies one or more files to another directory.

Parameters:

<SourceFile> String containing the path and file name of the source file.

<DestinationFile> String containing the path and name of the target file.
The path may be relative or absolute.

Usage: SCPI confirmed

MMEMory:DATA <FileName>, [<Block>]

This command writes block data into a file. The delimiter must be set to EOI to obtain error-free data transfer.

When you query the contents of a file, you can save them in a file on the remote control computer.

The command is useful for reading stored settings files or trace data from the instrument or for transferring them to the instrument.

Parameters:

<FileName> String containing the path and name of the target file.

<Block> Data block with the following structure.
#
Hash sign.
<number>
Length of the length information.
<number>
Length information of the binary data (number of bytes).
<data>
Binary data with the indicated <number> of bytes.

Example: `MMEM:NAME '\Public\User\Testfile.txt'`
Creates a new file called 'testfile.txt'.
`MMEM:DATA 'Testfile.txt',#220Contents of the file`
The parameter means:
#2: hash sign and length of the length information (20 bytes = 2 digits)
20: indicates the number of subsequent binary data bytes.
Contents of the file: store 20 binary bytes (characters) to the file.

Usage: SCPI confirmed

MMEMory:DELete <FileName>

This command deletes a file.

Parameters:
<FileName> String containing the path and file name of the file to delete.
The path may be relative or absolute.

Usage: Event
SCPI confirmed

MMEMory:MDIRectory <Directory>

This command creates a new directory.

Parameters:
<Directory> String containing the path and new directory name
The path may be relative or absolute.

Usage: Event

MMEMory:MOVE <SourceFile>,<NewFileName>

This command moves a file to another directory.

The command also renames the file if you define a new name in the target directory.

If you do not include a path for <NewFileName>, the command just renames the file.

Parameters:
<SourceFile> String containing the path and file name of the source file.

<NewFileName> String containing the path and name of the target file.

Example: `MMEM:MOVE 'C:\TEST01.CFG','SETUP.CFG'`
Renames TEST01.CFG in SETUP.CFG in directory C:\.

Usage: Event
SCPI confirmed

MMEMory:MSIS <Device>

This command selects the default storage device used by all MMEMory commands.

Parameters:

<Device>	'A:' | 'C:' | … | 'Z:' String containing the device drive name *RST: 'C:'
Usage:	SCPI confirmed

MMEMory:NAME <FileName>

This command creates a new and empty file.

It also sets the file name for screenshots taken with `HCOPy[:IMMediate<device>]` on page 771. Note that you have to route the printer output to a file.

Parameters:

<FileName>	String containing the path and name of the target file.
Example:	`MMEM:NAME 'C:\R_S\instr\user\PRINT1.BMP'` Selects the file name.
Usage:	Event SCPI confirmed

MMEMory:NETWork:DISConnect <Drive>

This command disconnects a network drive.

Parameters:

<Drive>	String containing the drive name.
Usage:	Event

MMEMory:NETWork:MAP <Drive>, <HostName> [, <UserName>, <Password>][, <Reconnect>]

This command maps a drive to a server or server directory of the network.

Note that you have to allow sharing for a server or folder in Microsoft networks first.

Parameters:

<Drive>	String containing the drive name or path of the directory you want to map.
<HostName>	String containing the host name of the computer or the IP address and the share name of the drive. '<\host name or IP address\share name>'
<UserName>	String containing a user name in the network. The user name is optional.

<Password> String containg the password corresponding to the <UserName>. The password is optional.

<Reconnect> ON | OFF

ON
Reconnects at logon with the same user name.

OFF
Doe not reconnect at logon.

Usage: Event

MMEMory:NETWork:UNUSeddrives?

This command returns a list of unused network drives.

Return values:
<DriveName> List of network drives in alphabetically descending order, e.g. 'W:,V:,U:,...'

Usage: Query only

MMEMory:NETWork:USEDdrives? <State>

This command returns a list of all network drives in use.

Parameters:
<State> You do not have to use the parameter. If you do not include the parameter, the command returns a list of all drives in use.
This is the same behavior as if you are using the parameter OFF.

ON
Returns a list of all drives in use including the folder information.

OFF
Returns al list of all drives in use.

Usage: Query only

MMEMory:RDIRectory <Directory>

This command deletes the indicated directory.

Parameters:
<Directory> String containing the path of the directory to delete.
Note that the directory you want to remove may contain no contents.

Usage: Event

10.7.2 Selecting the Items to Store

The following commands select the items to be included in the configuration file.

Depending on the used command, either the items from the entire instrument (`MMEMory:SELect[:ITEM]...`), or only those from the currently selected channel (`MMEM:SELect:CHANnel[:ITEM]...`) are stored.

MMEMory:SELect:CHANnel[:ITEM]:ALL
MMEMory:SELect[:ITEM]:ALL

This command includes all items when storing or loading a configuration file.

The items are:

- Hardware configuration: `MMEMory:SELect[:ITEM]:HWSettings`
- Limit lines: `MMEMory:SELect[:ITEM]:LINes:ALL`
- Spectrogram data: `MMEMory:SELect[:ITEM]:SGRam`
- Trace data: `MMEMory:SELect[:ITEM]:TRACe[:ACTive]`
- Transducers: `MMEMory:SELect[:ITEM]:TRANsducer:ALL`

Example: `MMEM:SEL:ALL`

Usage: Event

Manual control: See "Items" on page 371

MMEMory:SELect:CHANnel[:ITEM]:DEFault
MMEMory:SELect[:ITEM]:DEFault

This command selects the current settings as the only item to store to and load from a configuration file.

Manual control: See "Items" on page 371

MMEMory:SELect:CHANnel[:ITEM]:HWSettings <State>
MMEMory:SELect[:ITEM]:HWSettings <State>

This command includes or excludes hardware settings when storing or loading a configuration file.

Hardware settings include:

- general instrument configuration
- measurement hardware configuration including markers
- limit lines
  Note that a configuration may include no more than 8 limit lines. This number includes active limit lines as well as inactive limit lines that were used last.
  Therefore the combination of inactivate limit lines depends on the sequence of use with `MMEMory:LOAD:STATe`.
- color settings
- configuration for the hardcopy output

Parameters:

<State> ON | OFF

*RST: ON

Example: `MMEM:SEL:HWS ON`

Manual control: See "Items" on page 371

MMEMory:SELect:CHANnel[:ITEM]:LINes:ALL <State>
MMEMory:SELect[:ITEM]:LINes:ALL <State>

This command includes or excludes all limit lines (active and inactive) when storing or loading a configuration file.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `MMEM:SEL:LIN:ALL ON`

Manual control: See "Items" on page 371

MMEMory:SELect:CHANnel[:ITEM]:NONE
MMEMory:SELect[:ITEM]:NONE

This command does not include any of the following items when storing or loading a configuration file.

- Hardware configuration: `MMEMory:SELect[:ITEM]:HWSettings`
- Limit lines: `MMEMory:SELect[:ITEM]:LINes:ALL`
- Trace data: `MMEMory:SELect[:ITEM]:TRACe[:ACTive]`
- Transducers: `MMEMory:SELect[:ITEM]:TRANsducer:ALL`

Example: `MMEM:SEL:NONE`

Usage: Event

Manual control: See "Items" on page 371

MMEMory:SELect:CHANNel[:ITEM]:SGRam <boolean>
MMEMory:SELect[:ITEM]:SGRam <boolean>

This command includes or excludes spectrogram data when storing or loading a configuration file.

Parameters:

<State> **ON | OFF**

*RST: OFF

Example: `MMEM:SEL:SGR ON`
Adds the spectrogram data to the list of data subsets.

MMEMory:SELect:CHANNel[:ITEM]:TRACe[:ACTive] <State>
MMEMory:SELect[:ITEM]:TRACe[:ACTive] <State>

This command includes or excludes trace data when storing or loading a configuration file.

Parameters:

<State> ON | OFF

*RST: OFF, i.e. no traces is stored

Example: `MMEM:SEL:TRAC ON`

Manual control: See "Items" on page 371

MMEMory:SELect:CHANNel[:ITEM]:TRANsducer:ALL <State>
MMEMory:SELect[:ITEM]:TRANsducer:ALL <State>

This command includes or excludes transducer factors when storing or loading a configuration file.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `MMEM:SEL:TRAN:ALL ON`

Manual control: See "Items" on page 371
See "Save" on page 397

10.7.3 Storing and Loading Instrument Settings

See also:

- `INSTrument[:SELect]` on page 502 to select the channel.

MMEMory:CLEar:ALL

This command deletes all instrument configuration files in the current directory.

You can select the directory with `MMEMory:CDIRectory`.

Example: `MMEM:CLE:ALL`

Usage: Event

MMEMory:CLEar:STATe 1,<FileName>

This command deletes a instrument configuration file.

Parameters:
1

<FileName> String containing the path and name of the file to delete.
The string may or may not contain the file's extension.

Example: `MMEM:CLE:STAT 1,'TEST'`

Usage: Event

MMEMory:LOAD:AUTO 1, 'Factory' | <FileName>

This command restores an instrument configuration and defines that configuration as the default state.

The default state is restored after a preset (`*RST`) or after you turn on the R&S FSW.

Parameters:
1

'Factory' | <FileName>

'Factory'
Restores the factory settings as the default state.

'<file_name>
String containing the path and name of the configuration file.
Note that only *instrument* settings files can be selected for the startup recall function; channel settings files cause an error.

Example: `MMEM:LOAD:AUTO 1,'C:\R_S\Instr\user\TEST'`

Usage: Event

Manual control: See "Startup Recall" on page 373

MMEMory:LOAD:STATe 1, <FileName>

This command restores and activates an instrument configuration stored in a `*.dfl` file.

Note that files with other formats cannot be loaded with this command.

Parameters:
1

<FileName> String containing the path and name of the file to delete.
The string may or may not include the file's extension.

Example: `MMEM:LOAD:STAT 1,'C:\R_S\Instr\user\TEST01'`

Usage: SCPI confirmed

Manual control: See "Recall" on page 368
See "Recall in New Channel / Recall in Current Channel" on page 371

MMEMory:LOAD:TYPE:[CHANnel] <Mode>

This command defines whether the channel-specific settings that will be loaded with the subsequent `MMEM:LOAD:STAT` command will replace the current channel or activate a new channel.

Parameters:
<Mode> NEW | REPLace

NEW
The loaded settings will be activated in a new channel.

REPLace
The loaded settings will replace the currently active channel.

*RST: NEW

Example:
`INST:SEL 'SPECTRUM2'`
Selects measurement channel `'SPECTRUM2'`.
`MMEM:STOR:TYP CHAN`
Specifies that channel-specific data is to be stored.
`MMEM:STOR:STAT 1, 'C:\R_S\Instr\user\Spectrum'`
Stores the settings from channel `'SPECTRUM2'` to the file `'C:\R_S\Instr\user\Spectrum'`.
`MMEM:LOAD:TYP NEW`
Specifies that channel-specific settings are to be activated in a new channel.
`MMEM:LOAD:STAT 1, 'C:\R_S\Instr\user\Spectrum'`
Loads the channel-specific settings from the file `'C:\R_S\Instr\user\Spectrum'` to the new channel `'SPECTRUM2*'`.

MMEMory:STORe:STATe 1,<FileName>

This command saves the current instrument configuration in a *.dfl file.

Parameters:

1

<FileName>	String containing the path and name of the target file. The file extension is .dfl.
Example:	`MMEM:STOR:STAT 1,'Save'` Saves the current device settings in the file `Save.dfl`.
Usage:	Event SCPI confirmed
Manual control:	See "Save File" on page 371 See "Save" on page 397

MMEMory:STORe:STATe:NEXT

This command saves the current instrument configuration in a *.dfl file.

The file name depends on the one you have set with `MMEMory:STORe:STATe`. This command adds a consecutive number to the file name.

Example:	`MMEM:STOR:STAT 1,'Save'`
	Saves the current device settings in the file `Save.dfl`.
	`MMEM:STOR:STAT:NEXT`
	Saves the current device settings in the file `Save_001.dfl`
	`MMEM:STOR:STAT:NEXT`
	Saves the current device settings in the file `Save_002.dfl`

Usage:	Event
Manual control:	See "Save File" on page 371

MMEMory:STORe:TYPe <Mode>

This command defines whether the data from the entire instrument or only from the current channel is stored with the subsequent `MMEM:STOR`... command.

Parameters:

<Mode>	INSTrument | CHANnel *RST: INST

Example:	`INST:SEL 'SPECTRUM2'`
	Selects measurement channel `'SPECTRUM2'`.
	`MMEM:STOR:TYP CHAN`
	Specifies that channel-specific data is to be stored.
	`MMEM:STOR:PEAK 'SpectrumPeaks'`
	Stores the peak list from channel `'SPECTRUM2'` to the file `'SpectrumPeaks'`.

SYSTem:PRESet

This command presets the R&S FSW.

Example: `SYST:PRES`

Usage: Event
SCPI confirmed

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

For details see chapter 7.1.1, "Factory Default Configuration", on page 365.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual control: See "Preset Channel" on page 182

10.7.4 Storing or Printing Screenshots

Useful commands to configure screenshots described elsewhere

- `MMEMory:NAME` on page 760

Remote commands exclusive to configure screenshots

HCOPy:ABORt

This command aborts a running hardcopy output.

Example: `HCOP:ABOR`

Usage: Event
SCPI confirmed

HCOPy:CMAP<item>:DEFault<colors>

This command defines the color scheme for print jobs.

Suffix:

<item>
Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

<colors>
1...4
1
Current colors with a white background and a black grid.
2
Optimized colors.
3
Customized colors.
4
Current screen colors (setting for hardcopies).

Example: `HCOP:CMAP:DEF2`
Selects the optimized color set for the color settings of a printout or a hardcopy.

Usage: Event

Manual control: See "Print colors" on page 417

HCOPy:CMAP<item>:HSL <Color>

This command selects the color for various screen elements in print jobs.

Suffix:

<item>
Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

Parameters:

<Color>
hue
tint

sat
saturation

lum
brightness

The value range is 0 to 1 for all parameters.

Example: `HCOP:CMAP2:HSL 0.3,0.8,1.0`
Changes the grid color

Manual control: See "Defining User-specific Colors" on page 418

HCOPy:CMAP<item>:PDEFined <Color>

This command selects a predefined color for various screen elements in print jobs.

Suffix:
<item>
Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

Parameters:
<Color>
BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRAy | LGRAy | LBLUe | LGREen | LCYan | LRED | LMAGenta

Example: `HCOP:CMAP2:PDEF GRE`

Manual control: See "Modifying User-Defined Colors" on page 417
See "Predefined Colors" on page 418

HCOPy:DESTination<device> <Destination>

This command selects the destination of a print job.

Suffix:
<device>
1 | 2
Printing device.

Parameters:
<Destination>

'MMEM'
Sends the hardcopy to a file.
You can select the file name with `MMEMory:NAME`.
You can select the file format with `HCOPy:DEVice:LANGuage<device>`.

'SYST:COMM:PRIN'
Sends the hardcopy to a printer.
You can select the printer with `SYSTem:COMMunicate:PRINter:SELect<device>` .

'SYST:COMM:CLIP'
Sends the hardcopy to the clipboard.
The format should be WEMF.
*RST: 'SYST:COMM:CLIP'

Usage: SCPI confirmed

Manual control: See "Device" on page 385

HCOPy:DEVice:COLor <State>

This command turns color printing on and off.

Parameters:

<State>

ON
Color printing

OFF
Black and white printing

*RST: OFF

Example: `HCOP:DEV:COL ON`

Usage: SCPI confirmed

HCOPy:DEVice:LANGuage<device> <Format>

This command selects the file format for a print job.

Suffix:

<device>

1 | 2
Printing device.

Parameters:

<Format>

GDI
Graphics Device Interface.
Default format for the output to a printer configured under Windows. Must be selected for the output to the printer interface.
Can be used for the output to a file. The printer driver configured under Windows is used in this case and a printer-specific file format is thus generated.

BMP, JPG, PNG
Data format for output to files only.

Usage: SCPI confirmed

Manual control: See "Device Setup" on page 383
See "Output Medium" on page 384

HCOPy[:IMMediate<device>]

This command initiates a print job.

If you are printing to a file, the file name depends on `MMEMory:NAME`.

Suffix:

<device>

1 | 2
Printing device.

Usage: Event
SCPI confirmed

Manual control: See "Printing or Storing a Screenshot (Print Screen)" on page 383

HCOPy[:IMMediate<device>]:NEXT

This command initiates a print job.

If you are printing to a file, the file name depends on `MMEMory:NAME`. This command adds a consecutive number to the file name.

Suffix:

<device> 1 | 2
Printing device.

Usage: Event

Manual control: See "Printing or Storing a Screenshot (Print Screen)" on page 383

HCOPy:ITEM:ALL

This command includes all screen elements in the printout.

The screen elements include comments, title, time and date.

Usage: SCPI confirmed

Manual control: See "Printing or Storing a Screenshot (Print Screen)" on page 383

HCOPy:ITEM:WINDow:TEXT <Comment>

This command defines a comment to be added to the printout.

Parameters:

<Comment> String containing the comment.

Usage: SCPI confirmed

Manual control: See "Comment" on page 385

HCOPy:PAGE:ORIentation<device> <Orientation>

The command selects the format of the print job.

The command is only available if the output device is a printer.

Suffix:

<device> 1 | 2
Printing device.

Parameters:

<Orientation> LANDscape | PORTrait
*RST: PORTrait

Usage: SCPI confirmed

Manual control: See "Device Setup" on page 383
See "Orientation" on page 385

HCOPy:TDSTamp:STATe<device> <State>

This command includes or excludes the time and date in the printout.

Suffix:

<device> 1 | 2
Printing device.

Parameters:

<State> ON | OFF
*RST: OFF

SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?

This command queries the name of the first available printer.

To query the name of other installed printers, use SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]?.

Return values:

<PrinterName> String containing the name of the first printer as defined in Windows.
If the command cannot find a printer, it returns an empty string (' ').

Usage: Query only

Manual control: See "Device Setup" on page 383
See "Printer Name" on page 385

SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]?

This command queries the name of available printers.

You have to use SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt? for this command to work properly.

Return values:

<PrinterName> String containing the name of one printer as defined in Windows.
To get a complete list of printers you have to send this query several times until no more printers could be found. In that case, the return value is an empty string (' '). Further queries after the empty string result in an error.

Usage: Query only

Manual control: See "Device Setup" on page 383
See "Printer Name" on page 385

SYSTem:COMMunicate:PRINter:SELect<device> <PrinterName>

This command selects the printer that processes jobs sent by the R&S FSW.

Use HCOPy:DESTination<device> to select another output destination.

Suffix:

<device> 1 | 2

Printing device.

Parameters:

<PrinterName> String containing the printer name.

Use
- SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt? and
- SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]?

to query all available printers.

*RST: NONE

Manual control: See "Device Setup" on page 383

See "Printer Name" on page 385

10.7.5 Storing Measurement Results

The following commands can be used to store the results of a measurement.

Useful commands for storing results described elsewhere:

- FORMat[:DATA] on page 702

Remote commands exclusive to storing results:

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

See chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378 for details.

Parameters:

<State> ON | OFF

*RST: ON

Usage: SCPI confirmed

Manual control: See "Include Instrument Measurement Settings" on page 300

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see MMEMory:STORe<n>:TRACe on page 776).

For details on exporting data see chapter 6.3.2.3, "Trace Export Settings", on page 299.

Parameters:

<Selection>
: **SINGle**
Only a single trace is selected for export, namely the one specified by the MMEMory:STORe<n>:TRACe command.
ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the MMEMory:STORe<n>:TRACe command is ignored.
*RST: SINGle

Usage: SCPI confirmed

Manual control: See "Export all Traces and all Table Results" on page 300

MMEMory:STORe:LIST <FileName>

This command exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:LIST 'test'`
Stores the current list evaluation results in the `test.dat` file.

Manual control: See "Saving the Evaluation List" on page 115
See "Saving the Evaluation List" on page 136
See "Exporting the Peak List" on page 345

MMEMory:STORe:PEAK <FileName>

This command exports the marker peak list to a file.

The file format is *.dat.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:PEAK 'test'`
Saves the current marker peak list in the file `test.dat`.

Usage: Event

MMEMory:STORe:SGRam <FileName>

This command exports spectrogram data to an ASCii file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Parameters:

<FileName>	String containing the path and name of the target file.
Example:	`MMEM:STOR:SGR 'Spectrogram'` Copies the spectrogram data to a file.
Manual control:	See "Export Trace to ASCII File" on page 301 See "Export" on page 376

MMEMory:STORe:SPURious <FileName>

This command exports the marker peak list available for spurious emission measurements to a file.

Parameters:

<FileName>	String containing the path and name of the target file.
Example:	`MMEM:STOR:SPUR 'test'` Saves the current marker peak list in the file test.dat.
Usage:	Event

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

For details on the file format see chapter 7.3.4.1, "Reference: ASCII File Export Format", on page 378.

Parameters:

<Trace>	Number of the trace to be stored (This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see `FORMat:DEXPort:TRACes` on page 775).
<FileName>	String containing the path and name of the target file.
Example:	`MMEM:STOR1:TRAC 3,'TEST.ASC'` Stores trace 3 from window 1 in the file `TEST.ASC`.
Usage:	SCPI confirmed
Manual control:	See "Export Trace to ASCII File" on page 301 See "Export" on page 376

10.7.6 Examples: Managing Data

10.7.6.1 Storing Data

```
MMEM:MSIS 'C:'
//Selects drive C: as the default storage device.
-----Connecting a network drive--------
MMEM:NETW:USED?
//Returns a list of all drives in use in the network.
MMEM:NETW:UNUS?
//Returns a list of free drive names in the network.
MMEM:NETW:MAP 'T:','Server\ACLRTest'
//Maps drive T: to the directory 'Server\ACLRTest'
-----Saving data on the instrument-----
MMEM:MDIR 'C:\R_S\INST\USER\ACLRTest'
//Creates a directory called 'ACLRTest' on drive C:
MMEM:NAME 'C:\R_S\INST\USER\Test001.txt'
//Creates a file called 'Test001.txt'
MMEM:COMM 'ACLR test results'
//Creates a comment for the file.
MMEM:DATA 'Test001.txt',#212FileContents
//Writes 12 characters to the file 'Test001.txt'
-----Copying the data to another location---
MMEM:COPY 'C:\R_S\INST\USER\Results\Test001.txt','T:'
//Copies the specified file to network drive T:.
MMEM:DEL 'C:\R_S\INST\USER\Results\Test001.txt'
//Deletes the specified file from the instrument hard disk.
//or
MMEM:MOVE 'C:\R_S\INST\USER\Results\Test001.xml','D:\TestResults.txt'//
//Moves the file 'Test001.txt' to drive T:, renames it to 'Testresults.txt'
//and removes it from the instrument hard disk.
MMEM:RDIR 'C:\R_S\INST\USER\Results'
//Deletes the directory called 'Results' from drive C:, unless it still contains any content.
-----Disconnecting the network drive---
MMEM:NETW:DISC 'T:'
//Disconnect drive T:.
```

10.7.6.2 Loading Data

```
MMEM:CDIR?
//Returns the path of the current directory.
//e.g.
```

```
C:\R_S\Instr\user\
MMEM:CDIR 'C:\R_S\INST\USER\Results'
//Changes the current directory.
MMEM:CAT? 'C:\R_S\INST\USER\Results\*.xml'
//or
MMEM:CAT? '*.xml'
//Returns a list of all xml files in the directory 'C:\R_S\INST\USER\Results'.
MMEM:CAT:LONG? '*.xml'
//Returns additional information about the xml files in the directory 'C:\R_S\INST\USER\Resul
```

10.7.6.3 Storing Instrument Settings

In this example we will store the instrument settings for the "Spectrum" channel.

```
INST:SEL 'SPECTRUM'
//Selects measurement channel 'SPECTRUM'.
MEMM:STOR:TYPE CHAN
//Specifies that channel-specific data is to be stored.
MMEM:STOR:STAT 1, 'C:\R_S\Instr\user\Spectrum'
//Stores the channel settings from the 'Spectrum' channel
// to the file 'Spectrum.dfl'.
```

10.7.6.4 Loading Instrument Settings

In this example we will load the hardware settings from the configuration file `Spectrum.dfl` to a new "Spectrum2" channel.

```
Folgende zeile hat maximale länge
0123456789012345678901234567890123456789012345678901234567890123456789012345678

MEMM:LOAD:TYPE NEW
//Specifies that settings will be loaded to a new channel besides the existing
//'Spectrum' channel.
MMEM:SEL:CHAN:HWS ON
//Selects only hardware settings to be loaded.
MMEM:LOAD:STAT 1, 'C:\R_S\Instr\user\Spectrum'
//Loads the channel-specific settings from the file 'C:\R_S\Instr\user\Spectrum.dfl'
//to a new channel. The new channel is named 'Spectrum2' to avoid a naming conflict
//with the existing 'Spectrum' channel.
INST:REN 'Spectrum2','Spectrum3'
//Renames the loaded channel to 'Spectrum3'.
```

10.7.6.5 Printing to a File

```
HCOP:DEST 'MMEM'
//Prints the data to a file.
HCOP:DEV:LANG BMP
//Selects bmp as the file format.
MMEM:NAME 'C:\R_S\INST\USER\Screenshot.bmp'
//Selects the file name for the printout.
```

```
HCOP:ITEM:ALL
//Prints all screen elements
HCOP:ITEM:WIND:TEXT 'ACLRResults'
//Adds a comment to the printout.
HCOP
//Stores the printout in a file called 'Screenshot.bmp'.
HCOP:NEXT
//Stores the printout in a file called 'Screenshot_001.bmp'.
```

10.7.6.6 Printing on a Printer

```
HCOP:DEST2 'SYST:COMM:PRIN'
//Prints the data on a printer.
SYST:COMM:PRIN:ENUM:FIRS?
SYST:COMM:PRIN:ENUM?
//Returns the available printers, e.g.
'LASER on LPT1'
''
//Means that one printer is available.
SYST:COMM:PRIN:SEL2 'LASER on LPT1'
//Selects the printer for the print job on device 2.
HCOP:PAGE:ORI2 LAND
//Selects the landscape format for the printout.
HCOP:TDST:STAT2 ON
//Includes date and time on the printout.
HCOP:ITEM:ALL
//Prints all screen elements
HCOP
//Initiates the printout.
```

10.8 Configuring the R&S FSW

The remote commands required to set up the R&S FSW are described here.

10.8.1 Basic Instrument Setup

SYSTem:CLOGging <State>

This command turns logging of remote commands on and off.

Parameters:

<State>

ON
Writes all remote commands that have been sent to a file.
The destination is `C:\R_S\instr\ScpiLogging\ScpiLog.txt`.

OFF

*RST: OFF

Manual control: See "I/O Logging" on page 469

SYSTem:SHUTdown

This command shuts down the R&S FSW.

Usage: Event

10.8.2 Configuring the Reference Frequency

[SENSe:]ROSCillator:O100 <State>

If enabled, a 100 MHz reference signal is provided to the REF OUTPUT 100 MHZ connector.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `ROSC:O100 ON`

Usage: SCPI confirmed

Manual control: See "Reference Frequency Output" on page 392

[SENSe:]ROSCillator:O640 <State>

If enabled, a 640 MHz reference signal is provided to the REF OUTPUT 640 MHZ connector.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

Example: `ROSC:O640 ON`

Usage: SCPI confirmed

Manual control: See "Reference Frequency Output" on page 392

SOURce:EXTernal:ROSCillator:EXTernal:FREQuency <Frequency>

This command defines the frequency of the external reference oscillator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Parameters:

<Frequency> Range: 1 MHz to 20 MHz

Example: `ROSC:EXT:FREQ 13MHZ`
Sets the frequency to 13 MHz.
`SOUR:EXT:ROSC:EXT:FREQ 13MHZ`

Manual control: See "Reference Frequency Input" on page 391

[SENSe:]ROSCillator:SOURce <Source>

This command selects the reference oscillator.

If you want to select the external reference, it must be connected to the R&S FSW.

Parameters:

<Source>

INTernal
the internal reference is used (10 MHz)

EXTernal
the external reference from REF INPUT 1..20 MHZ connector is used with a variable frequency; if none is available, an error flag is displayed in the status bar

E10
the external reference from REF INPUT 1..20 MHZ connector is used with a fixed 10 MHZ frequency; if none is available, an error flag is displayed in the status bar

E100
the external reference from REF INPUT 100 MHZ connector is used; if none is available, an error flag is displayed in the status bar

EAUTo
the external reference is used as long as it is available, then the instrument switches to the internal reference

SYNC
the external reference is used; if none is available, an error flag is displayed in the status bar

Example: `ROSC:SOUR EXT`

Usage: SCPI confirmed

Manual control: See "Reference Frequency Input" on page 391
See "Behavior in case of missing external reference" on page 391

[SENSe:]ROSCillator:SOURce:EAUTo?

This command queries the current reference type in case you have activated an automatic switch to the internal reference if the external reference is missing.

Parameters:

<Reference>

INT
internal reference

EXT
external reference

Example: `SENS:ROSC:SOUR:EAUT?`
Queries the currently available reference type.

Usage: Query only

Manual control: See "Reference Frequency Input" on page 391
See "Behavior in case of missing external reference" on page 391

[SENSe:]ROSCillator:SYNC <State>

If enabled, a 100 MHz reference signal is provided to the SYNC TRIGGER OUTPUT connector.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `ROSC:SYNC ON`

Usage: SCPI confirmed

Manual control: See "Reference Frequency Output" on page 392

10.8.3 Calibration and Temperature Checks

The following commands control calibration and temperature checks on the R&S FSW.

DIAGnostic:SERVice:INPut:MC:DISTance <Bandwidth>

This command selects the distance of the peaks of the microwave calibration signal for calibration of the YIG filter.

Parameters:

<Bandwidth> **SMALl**
Small offset of combline frequencies.

WIDE
Wide offset of combline frequencies.

Manual control: See "Calibration Frequency MW" on page 407

DIAGnostic:SERVice:INPut:PULSed:CFRequency <Frequency>

This command defines the frequency of the calibration signal.

Before you can use the command, you have to feed in a calibration signal with `DIAGnostic:SERVice:INPut[:SELect]`.

Parameters:

<Frequency>
Possible frequencies of the calibration signal are fix.
If you define a frequency that is not available, the R&S FSW uses the next available frequency. Example: a frequency of 20 MHz is rounded up to the next available frequency (21.33 MHz).
*RST: 64 MHz
Default unit: Hz

Manual control: See "Calibration Frequency RF" on page 406

DIAGnostic:SERVice:INPut:RF:SPECtrum <Bandwidth>

This command selects the bandwidth of the calibration signal.

Parameters:

<Bandwidth>
NARRowband
Narrowband signal for power calibration of the frontend.
BROadband
Broadband signal for calibration of the IF filter.

Manual control: See "Calibration Frequency RF" on page 406
See "Spectrum" on page 406

DIAGnostic:SERVice:INPut[:SELect] <Signal>

This command selects if the R&S FSW feeds in the signal from the RF input or the calibration signal.

Parameters:

<Signal>
CALibration
Feeds in the calibration signal.
MCALibration
Feeds in the calibration signal for the microwave range.
RF
Feeds in the signal from the RF input.
*RST: RF

Example:
```
DIAG:SERV:INP CAL
```
Feeds in the the calibration signal.

Manual control: See "None" on page 406

DIAGnostic:SERVice:STESt:RESult?

This command queries the self test results.

Return values:

<Results>
String of data containing the results.
The rows of the self test result table are separated by commas.

Example: `DIAG:SERV:STES:RES?`
would return, e.g.
`"Total Selftest Status: PASSED", "Date (dd/mm/yyyy): 09/07/2004 TIME: 16:24:54", "Runtime: 00:06", "...`

Usage: Query only

SOURce:TEMPerature:FRONtend?

This command queries the current frontend temperature of the R&S FSW.

During self-alignment, the instrument's (frontend) temperature is also measured (as soon as the instrument has warmed up completely). This temperature is used as a reference for a continuous temperature check during operation. If the current temperature deviates from the stored self-alignment temperature by a certain degree, a warning is displayed in the status bar indicating the resulting deviation in the measured power levels. A status bit in the `STATUs:QUEStionable:TEMPerature` register indicates a possible deviation.

Return values:
<Temperature> Temperature in degrees Celsius.

Example: `SOUR:TEMP:FRON?`
Queries the temperature of the frontend sensor.

Usage: Query only

10.8.4 Working with Transducers

The following commands configure and control transducer factors.

Useful commands for transducer managament described elsewhere

- `MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 764

Remote commands exclusive to transducer management

[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] <State>

This command turns an automatic adjustment of the reference level to the transducer on and off.

Before you can use the command, you have to select and turn on a transducer.

Parameters:

<State> ON | OFF
*RST: OFF

Manual control: See "Adjusting the Reference Level" on page 395

[SENSe:]CORRection:TRANsducer:COMMent <Comment>

This command defines the comment for the selected transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:

<Comment> *RST: (empty comment)

Manual control: See "Comment" on page 396

[SENSe:]CORRection:TRANsducer:DATA <Frequency>,<Level>

This command defines the shape of the transducer factor.

Parameters:

<Frequency>, <Level> The unit for <Frequency> is Hz. Frequencies have to be sorted in ascending order.
The unit for <Level> depends on `[SENSe:]CORRection:TRANsducer:UNIT`.

Manual control: See "Data points" on page 397

[SENSe:]CORRection:TRANsducer:DELete

This command deletes the currently selected transducer factor.

Before you can use the command, you have to select a transducer.

Example: `CORR:TRAN:DEL`

Usage: Event

Manual control: See "Delete Line" on page 395

[SENSe:]CORRection:TRANsducer:SCALing <ScalingType>

This command selects the frequency scaling of the transducer factor.

Parameters:

<ScalingType> LINear | LOGarithmic
*RST: LINear

Manual control: See "X-Axis Scaling" on page 397

[SENSe:]CORRection:TRANsducer:SELect <Name>

This command selects a transducer factor.

Parameters:

<Name> String containing the name of the transducer factor.
If the name does not exist yet, the R&S FSW creates a transducer factor by that name.

Example: `CORR:TRAN:SEL 'FACTOR1'`

Manual control: See "Activating/Deactivating" on page 394
See "Create New Line" on page 395
See "Name" on page 396

[SENSe:]CORRection:TRANsducer[:STATe] <State>

This command turns the selected transducer factor on or off.

Before you can use the command, you have to select a transducer.

Parameters:

<State> ON | OFF
*RST: OFF

Manual control: See "Activating/Deactivating" on page 394

[SENSe:]CORRection:TRANsducer:UNIT <Unit>

This command selects the unit of the transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:

<Unit> string as defined in table below
*RST: DB

Example: `CORR:TRAN:UNIT 'DBUV'`

Manual control: See "Unit" on page 396

String	Unit
'DB'	dB
'DBM'	dBm
'DBMV'	dBmV
'DBUV'	dBµV
'DBUV/M'	dBµV/m
'DBUA'	dBµA
'DBUA/M'	dBµA/m

String	Unit
'DBPW'	dBpW
'DBPT'	dBpT

10.8.5 Customizing the Screen Layout

The remote commands required to set up the display of the R&S FSW are described here.

10.8.5.1 General Display Settings and Items

The following commands add, remove or customize general display and screen elements.

Useful commands for general display settings described elsewhere

- `DISPlay:MTABle` on page 710

Remote commands exclusive to general display settings

DISPlay:ANNotation:FREQuency <State>

This command turns the label of the x-axis on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DISP:ANN:FREQ OFF`

Usage: SCPI confirmed

Manual control: See "Diagram Footer (Annotation)" on page 414

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format> **SPLit**
Displays the MultiView tab with an overview of all active channels
(See chapter 3.1, "R&S MultiView", on page 19).

SINGle
Displays the measurement channel that was previously focused.

*RST: SPL

Example: `DISP:FORM SING`

DISPlay:PSAVe:HOLDoff <Minutes>

This command defines the time until the R&S FSW turns the display power save mode on.

Parameters:

<Minutes> Minutes until power save mode starts. Note that the number you enter may have no dimension.

Range: 1 to 100
*RST: 15

Example: `DISP:PSAV:HOLD 30`

Manual control: See "Display Power Save Function" on page 412

DISPlay:PSAVe[:STATe] <State>

This command turns the power save mode of the display on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP:PSAVe ON`
Switches on the power-save mode.

Manual control: See "Display Power Save Function" on page 412

DISPlay:SBAR[:STATe] <State>

This command turns the status bar on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DISP:SBAR:OFF`

Manual control: See "Status Bar" on page 413

DISPlay:SKEYs[:STATe] <State>

This command turns the softkey bar on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DISP:SKEY:OFF`

Manual control: See "Softkey Bar" on page 414

DISPlay:TBAR[:STATe] <State>

This command turns the toolbar on or off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP:TOOL ON`

Manual control: See "Toolbar" on page 413

DISPlay:TOUChscreen:STATe <State>

This command controls the touch screen functionality.

Parameters:

<State>

ON
Touch screen is active for entire screen

OFF
Touch screen is inactivate for entire screen

FRAMe
Touch screen is inactivate for the diagram area of the screen, but active for softkeys, toolbars and menus.

*RST: ON

Example: `DISP:TOUC:STAT ON`

Manual control: See "Deactivating and Activating the Touch Screen" on page 411

DISPlay[:WINDow]:TIME <State>

This command adds or removes the date and time from the display.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DISP:TIME ON`

Manual control: See "Date and Time" on page 414

DISPlay[:WINDow]:TIME:FORMat <Format>

This command selects the time and date format.

Parameters:

<Format>

DE
dd.mm.yyyy hh:mm:ss
24 hour format.

US
mm/dd/yyyy hh:mm:ss
12 hour format.

*RST: DE

Example:

```
DISP:TIME ON
```
Switches the screen display of date and time on.
```
DISP:TIME:FORM US
```
Switches the date and time format to US.

Manual control: See "Date and Time Format" on page 412

SYSTem:DISPlay:FPANel[:STATe] <State>

This command includes or excludes the front panel keys when working with the remote desktop.

Parameters:

<State> ON | OFF

*RST: ON

Manual control: See "Front Panel" on page 414
See "Mini Front Panel" on page 415

10.8.5.2 Colors and Themes

Useful commands to customize display colors described elsewhere

The HCOPY commands define the print colors and thus only take effect on the display colors, if the display shows the printing colors.

- `HCOPy:CMAP<item>:DEFault<colors>` on page 769
- `HCOPy:CMAP<item>:HSL` on page 769
- `HCOPy:CMAP<item>:PDEFined` on page 770

Remote commands exclusive to customize the display colors and themes

---

DISPlay:CMAP<item>:DEFault<colors>

This command resets the color scheme for the display.

Suffix:

<item> Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

<colors> 1...4
1
Current colors with a white background and a black grid.
2
Optimized colors.
3
Customized colors.
4
Current screen colors (setting for hardcopies).

Example: `DISP:CMAP:DEF2`
Selects default setting 2 for setting the colors.

Usage: Event
SCPI confirmed

Manual control: See "Screen colors" on page 417

DISPlay:CMAP<item>:HSL <Color>

This command selects the color for various screen elements in the display.

Suffix:

<item> Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

Parameters:

<Color> **hue**
tint

sat
saturation

lum
brightness

The value range is 0 to 1 for all parameters.

Example: `DISP:CMAP2:HSL 0.3,0.8,1.0`
Changes the grid color.

DISPlay:CMAP<item>:PDEFined <Color>

This command selects a predefined color for various screen elements.

Suffix:
<item> Selects the item for which the color scheme is to be defined.
For more information see chapter 10.8.5.3, "CMAP Suffix Assignment", on page 793.

Parameters:
<Color> BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRAy | LGRAy | LBLUe | LGREen | LCYan | LRED | LMAGenta

Example: `DISP:CMAP2:PDEF GRE`

Manual control: See "Restoring the User Settings to Default Colors" on page 419

DISPlay:THEMe:CATalog?

This command queries all available display themes.

Parameters:
<Themes> String containing all available display themes.

Example: `DISP:THEMe:CAT?`

Usage: Query only

DISPlay:THEMe:SELect <Theme>

This command selects the display theme.

Parameters:
<Theme> String containing the name of the theme.
*RST: SPL

Example: `DISP:THEM:SEL "OceanBlue"`

Manual control: See "Theme" on page 417

10.8.5.3 CMAP Suffix Assignment

Several commands to change the color settings of individual items of the display or printout are available. Which item is to be configured is defined using a <CMAP> suffix. The following assignment applies:

Suffix	Description
CMAP1	Background
CMAP2	Grid
CMAP3 *)	Common Text
CMAP4 *)	Check Status OK
CMAP5 *)	Check Status Error
CMAP6 *)	Text Special 1
CMAP7 *)	Text Special 2
CMAP8	Trace 1
CMAP9	Trace 2
CMAP10	Trace 3
CMAP11	Marker Info Text
CMAP12	Limit Lines
CMAP13	Limit and Margin Check – "Pass"
CMAP14	Limit and Margin Check – "Fail"
CMAP15 *)	Softkey Text
CMAP16 *)	Softkey Background
CMAP17 *)	Selected Field Text
CMAP18 *)	Selected Field Background
CMAP19 *)	Softkey 3D Bright Part
CMAP20 *)	Softkey 3D Dark Part
CMAP21 *)	Softkey State "On"
CMAP22 *)	Softkey State "Dialog open"
CMAP23 *)	Softkey Text Disabled
CMAP24	Logo
CMAP25	Trace 4
CMAP26	Grid – Minorlines
CMAP27	Marker
CMAP28	Display Lines
CMAP29 *)	Sweepcount – Text
CMAP30	Limit and Margin Check – Text
CMAP31	Limit and Margin Check – \"Margin\"
CMAP32 *)	Table Overall – Title Text
CMAP33 *)	Table Overall – Title Background

Suffix	Description
CMAP34 *)	Table Overall – Text
CMAP35 *)	Table Overall – Background
CMAP36 *)	Table Value – Title Text
CMAP37 *)	Table Value – Title Background
CMAP38 *)	Table Value – Text
CMAP39 *)	Table Value – Background
CMAP40	Trace 5
CMAP41	Trace 6

*) these settings can only be defined via the theme (`DISPlay:THEMe:SELect`) and are thus ignored in the SCPI command

10.8.6 Configuring the Network and Remote Control

The following commands are required to configure a network or remote control for the R&S FSW.

Useful commands for configuring remote control described elsewhere:

- `SYSTem:LANGuage` on page 809

Remote commands exclusive to

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <Address>

This command sets the GPIB address of the R&S FSW.

Parameters:

<Address>	Range:	0 to 30
	*RST:	(no influence on this parameter, factory default 20)

Example: `SYST:COMM:GPIB:ADDR 18`

Usage: SCPI confirmed

Manual control: See "GPIB Address" on page 468

SYSTem:COMMunicate:GPIB[:SELF]:RTERminator <Terminator>

This command selects the GPIB receive terminator.

According to the standard the terminator in ASCII is <LF> and/or <EOI>. For binary data transfers (e.g. trace data) from the control computer to the instrument, the binary code (0AH) used for <LF> might be included in the binary data block, and therefore should not be interpreted as a terminator in this particular case. This can be avoided by changing the receive terminator to EOI.

Output of binary data from the instrument to the control computer does not require such a terminator change.

Parameters:

<Terminator> LFEOI | EOI

*RST: (no influence on this parameter, factory default LFEOI)

Example: `SYST:COMM:GPIB:RTER EOI`

Manual control: See "GPIB Terminator" on page 469

SYSTem:DISPlay:UPDate <State>

This command turns the display during remote operation on and off.

If on, the R&S FSW updates the diagrams, traces and display fields only.

The best performance is obtained if the display is off during remote control operation.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SYST:DISP:UPD ON`

Manual control: See "Remote Display Update" on page 469

SYSTem:IDENtify:FACTory

This command resets the query to `*IDN?` to its default value.

Usage: Event

Manual control: See "Reset to Factory String" on page 468

SYSTem:IDENtify[:STRing] <String>

This command defines the response to `*IDN?`.

Parameters:

<String> String containing the description of the instrument.

Manual control: See "Identification String" on page 468

SYSTem:LXI:INFo?

This command queries the LXI settings.

Return values:

<LXIInfo> <current version> | <LXI class> | <Computername> | <MAC adress> | <IP adress> | <Auto MDIX>

String containing the current LXI parameters.

- <version>
- <LXIClass>
- <ComputerName>
- <MACAddress>
- <IPAddress>
- <AutoMDIX>

Usage: Query only

Manual control: See "Current LXI Configuration" on page 473

SYSTem:LXI:LANReset

This command resets the LAN configuration as required by the LXI standard. The command also resets the LXI password and instrument description.

Usage: Event

Manual control: See "LAN Reset" on page 474

SYSTem:LXI:MDEScription <Description>

This command defines the LXI instrument description.

Parameters:

<Description> String containing the instrument description.

Manual control: See "LXI Manufacturer Description" on page 474

SYSTem:LXI:PASSword <Password>

This command defines the LXI password.

Parameters:

<Password> String containing the password.

Return values:

<Password> The query returns the current password.

Manual control: See "LXI Password" on page 473

10.8.7 Checking the System Configuration

DIAGnostic:INFO:CCOunter? <Relay>

This command queries how many switching cycles the individual relays have performed since they were installed.

Query parameters:

<Relay>

ACDC
Mechanical Attenuation Coupling

ATT5
Mechanical Attenuation 05 DB

ATT10
Mechanical Attenuation 10 DB

ATT20
Mechanical Attenuation 20 DB

ATT40
Mechanical Attenuation 40 DB

CAL
Mechanical Calibration Source

EATT
Electrical Attenuation Bypass

PREamp
Preamplifier Bypass

Return values:

<Cycles> Number of switching cycles.

Example: `DIAG:INFO:CCO? CAL`

Usage: Query only

Manual control: See "Relay Cycle Counter" on page 410

DIAGnostic:SERVice:BIOSinfo?

This command queries the BIOS version of the CPU board.

Return values:

<BiosInformation> String containing the BIOS version.

Example: `DIAG:SERV:BIOS?`
Returns the BIOS version.

Usage: Query only

DIAGnostic:SERVice:HWINfo?

This command queries hardware information.

Return values:

<Hardware> String containing the following information for every hardware component.
<component>: name of the hardware component
<serial#>: serial number of the component
<order#>: order number of the component
<model>: model of the component
<code>: code of the component
<revision>: revision of the component

Example: `DIAG:SERV:HWIN?`
Queries the hardware information.

```
"FRONTEND|100001/003|1300.3009|03|01|00|00",
"MOTHERBOARD|123456/002|1300.3080|02|00|00|00",
...
```

Usage: Query only

DIAGnostic:SERVice:VERSinfo?

This command queries information about the hardware and software components.

Return values:

<Information> String containing the version of hardware and software components including the types of licenses for installed firmware options.

Example: `DIAG:SERV:VERS?`
Queries the version information.
Response:

```
Instrument Firmware |1.10
BIOS |FSW Analyzer BIOS V1.03-1-32-4-3 IPC10
Image Version |1.2.0
PCI-FPGA |9.01
SA-FPGA |2.43
MB-FPGA |2.0.8.0
SYNTH-FPGA |3.9.0.0
REF-FPGA |3.4.0.0
Data Sheet Version |01.00
Time Control Management |active
High Pass Filter 1...3GHz B13 ||permanent
Analog Demod K7| |permanent
```

Usage: Query only
SCPI confirmed

SYSTem:ERRor:CLEar:ALL

This command deletes all contents of the "System Messages" table.

Example: `SYST:ERR:CLE:ALL`

Usage: Event

SYSTem:ERRor:EXTended? <MessageType>[, <ChannelName>]

This command queries all system messages, or all messages of a defined type, displayed in the status bar for a specific measurement channel (application).

Note: This command queries the strings displayed for manual operation. For remote programs, do not define processing steps depending on these results. Instead, query the results of the `STATus:QUEStionable:EXTended:INFO` status register, which indicates whether messages of a certain type have occurred (see "STATus:QUEStionable:EXTended:INFO Register" on page 454).

Query parameters:

<MessageType> ALL | INFO | WARNing | ERRor | FATal | MESSage

<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:

<Messages> String containing all messages of the selected type for the specified measurement channel. Each message is separated by a comma and inserted in parentheses. If no messages are available, empty parentheses are returned.

Example: `SYST:ERR:EXT? ALL`
Returns all messages for the currently active application, e.g. *"Message 1","Message 2"*.

Example: `SYST:ERR:EXT? FAT,'Spectrum2'`
Queries fatal errors in the 'Spectrum2' application. If none have occurred, the result is: *" "*.

Usage: Query only

SYSTem:ERRor:LIST?

This command queries the system messages.

Return values:

<Messages> String containing all messages in the "System Messages" table.

Example: `SYST:ERR:LIST?`

Usage: Query only

SYSTem:ERRor[:NEXT]?

This command queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

For details on error queues see chapter 9.1.7, "Status Reporting System", on page 445.

Usage: Query only

SYSTem:FORMat:IDENt <IDNFormat>

This command selects the response format to the `*IDN?` query.

Parameters:

<IDNFormat>

LEGacy
Format is compatible to R&S FSP/FSU/FSQ/FSG family.

NEW | FSL
R&S FSW format
Format is also compatible to the R&S FSL and R&S FSV family

*RST: NEW

Example: `SYST:FORM:IDEN LEG`
Adapts the return value of *IDN? to the R&S FSP/FSU/FSQ family.

Manual control: See "*IDN Format" on page 469

SYSTem:PRESet:COMPatible <OpMode>

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

For details on operating modes see chapter 3, "Applications and Operating Modes", on page 18.

Parameters:

<OpMode>

MSRA
Defines MSRA as the default operating mode as the presetting.

SANalyzer
(Default:) Defines Signal and Spectrum Analyzer operating mode as the presetting.

*RST: SAN

Usage: Event

10.8.8 Using Service Functions

DIAGnostic:SERVice:SFUNction <ServiceFunction>

This command starts a service function.

The service functions are available after you have entered the level 1 or level 2 system password.

Parameters:

<ServiceFunction> String containing the ID of the service function.
The ID of the service function is made up out of five numbers, separated by a point.
- function group number
- board number
- function number
- parameter 1 (see the Service Manual)
- parameter 2 (see the Service Manual)

Usage: Event

Manual control: See "Service Function" on page 408
See "Send" on page 409

DIAGnostic:SERVice:SFUNction:LASTresult?

This command queries the results of the most recent service function you have used.

Usage: Query only

DIAGnostic:SERVice:SFUNction:RESults:DELete

This command deletes the results of the most recent service function you have used.

Usage: Event

Manual control: See "Clear Results" on page 409

DIAGnostic:SERVice:SFUNction:RESults:SAVE <FileName>

This command saves the results of the most recent service function you have used.

Parameters:

<FileName> String containing the file name.

Manual control: See "Save Results" on page 409

DIAG:SERV:INP[:SEL] <CalSignal>

This command activates or deactivates the use of an internal calibration signal as input to the optional Analog Baseband interface. This signal is only available if the R&S FSW-B71 option is installed.

Parameters:

<CalSignal>

AIQ
Uses Analog Baseband calibration signal.

RF
No Analog Baseband calibration signal is sent.

*RST: RF

Example: DIAG:SERV:INP AIQ

Manual control: See "Calibration Analog Baseband" on page 407

DIAG:SERV:INP:AIQ[:TYPE] <SignalType>

This command defines the type of calibration signal to be used for Analog Baseband. This command is only available if the R&S FSW-B71 option is installed.

Parameters:

<SignalType>

AC
1.5625 MHz square wave AC signal

DC
1.5625 MHz square wave DC signal

DCZ
no signal

*RST: AC

Example: `DIAG:SERV:INP:AIQ:TYPE DCZ`

Manual control: See "Calibration Analog Baseband" on page 407
See "Calibration Signal Type" on page 407

DIAG:SERV:INP:AIQ:OUT <State>

If enabled, the Analog Baseband calibration signal is output to the TRIGGER INPUT/OUTPUT connector (Trigger 2) on the front panel of the R&S FSW.

Parameters:

<State> ON | OFF

*RST: OFF

Example: DIAG:SERV:INP:AIQ:OUT ON

Manual control: See "Calibration Analog Baseband" on page 407
See "Calibration Signal Output" on page 407

10.9 Using the Status Register

For more information on the contents of the status registers see:

- "STATus:QUEStionable:ACPLimit Register" on page 453
- "STATus:QUEStionable:FREQuency Register" on page 455
- "STATus:QUEStionable:LIMit Register" on page 455
- "STATus:QUEStionable:LMARgin Register" on page 456
- "STATus:QUEStionable:POWer Register" on page 457
- "STATus:QUEStionable:TEMPerature Register" on page 457
- "STATus:QUEStionable:TIMe Register" on page 458

10.9.1 General Status Register Commands

STATus:PRESet

This command resets the edge detectors and `ENABle` parts of all registers to a defined value. All `PTRansition` parts are set to `FFFFh`, i.e. all transitions from 0 to 1 are detected. All `NTRansition` parts are set to 0, i.e. a transition from 1 to 0 in a `CONDition` bit is not detected. The `ENABle` part of the `STATus:OPERation` and `STATus:QUEStionable` registers are set to 0, i.e. all events in these registers are not passed on.

Usage: Event

STATus:QUEue[:NEXT]?

This command queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

This command is identical to the `SYSTem:ERRor[:NEXT]?` command.

Usage: Query only

10.9.2 Reading Out the CONDition Part

For more information on the condition part see chapter 9.1.7.2, "Structure of a SCPI Status Register", on page 447.

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:ACPLimit:CONDition? <ChannelName>
STATus:QUEStionable:EXTended:CONDition? <ChannelName>
STATus:QUEStionable:EXTended:INFO:CONDition? <ChannelName>
STATus:QUEStionable:FREQuency:CONDition? <ChannelName>
STATus:QUEStionable:LIMit<n>:CONDition? <ChannelName>
STATus:QUEStionable:LMARgin<n>:CONDition? <ChannelName>
STATus:QUEStionable:POWer:CONDition? <ChannelName>
STATus:QUEStionable:TEMPerature:CONDition? <ChannelName>
STATus:QUEStionable:TIME:CONDition? <ChannelName>

These commands read out the CONDition section of the status register.

The commands do not delete the contents of the CONDition section.

Query parameters:

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

Usage: Query only

10.9.3 Reading Out the EVENt Part

For more information on the event part see chapter 9.1.7.2, "Structure of a SCPI Status Register", on page 447.

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:ACPLimit[:EVENt]? <ChannelName>
STATus:QUEStionable:EXTended[:EVENt]? <ChannelName>
STATus:QUEStionable:EXTended:INFO[:EVENt]? <ChannelName>
STATus:QUEStionable:FREQuency[:EVENt]? <ChannelName>
STATus:QUEStionable:LIMit<n>[:EVENt]? <ChannelName>
STATus:QUEStionable:LMARgin<n>[:EVENt]? <ChannelName>
STATus:QUEStionable:POWer[:EVENt]? <ChannelName>
STATus:QUEStionable:TEMPerature[:EVENt]? <ChannelName>
STATus:QUEStionable:TIME[:EVENt]? <ChannelName>

These commands read out the EVENt section of the status register.

At the same time, the commands 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

10.9.4 Controlling the ENABle Part

For more information on the enable part see chapter 9.1.7.2, "Structure of a SCPI Status Register", on page 447.

STATus:OPERation:ENABle <SumBit>
STATus:QUEStionable:ENABle <SumBit>
STATus:QUEStionable:ACPLimit:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:INFO:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:FREQuency:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LMARgin<n>:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:TEMPerature:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:TIME:ENABle <SumBit>,<ChannelName>

These commands control the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to bereported 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.

10.9.5 Controlling the Negative Transition Part

For more information on the positive transition part see chapter 9.1.7.2, "Structure of a SCPI Status Register", on page 447.

STATus:OPERation:NTRansition <SumBit>
STATus:QUEStionable:NTRansition <SumBit>
STATus:QUEStionable:ACPLimit:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:INFO:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:FREQuency:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LMARgin<n>:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:TEMPerature:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:TIME:NTRansition <SumBit>,<ChannelName>

These commands control 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.

10.9.6 Controlling the Positive Transition Part

For more information on the negative transition part see chapter 9.1.7.2, "Structure of a SCPI Status Register", on page 447.

STATus:OPERation:PTRansition <SumBit>
STATus:QUEStionable:PTRansition <SumBit>
STATus:QUEStionable:ACPLimit:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:EXTended:INFO:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:FREQuency:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LMARgin<n>:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:TEMPerature:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:TIME:PTRansition <SumBit>,<ChannelName>

These commands control the Positive TRansition part of a register.

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

Parameters:

<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.

10.10 Emulating Other Instruments' Commands

The R&S FSW analyzer family supports a subset of the GPIB commands of several HP and PSA instruments.

For details see chapter 9.2, "GPIB Languages", on page 462.

10.10.1 Setting up Instrument Emulation

The following commands are required to set up the use of commands to emulate other instruments.

SYSTem:HPCoupling <CouplingType>

Controls the default coupling ratios in the HP emulation mode for:

- span and resolution bandwidth (Span/RBW) and
- resolution bandwidth and video bandwidth (RBW/VBW)

For FSP (=FSW), the standard parameter coupling of the instrument is used. As a result, in most cases a shorter sweep time is used than in case of HP.

This command is only available if a HP language is selected using `SYSTem:LANGuage` on page 809.

Parameters:

<CouplingType> HP | FSP

*RST: FSP

Example: `SYSTem:HPC HP`

Manual control: See "Coupling" on page 471

SYSTem:IFGain:MODE <Mode>

Configures the internal IF gain settings in HP emulation mode due to the application needs. This setting is only taken into account for resolution bandwidth < 300 kHz and is only available if a HP language is selected using `SYSTem:LANGuage`.

Parameters:

<Mode> NORM | PULS

NORM
Optimized for high dynamic range, overload limit is close to reference level.

PULS
Optimized for pulsed signals, overload limit up to 10 dB above reference level.

*RST: NORM

Example: `SYST:IFG:MODE PULS`

Manual control: See "IF Gain" on page 471

SYSTem:LANGuage <Language>

This command defines the system language.

For details see chapter 9.2, "GPIB Languages", on page 462.

Note: as of firmware version 1.60, this command is also used to emulate previous R&S signal and spectrum analyzers, making the `SYST:COMP` command obsolete.

Note: For PSA89600 emulation, the option is indicated as "B7J" for the `*OPT?` query ("B7J, 140" if Wideband is activated).

Parameters:

<Language> "SCPI" | "8560E" | "8561E" | "8562E" | "8563E" | "8564E" | "8565E" | "8566A" | "8566B" | "8568A" | "8568A_DC" | "8568B" | "8568B_DC" | "8591E" | "8594E" | "71100C" | "71200C" | "71209A" | "PSA89600" | "FSP" | "FSU" | "FSQ" | "FSV" | "FSEA" | "FSEB" | "FSEM" | "FSEK"

*RST: SCPI

Example: `SYST:LANG '8560E'`
Sets the system language to 8560E to simulate the HP model.

Usage: SCPI confirmed

Manual control: See "Language" on page 470

SYST:PSA:WIDeband <State>

This command defines which option is returned when the `*OPT?` query is executed, depending on the state of the wideband option.

It is only available for PSA89600 emulation.

Parameters:

<State> ON | OFF | HIGH

OFF
The option is indicated as "B7J"

ON
The 40 MHz wideband is used.
The option is indicated as "B7J, 140".

HIGH
The 80 MHz wideband is used.
The option is indicated as "B7J, 122".

*RST: OFF

Manual control: See "Language" on page 470
See "Wideband" on page 472

SYSTem:REVision:FACTory

Resets the response to the REV? query to the default value, e.g. after a user string was defined using the `SYSTem:REVision[:STRing]` command. (REV? query available for HP emulation only, see `SYSTem:LANGuage` on page 809.)

Example: Define the system language:
`SYST:LANG '8563E'`
Set the response back to factory setting:
`SYS:REV:FACT`
Query the revision:
`REV?`
Response:
`920528`

Manual control: See "Resetting the Factory Revision" on page 472

SYSTem:REVision[:STRing] <Name>

Sets the response to the `REV?` query to the defined string (HP emulation only, see `SYSTem:LANGuage` on page 809).

Parameters:
<Name>

Example: Define the system language:
`SYST:LANG '8563E'`
Query the revision:
`REV?`
Response:
`920528`
Set the response to 'NewRevision':
`SYST:REV:STR 'NewRevision'`
Query the response:
`SYST:REV:STR?`
Response:
`NewRevision`

Manual control: See "Revision String" on page 472

SYSTem:RSW <State>

Controls a repeated sweep of the E1 and MKPK HI HP model commands (for details on the commands refer to chapter 10.10.2, "Reference: GPIB Commands of Emulated HP Models", on page 811). If the repeated sweep is OFF, the marker is set without sweeping before.

This command is only available if a HP language is selected using `SYSTem:LANGuage` on page 809

Parameters:

<State> ON | OFF
*RST: OFF

Example: `SYSTem:RSW ON`

Manual control: See "Sweep Repeat" on page 471

10.10.2 Reference: GPIB Commands of Emulated HP Models

The R&S FSW analyzer family supports a subset of the GPIB commands of HP models 8560E, 8561E, 8562E, 8563E, 8564E, 8565E, 8566A, 8566B, 8568A, 8568B and 8594E.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

This includes the support of syntax rules for not only newer device families (B and E models) but for the previous A family as well.

In many cases the selection of commands supported by the R&S FSW is sufficient to run an existing GPIB program without adaptation.

After the introduction, this section includes the following topics:

10.10.2.1 Command Set of Models 8560E, 8561E, 8562E, 8563E, 8564E, 8565E, 8566A/B, 8568A/B, 8591E, 8594E, 71100C, 71200C, and 71209A

As with the original units, the R&S FSW includes the command set of the A models in the command set of the B models.

The HP model 8591E is compatible to HP model 8594E, the HP models 71100C, 71200C, and 71209A are compatible to HP models 8566A/B.

Command	Supported subset	Function	Corresp. HP-Models	Status
A1	A1	Clear/Write A	HP 8566A/ HP 8568A	available
A2	A2	Max Hold A	HP 8566A/ HP 8568A	available
A3	A3	View A	HP 8566A/ HP 8568A	available
A4	A4	Blank A	HP 8566A/ HP 8568A	available
ABORT 1)	ABORT	Stop previous function	HP 856xE/ HP 8566B/HP 8568B/HP 8594E	available
ADD		Add	HP 8566B/ HP 8568B/ HP 8594E	available
ADJALL	ADJALL	Adjust all	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ADJCRT 2)	ADJCRT	Adjust CRT	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ADJIF 2)	ADJIF	Auto adjust IF	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AMB	AMB ON|OFF AMB 1|0 AMB?	Trace A – B -> Trace A	HP 856xE/ HP 8594E	available
AMBPL	AMBPL ON|OFF AMBPL 1|0 AMBPL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ANNOT	ANNOT ON|OFF ANNOT 1|0 ANNOT?	Annotation	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
APB	APB	Trace A + B -> Trace A	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AT	AT <numeric_value> DB | DM AT DN AT UP AT AUTO AT?	Attenuation	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AUNITS	AUNITS DBM | DBMV | DBUV | AUNITS?	Amplitude Units	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AUTOCPL	AUTOCPL	Coupling default	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AXB	AXB	Exchange trace A and B	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
B1	B1	Clear/Write B	HP 8566A/ HP 8568A	available
B2	B2	Max Hold B	HP 8566A/ HP 8568A	available
B3	B3	View B	HP 8566A/ HP 8568A	available
B4	B4	Blank B	HP 8566A/ HP 8568A	available
BL	BL	Trace B – Display Line -> Trace B	HP 8566A/ HP 8568A	available
BML	BML	Trace B – Display Line -> Trace B	HP 856xE/ HP8594E	available
BTC	BTC	Transfer Trace B -> C	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
BXC	BXC	Exchange Trace B and C	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
BLANK	BLANK TRA|TRB|TRC	Blank Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
C1	C1	A-B off	HP 8566A/ HP 8568A	available
C2	C2	A-B -> A	HP 8566A/ HP 8568A	available
CA	CA	Couple Attenuation	HP 8566A/ HP 8568A	available
CAL [1)]	CAL ALL CAL ON CAL OFF	Start analyzer self alignment	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CF	CF <numeric_value> HZ|KHZ|MHZ|GHZ CF UP CF DN CF?	Center Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CHANPWR	CHANPWR TRA|TRB, <numeric_value>,?	Channel Power Measurement	HP 856xE/ HP 8594E	available
CHPWRBW	CHPWRBW <numeric_value> HZ|KHZ|MHZ|GHZ	Channel Power Bandwidth	HP 856xE/ HP 8594E	available
CLRW	CLRW TRA|TRB|TRC	Clear/Write Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CLS [1)]	CLS	Clear all status bits	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
CONTS	CONTS		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
COUPLE	COUPLE AC|DC	Input coupling	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CR	CR	Couple RBW	HP 8566A/ HP 8568A	available
CS	CS	Couple Step Size	HP 8566A/ HP 8568A	available
CT	CT	Couple SWT	HP 8566A/ HP 8568A	available
CTA		Convert to absolute units	HP 8566B/ HP 8568B/ HP 8594E	available
CV	CV	Couple VBW	HP 8566A/ HP 8568A	available
D1 2)	D1	Display Size normal	HP 8566A/ HP 8568A	available
DA 2)	DA	Display address		available
DEMOD 1)	DEMOD ON|OFF|AM|FM	AF Demodulator	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DEMODAGC 2)	DEMODAGC ON|OFF|1|0 DEMODAGC?	Demodulation AGC	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DEMODT	DEMODT <numeric_value> S|MS|US|SC DEMODT UP|DN DEMODT?	Demodulation time	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DET	DET POS|SMP|NEG DET?	Detector	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
DISPOSE [2)]	ONEOS | TRMATH | ONSWP | ALL | <numeric_value>			available
DIV		Divide	HP 8566B/ HP 8568B/ HP 8594E	available
DL	DL <numeric_value> DB|DM DL DN DL UP DL ON DL OFF DL?	Display Line	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DLE	DLE ON|OFF	Display Line enable	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DONE	DONE DONE?	Done query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DW [2)]	DW	Write to display and increment address		available
E1	E1	Peak Search	HP 8566A/ HP 8568A	available
E2	E2	Marker to Center Freq.	HP 8566A/ HP 8568A	available
E3	E3	Deltamarker Step Size	HP 8566A/ HP 8568A	available
E4	E4	Marker to Ref. Level	available	available
EDITDONE		limit line edit done	HP 856xE	available
EDITLIML		edit limit line	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
ERR	ERR 250 cal level error ERR 300 LO unlock ERR 472 cal error digital filter ERR 473 cal error analog filter ERR 552 cal error log amp ERR 902 unscale tracking generator ERR 906 oven cold ERR 117 numeric unit error ERR 112 Unrecognized Command	Now some FSx errors are mapped to HP errors.	HP8568A HP856xE	not yet available
ERR?	ERR?	Error queue query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not yet available
EX	EX	Exchange trace A and B	HP 8566A/ HP 8568A	available
FA	FA <numeric_value> HZ|KHZ|MHZ|GHZ FA UP FA DN FA?	Start Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FB	FB <numeric_value> HZ|KHZ|MHZ|GHZ FB UP FB DN FB?	Stop Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FDSP		Frequency display off	8560E 8561E 8562E 8563E 8564E 8565E	available
FOFFSET [1)]	FOFFSET <numeric_value> HZ|KHZ|MHZ|GHZ FOFFSET?	Frequency Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
FREF	FREF INT|EXT	Reference Frequency	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FS	FS	Full Span	HP 8566A/ HP 8568A	available
FUNCDEF		Define Function Function must be in one line between delimiters @	HP 8594E/ HP 856xE/ HP 8566B	available
GATE [1)]	GATE ON|OFF GATE 1|0		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GATECTL [1)]	GATECTL EDGE|LEVEL GATECTL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GD [1)]	GD <numeric_value> US|MS|SC GD DN GD UP GD?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GL [1)]	GL <numeric_value> US|MS|SC GL DN GL UP GL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GP [1)]	GP POS|NEG GP?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GRAT [2)]	GRAT ON|OFF	Graticule	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
I1	I1		HP 8566A/ HP 8568A	available
I2	I2		HP 8566A/ HP 8568A	available

Command	**Supported subset**	**Function**	**Corresp. HP-Models**	**Status**
ID	ID ID?	Identify	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
INZ [1)]	INZ 75 INZ 50 INZ?	Input Impedance	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
IP	IP	Instrument preset	HP 8566A/ HP 8568A	available
KEYDEF	KEYDEF	Key definition	HP 8566B/ HP 856xE/ HP 859xE	available
KEYEXEC	KEYEXEC	Key execute	HP 8566B	available
KS=	KS= <numeric_value> HZ|KHZ|MHZ|GHZ KS= DN KS= UP KS=?	Marker Frequency Counter Resolution	HP 8566A/ HP 8568A	available
KS/	KS/	Manual Peaking	HP 8566A/ HP 8568A	available
KS(	KS(	Lock register	HP 8566A/ HP 8568A	available
KS)	KS)	Unlock register	HP 8566A/ HP 8568A	available
KS91	KS91	Read Amplitude Error	HP 8566A/ HP 8568A	available
KSA	KSA	Amplitude Units in dBm	HP 8566A/ HP 8568A	available
KSB	KSB	Amplitude Units in dBmV	HP 8566A/ HP 8568A	available
KSC	KSC	Amplitude Units in dBuV	HP 8566A/ HP 8568A	available
KSD	KSD	Amplitude Units in V	HP 8566A/ HP 8568A	available
KSE	KSE <numeric_value>| <char data>@	Title mode	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
KSG	KSG KSG ON KSG <numeric_value>	Video Averaging on	HP 8566A/ HP 8568A	available
KSH	KSH	Video Averaging Off	HP 8566A/ HP 8568A	available
KSK		Marker to Next Peak	HP 8566A/ HP 8568A	available
KSL		Marker Noise off	HP 8566A/ HP 8568A	available
KSM		Marker Noise on	HP 8566A/ HP 8568A	available
KSO	KSO	Deltamarker to span	HP 8566A/ HP 8568A	available
KSP	KSP <numeric_value>	HPIB address	HP 8566A/ HP 8568A	available
KSQ [2)]	KSQ	Band lock off	HP 8566A/ HP 8568A	available
KST	KST	Fast Preset	HP 8566A/ HP 8568A	available
KSV	KSV <numeric_value> HZ|KHZ|MHZ|GHZ KSV?	Frequency Offset	HP 8566A/ HP 8568A	available
KSW	KSW	Error Correction Routine	HP 8566A/ HP 8568A	available
KSX	KSX	Correction Values On	HP 8566A/ HP 8568A	available
KSY	KSY	Correction Values Off	HP 8566A/ HP 8568A	available
KSZ	KSZ <numeric_value> DB KSZ?	Reference Value Offset	HP 8566A/ HP 8568A	available
KSa	KSa	Normal Detection	HP 8566A/ HP 8568A	available
KSb	KSb	Pos Peak Detection	HP 8566A/ HP 8568A	available
KSd	KSd	Neg Peak Detection	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
KSe	KSe	Sample Detection	HP 8566A/ HP 8568A	available
KSg		CRT beam off		available
KSh		CRT beam on		available
KSj	KSj	View Trace C	HP 8566A/ HP 8568A	available
KSk	KSk	Blank Trace C	HP 8566A/ HP 8568A	available
KSl	KSl	Transfer B to C	HP 8566A/ HP 8568A	available
KSm	KSm	Graticule off	HP 8566A/ HP 8568A	available
KSn 2)	KSn	Grid on	HP 8566A/ HP 8568A	available
KSo	KSn	Character display off	HP 8566A/ HP 8568A	available
KSp	KSp	Character display on	HP 8566A/ HP 8568A	available
KSr	KSr	Create service request	HP 8566A/ HP 8568A	available
KSt 2)	KSt	Band lock on	HP 8566A/ HP 8568A	available
KSv 2)	KSv	Signal ident on	HP 8566A/ HP 8568A	available
L0	L0	Display line off	HP 8566A/ HP 8568A	available
LB	LB <numeric_value>| <char data>@	Label	HP 8566A/ HP 8568A	available
LF	LF	Low frequency band pre-set	HP 8566A/ HP 8568A	available
LIMD		limit line delta	HP 856xE	available
LIMF		limit line frequency	HP 856xE	available
LIMIFAIL		limit fail query	HP 856xE	available
LIMIPURGE		purge limit line	HP 856xE	available
LIMIRCL		recall limit line	HP 856xE	available
LIMIREL		relative limit line	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
LIMISAV		save limit line	HP 856xE	available
LIMITEST		limit line test	HP 856xE	available
LIML		lower limit line value	HP 856xE	available
LIMM		middle limit line value	HP 856xE	available
LIMTFL		flat limit line segment	HP 856xE	available
LIMTSL		slope limit line segment	HP 856xE	available
LIMU		upper limit line value	HP 856xE	available
LG	LG <numeric_value> DB | DM LG?	Amplitude Scale Log	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
LL [2)]	LL	Plot command	HP 8566A/ HP 8568A	available
LN	LN	Amplitude Scale Lin	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
M1	M1	Marker Off	HP 8566A/ HP 8568A	available
M2	M2 M2 <numeric_value> HZ|KHZ|MHZ|GHZ M2 DN M2 UP M2?	Marker Normal	HP 8566A/ HP 8568A	available
M3	M3 M3 <numeric_value> HZ|KHZ|MHZ|GHZ M3 DN M3 UP M3?	Delta Marker	HP 8566A/ HP 8568A	available
M4	M4 <numeric_value> HZ|KHZ|MHZ|GHZ	Marker Zoom	HP 8566A/ HP 8568A	available
MA	MA	Marker Amplitude	HP 8566A/ HP 8568A	available
MC0	MC0	Marker Count off	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MC1	MC1	Marker Count on	HP 8566A/ HP 8568A	available
MDS	MDS	Measurement data size	HP 8566B	available
MEAS		Measurement status	HP 856xE	available
MF	MF MF?	Marker Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MINH[1)]	MINH TRC	Minimum Hold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKA	MKA <numeric_value> MKA?	Marker Amplitude	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKACT	MKACT 1 MKACT?	Select the active marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
MKBW [1)]	MKBW <numeric_value> MKBW ON MKBW OFF	N dB Down	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKD	MKD MKD <numeric_value> HZ|KHZ| MHZ|GHZ MKD DN MKD UP MKD ON MKD OFF MKD?	Delta Marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKDR	MKDR <numeric_value> HZ|KHZ| MHZ|GHZ| S|SC|MS|MSEC| USMKDR?	Delta Marker reverse	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MKDR?		Delta Marker reverse query		available
MKF	MKF <numeric_value> HZ|KHZ|MHZ|GHZ MKF?	Set Marker Frequency	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKFC	MKFC ON|OFF	Frequency Counter on/off	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKFCR [1)]	MKFCR <numeric_value> HZ|KHZ| MHZ|GHZ MKFCR DN MKFCR UP MKFCR?	Frequency Counter Resolution	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKMIN	MKMIN	Marker -> Min	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKN	MKN MKN <numeric_value> HZ|KHZ|MHZ|GHZ MKN DN MKN UP MKN ON MKN OFF MKN?	Normal Marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKNOISE	MKNOISE ON|OFF MKNOISE 1|0 MKNOISE?	Noise Measurement	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKOFF	MKOFF MKOFF ALL	Marker off	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKP	MKP <numeric_value> MKP?	Marker position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MKPK	MKPK MKPK HI MKPK NH MKPK NR MKPK NL	Marker Search	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKPT	MKPT MKPT HI MKPT NH MKPT NR MKPT NL	Marker Peak Threshold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKPX	MKPX <numeric_value> DB MKPX DN MKPX UP MKPX?	Peak Excursion	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKRL	MKRL	Ref Level = Marker Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKSP	MKSP	Deltamarker to span	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKSS	MKSS	CF Stepsize = Marker Freq	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKT	MKT <numeric_value> S|MS|US|SC MKT?	MKF = fstart + MKT/ SWT*Span	HP 856xE/ HP 8594E	available
MKTRACE	MKTRACE TRA|TRB| TRC	Marker to Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKTRACK	MKTRACK ON|OFF MKTRACK 1|0 MKTRACK?	Signal Track	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	**Supported subset**	**Function**	**Corresp. HP-Models**	**Status**
MKTYPE	MKTYPE AMP MK TYPE?	Marker type	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ML		Mixer level	HP 856xE	available
MOV	MOV TRA|TRB|TRC, TRA|TRB|T RC	Move Trace Contents	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MPY		Multiply	HP 8566B/ HP 8568B/ HP 8594E	available
MT0	MT0	Marker Track Off	HP 8566A/ HP 8568A	available
MT1	MT1	Marker Track On	HP 8566A/ HP 8568A	available
MXMH	MXMH TRA|TRB	Maximum Hold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
NORMALIZE	NORMALIZE	Normalize trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available available
NRL [1)]	NRL <numeric_value> DB | DM NRL?	Normalized Reference Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
NRPOS	NRPOS <numeric_value> NRL?	Normalize position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
O1	O1	Format ASCII, Values 0 to 4095	HP 8566A/ HP 8568A	available
O2	O2	Format Binary, Values 0 to 4095	HP 8566A/ HP 8568A	available
O3	O3	Format ASCII	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
OA	OA	Output All	HP 8566A/ HP 8568A	available
OL	OL <80 characters> OL?	Output Learn String	HP 8566A/ HP 8568A	available
OT	OT	Output Trace Annotations	HP 8566A/ HP 8568A	available
PA	PA <numeric_value>, <numeric_value	Plot command	HP 8566A/ HP 8568A	available
PD	PD <numeric_value>, <numeric_value	Plot command	HP 8566A/ HP 8568A	available
PH_MKF		Spot frequency in Hz	HP 856xE	available
PH_FMIN		Min offset frequency to be measured	HP 856xE	available
PH_FMAX		Max offset frequency to be measured	HP 856xE	available
PH_MKA		Queries amplitude at the spot frequency	HP 856xE	available
PH_DRIFT		0: for stable signals, 1: for drifty	HP 856xE	available
PH_RLVL		Reference level for the log plot	HP 856xE	available
PH_SMTHV		Trace smoothing	HP 856xE	available
PH_VBR		Filtering	HP 856xE	available
PH_RMSPT		Amount of data points to skip when doing the integration	HP 856xE	available
PH_RMSFL		Lower integration frequency in Hz	HP 856xE	available
PH_RMSFU		Upper integration frequency in Hz	HP 856xE	available
PH_EXIT		Quits phase noise	HP 856xE	available
PH_F_UDT		Updates internal frequency variables	HP 856xE	available
PH_LMT_L		Apply limits to PH_FMIN and PH_FMAX	HP 856xE	available
PH_MEAS		Generates log frequency plot	HP 856xE	available
PH_MKF_D		Updates the spot frequency	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
PH_RMS		Requests the rms phase noise	HP 856xE	available
PH_RMSFT		Updates internal frequency variables	HP 856xE	available
PH_RMSX		Calculates the rms phase noise	HP 856xE	available
PH_SPOTF		Executes the spot frequency measurement	HP 856xE	available
PLOTORG 2)	PLOTORG DSP|GRT	Plot command	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PLOTSRC 2)	PLOTSRC ANNT|GRT|TRB| TRA|ALLDSP|GRT	Plot command	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PP	PP	Preselector Peaking	HP 8566A/ HP 8568A	available
PRINT 1)	PRINT PRINT 1|0	Hardcopy	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PSDAC 2)	PSDAC <numeric_value> PSDAC UP|DN	Preselector DAC value	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PSTATE 2)	PSTATE ON|OFF|1|0	Protect State	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PU	PU	Pen Up	HP 8566A/ HP 8568A	available
PWRBW	PWRBW	Power Bandwidth	HP 8566B/ HP 859x/ HP 856xE	available
R1	R1	Set Status Bit Enable	HP 8566A/ HP 8568A	available
R2	R2	Set Status Bit Enable	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
R3	R3	Set Status Bit Enable	HP 8566A/ HP 8568A	available
R4	R4	Set Status Bit Enable	HP 8566A/ HP 8568A	available
RB	RB <numeric_value> HZ|KHZ|MHZ|GHZ RB DN RB UP RB AUTO RB?	Resolution Bandwidth	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RBR	RBR <numeric_value> RBR DN RBR UP RBR?	Resolution Bandwidth Ratio	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RC1…6	RC1…6	Recall Last State	HP 8566A/ HP 8568A	available
RCLS	RCLS <numeric_value>	Recall State Register	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RCLT	RCLT TRA|TRB, <number>	Recall Trace	HP856xE/ HP8594E	available
RESET	RESET	Instrument preset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
REV	REV REV?	Firmware revision	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RL	RL <numeric_value> DB|DM RL DN RL UP RL?	Reference Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RLCAL	RLCAL <numeric_value> RL?	Reference Level Calibration	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
RCLOSCAL	RCLOSCAL	Recall Open/Short Average	HP 856xE/ HP 8594E	not available
RCLTHRU	RCLTHRU	Recall Thru	HP 856xE/ HP 8594E	not available
RLPOS [1)]	RLPOS <numeric_value> RLPOS DN RLPOS UP RLPOS?	Reference Level Position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ROFFSET	ROFFSET <numeric_value> DB | DM ROFFSET?	Reference Level Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RQS	RQS	Service Request Bit mask	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
S1	S1	Continuous Sweep	HP 8566A/ HP 8568A	available
S2	S2	Single Sweep	HP 8566A/ HP 8568A	available
SADD		add a limit line segment	HP 856xE	available
SAVES	SAVES <numeric_value>	Save State Register	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SAVET	SAVET TRA|TRB,<number>	Save Trace	HP856xE/ HP8594E	available
SDEL		delete limit line segment	HP 856xE	available
SDON		limit line segment done	HP 856xE	available
SEDI		edit limit line segment	HP 856xE	available
SMOOTH	SMOOTH TRA|TRB|TRC, <number of points>	Smooth Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SNGLS	SNGLS	Single Sweep	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
SQUELCH [2)]	SQUELCH <numeric_value> DM | DB SQUELCH UP|DN SQUELCH ON|OFF	Squelch	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SP	SP <numeric_value> HZ|KHZ|MHZ|GHZ SP DN SP UP SP?	Span	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SRCNORM [1)]	SRCNORM ON|OFF SRCNORM 1|0	Source Normalization	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SRCPOFS [1)]	SRCPOFS <numeric_value> DB | DM SRCPOFS DN SRCPOFS UP SRCPOFS?	Source Power Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SRCPWR [1)]	SRCPWR <numeric_value> DB | DM SRCPWR DN SRCPWR UP SRCPWR ON SRCPWR OFF SRCPWR?	Source Power	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SS	SS <numeric_value> HZ|KHZ|MHZ|GHZ SS DN SS UP SS AUTO SS?	CF Step Size	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ST	ST <numeric_value> US|MS|SC ST DN ST UP ST AUTO ST?	Sweep Time	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
STB	STB	Status byte query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
STOREOPEN	STOREOPEN	Store Open	HP 856xE/ HP 8594E	not available
STORESHORT	STORESHORT	Store Short	HP 856xE/ HP 8594E	not available
STORETHRU	STORETHRU	Store Thru	HP 856xE/ HP 8594E	not available
SUB		Subtract	HP 8566B/ HP 8568B/ HP 8594E	available
SUM		sum of trace amplitudes	HP 8566B/ HP 8568B/ HP 8594E	available
SV1…6	SV1…6	Save State	HP 8566A/ HP 8568A	available
SWPCPL [2)]	SWPCPL SA | SR SWPCPL?	Sweep Couple	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SWPOUT [2)]	SWPOUT FAV|FAVA|RAMP SWPOUT?	Sweep Output	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
T0	T0	Threshold off	HP 8566A/ HP 8568A	available
T1	T1	Free Run Trigger	HP 8566A/ HP 8568A	available
T2 [2)]	T2	Line Trigger	HP 8566A/ HP 8568A	available
T3	T3	External Trigger	HP 8566A/ HP 8568A	available
T4	T4	Video Trigger	HP 8566A/ HP 8568A	available
TA	TA	Transfer A	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
TACL	TACL?	Returns instantaneous measurement results. See TRACe<trace #>:IMMediate:LEVel? for full description.		not available
TBCL	TBCL?			
TCCL	TCCL?			
TACR	TACR?	Returns instantaneous measurement results. See TRACe<trace #>:IMMediate:LEVel? for full description.		not available
TBCR	TBCR?			
TCCR	TCCR?			
TB	TB	Transfer B	HP 8566A/ HP 8568A	available
TDF	TDF P TDF M TDF B TDF A TDF I	Trace Data Format	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TH	TH <numeric_value> DB|DM TH DN TH UP TH ON TH OFF TH AUTO TH?	Threshold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
THE	THE ON| OFF	Threshold Line enable	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TIMEDSP [1)]	TIMEDSP ON|OFF TIMEDSP 1|0 TIMEDSP?	Time Display	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TM	TM FREE|VID|EXT|LINE[2)] TM?	Trigger Mode	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TM LINE [2)]	TM LINE	Trigger Line	HP 8566B	available

Command	Supported subset	Function	Corresp. HP-Models	Status
TRA	TRA B TRA A TRA I	Transfer A	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TRB	TRB B TRB A TRB I	Transfer B	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TRSTAT	TRSTAT?	Trace State Query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TS	TS	Take Sweep	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
UR [2)]	UR	Plot Command	HP 8566A/ HP 8568A	available
VARDEF	VARDEF	Variable definition, arrays are not supported	HP 8566B/ HP 8568B/ HP 8594E	available
VAVG	VAVG VAVG TRA|TRB|TRC	Video Averaging	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VB	VB <numeric_value> HZ|KHZ|MHZ|GHZ VB DN VB UP VB AUTO VB?	Video Bandwidth	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VBR [1)]	VBR <numeric_value> VBR DN VBR UP VBR?	Video Bandwidth Ratio	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VIEW	VIEW TRA|TRB|TRC		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
VTL	VTL <numeric_value> DB|DM VTL DN VTL UP VTL?	Video Trigger Level	HP 856xE/ HP 8594E	not available
1) HP 8594E only				
2) Command is accepted without error message, but is ignored				

10.10.2.2 Special Features of the Syntax Parsing Algorithms for 8566A and 8568A Models

The command syntax is very different for models A and B. Different names are assigned to identical instrument functions, and the command structure likewise differs considerably between models A and models B.

The command structure for models A is as follows:

```
<command>::= <command code>[<SPC>][<data>|<step>][<SPC>][<delimiter>][<command code>]…<delimiter>

<data>::= <Value>[<SPC>][<units code>][<SPC>][<delimiter>][<SPC>][<data>]…

<step>::= UP|DN
```

where

<command code> = see Table "Supported Commands"

<Value> = integer or floating-point numerical value

<units code> = DM | -DM | DB | HZ | KZ | MZ | GZ | MV | UV | SC | MS | US

<delimiter> = <CR> | <LF> | <,> | <;> | <ETX>

<SPC> = 32_{10}

<ETX> = 3_{10}

Command sections given in [ ] are optional.

The R&S FSW GPIB hardware differs from that used in the HP analyzers. Therefore, the following constraint exists:

<LF>| <EOI> are still used as delimiters since the GPIB hardware is able to identify them. The other delimiters are identified and evaluated during syntax analysis.

10.10.2.3 Special Behavior of Commands

Command	Known Differences
ABORT	Does not automatically set the command complete bit (bit 4) in the status byte. An additional DONE is required for that purpose.
ANNOT	Only frequency axis annotation is affected.
AT	AT DN/UP: Step size
CAL	The CAL commands do not automatically set the command complete bit (bit 4) in the status byte. An additional DONE command is required for that purpose.
CF	Default value, range, step size
CR	Default ratio Span/RBW
CT	Formula for coupled sweep time
CV	Default ratio RBW/VBW
DEMOD	requires option R&S FSW-B3
DET	DET? returns SAMP instead of SMP on the R&S FSW. DET not automatically set the command complete bit (bit 4) in the status byte. An additional DONE is required for that purpose.
ERR?	Deletes the error bit in the status register but always returns a '0' in response.
FA	Default value, range, step size
FB	Default value, range, step size
ID	Query of instrument ID. The instrument ID defined in "SETUP > Network + Remote > GPIB > Identification String" is returned.
M2	Default value, range, step size
M3	Default value, range, step size
MKACT	Only marker 1 is supported as the active marker.
MKBW	Default value
MKPT	Step size
MKPX	Step size
OL?	Storage of instrument settings: 80 characters are returned as information on the instrument settings. The contents of the 80 characters returned does not correspond to the original data contents of the 8566A/8568A family.
OL	Readout of instrument settings: The 80 characters read by means of OL? are accepted as information on the corresponding instrument settings. The contents of the 80 characters read does not correspond to the original data contents of the 8566A/8568A family.
RB	Default value, range, step size
RL	Default value, step size

Command	Known Differences
RLPOS	Adapts the position of the reference level even if the tracking generator normalization is not active.
RQS	Supported bits:

1. (Units key pressed)
2. (End of Sweep)
3. (Device error)
4. (Command complete)
5. (Illegal command)

10.10.2.4 Model-Dependent Default Settings

If the GPIB language is switched over to an 85xx model, the GPIB address is automatically switched over to 18 provided that the default address of the R&S FSW (20) is still set. If a different value is set, this value is maintained. Upon return to SCPI, this address remains unchanged.

The following table shows the default settings obtained after a change of the GPIB language and for the commands IP, KST and RESET:

Model	# of Trace Points	Start Freq.	Stop Freq.	Ref Level	Input Coupling
8566A/B	1001	2 GHz	22 GHz	0 dBm	AC
8568A/B	1001	0 Hz	1.5 GHz	0 dBm	AC
8560E	601	0 Hz	2.9 GHz	0 dBm	AC
8561E	601	0 Hz	6.5 GHz	0 dBm	AC
8562E	601	0 Hz	13.2 GHz	0 dBm	AC
8563E	601	0 Hz	26.5 GHz	0 dBm	AC
8564E	601	0 Hz	40 GHz	0 dBm	AC
8565E	601	0 Hz	50 GHz	0 dBm	AC
8594E	401	0 Hz	3 GHz	0 dBm	AC

Stop frequency

The stop frequency given in the table may be limited to the corresponding frequency range of the R&S FSW.

Command LF sets the stop frequency for 8566A/B to a maximum value of 2 GHz.

Test points (trace points)

The number of trace points is switched over only upon transition to the REMOTE state.

10.10.2.5 Data Output Formats

In the case of the SCPI and IEEE488.2 standards, the output formats for numerical data are flexible to a large extent. The output format for the HP units, by contrast, is accurately defined with respect to the number of digits. The memory areas for reading instrument data have therefore been adapted accordingly in the remote-control programs for instruments of this series.

Therefore, in response to a query, the R&S FSW returns data of the same structure as that used by the original instruments; this applies in particular to the number of characters returned.

Two formats are currently supported when trace data is output: Display Units (command O1) and physical values (command O2, O3 or TDF P). As to the "Display Units" format, the level data of the R&S FSW is converted to match the value range and the resolution of the 8566/8568 series. Upon transition to the **REMOTE** state, the R&S FSW is reconfigured such that the number of test points (trace points) corresponds to that of the 85xx families (1001 for 8566A/B and 8568A/B, 601 for 8560E to 8565E, 401 for 8594E).

10.10.2.6 Trace Data Output Formats

All formats are supported for trace data output: display units (command O1), display units in two byte binary data (command O2 or TDF B and MDS W), display units in one byte binary data (command O4 or TDF B and MDS B) and physical values (commands O3 or TDF P). With format "display units" the level data is converted into value range and resolution of the 8566/8568 models. On transition to REMOTE state the number of trace points are reconfigured in order to be conform to the selected instrument model (1001 for 8566A/B and 8568 A/B, 601 for 8560E to 8565E, 401 for 8594E).

10.10.2.7 Trace Data Input Formats

Trace data input is only supported for binary date (TDF B, TDF A, TDF I, MDS W, MDS B).

10.10.2.8 GPIB Status Reporting

The assignment of status bits by commands R1, R2, R3, R4, RQS is supported.

The STB command and the serial poll respond with an 8-bit value with the following assignment:

Bit enabled by RQS	Description
0	not used (value 0)
1	Units key pressed
2	End of Sweep
3	Device Error
4	Command Complete

Bit enabled by RQS	Description
5	Illegal Command
6	Service Request
7	not used (value 0)

Bits 0 and 7 are not used and always have the value 0.

Please note that the R&S FSW reports any key pressed on the front panel rather than only the unit keys if bit 1 was enabled.

Another difference is the behavior of bit 6 when using the STB? query. On the HP analyzers this bit monitors the state of the SRQ line on the bus. On the R&S FSW this is not possible. Therefore this bit is set, as soon as one of the bits 1 to 5 is set. It won't be reset by performing a serial poll.

10.10.3 Reference: Command Set of Emulated PSA Models

The R&S FSW analyzer family supports a subset of the GPIB commands of PSA89600 instruments.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

In many cases the selection of commands supported by the R&S FSW is sufficient to run an existing GPIB program without adaptation.

Supported 89600 commands
*CAL?
*CLS
*ESE
*ESR?
*IDN?
*IST?
*OPC
*OPT?
*PCB
*PRE
*PSC
*RST
*SRE
*STB?

Supported 89600 commands
*TRG
*TST?
*WAI
:CALibration:AUTO OFF|ON|ALERt
:CALibration:TCORrections AUTO|ON|OFF
:CONFigure:WAVeform
:DIAGnostic:EABY ON|OFF
:DIAGnostic:LATCh:VALue <numeric>
:DIAGnostic:LATCh:SELect <string>
:DISPlay:ANNotation:TITLe:DATA <string>
:DISPlay:ENABle OFF|ON
:DISPlay:WINDow:TRACe:Y:[SCALe]:PDIVision <numeric>
:DISPlay:WINDow:TRACe:Y:[SCALe]:RLEVel <numeric>
:DISPlay:WINDow:TRACe:Y:[SCALe]:RLEVel:OFFSet <numeric>
:FORMat:BORDer NORMal|SWAPped
:FORMat[:DATA] ASCii|REAL|UINT|MATLAB,<numeric>
:INITiate:CONTinuous OFF|ON
:INITiate[:IMMediate]
:INSTrument:CATalog?
:INSTrument:NSELect <numeric>
:MMEMory:CATalog? <dir_name>
:MMEMory:COPY <'file_name1'>,<'file_name2'>
:MMEMory:DATA <'file_name'>,<definite_length_block>
:MMEMory:DELete <'file_name'>
:MMEMory:LOAD:STATe 1,<'file_name'>
:MMEMory:LOAD:TRACe 1,<'file_name'>
:MMEMory:MDIRectory <'dir_name'>
:MMEMory:MOVE <'file_name1'>,<'file_name2'>
:MMEMory:STORe:STATe 1,<'file_name'>
:MMEMory:STORe:TRACe <numeric>,<'file_name'>
:READ:WAVform?
[:SENSe]:FREQuency:CENTer <numeric>
[:SENSe]:FREQuency:STARt <numeric>

Supported 89600 commands
[:SENSe]:FREQuency:STOP <numeric>
[:SENSe]:FREQuency:SPAN <numeric>
[:SENSe]:POWer:ATTenuation <numeric>
[:SENSe]:ROSCillator:EXTernal:FREQuency <numeric>
[:SENSe]:ROSCillator:OUTPut OFF|ON
[:SENSe]:ROSCillator:SOURce INTernal|EXTernal|EAUTo
[:SENSe]:SPECtrum:TRIGger:SOURce EXTernal<1|2>|IF|IMMediate
[:SENSe]:WAVeform:ADC:RANGe P6
[:SENSe]:WAVeform:APER?
[:SENSe]:WAVeform:AVERage:TACount <numeric>
[:SENSe]:WAVeform:BWIDth:ACTive?
[:SENSe]:WAVeform:BWIDth:TYPE FLAT|GAUSsian
[:SENSe]:WAVeform:IFGain <numeric>
[:SENSe]:WAVeform:IFPath NARRow|WIDE
[:SENSe]:WAVeform:NCPTrace ON|OFF
[:SENSe]:WAVeform:PDIT ON|OFF
[:SENSe]:WAVeform:SRATe <numeric>
[:SENSe]:WAVeform:SWEep:TIME <numeric>
[:SENSe]:WAVeform:TRIGger:EOFFset?
[:SENSe]:WAVeform:TRIGger:INTerpolation ON|OFF
[:SENSe]:WAVeform:TRIGger:SOURce EXTernal<1|2>|IF|IMMediate
:STATus:QUEStionable:CONDition?
:STATus:QUEStionable:ENABle <number>
:STATus:QUEStionable:NTRansition <number>
:STATus:QUEStionable:PTRansition <number>
:STATus:QUEStionable[:EVENt]?
:STATus:QUEStionable:CALibration:CONDition?
:STATus:QUEStionable:CALibration:ENABle <number>
:STATus:QUEStionable:CALibration:NTRansition <number>
:STATus:QUEStionable:CALibration:PTRansition <number>
:STATus:QUEStionable:CALibration[:EVENt]?
:STATus:QUEStionable:FREQuency:CONDition?
:STATus:QUEStionable:FREQuency:ENABle <number>

Supported 89600 commands
:STATus:QUEStionable:FREQuency:NTRansition <number>
:STATus:QUEStionable:FREQuency:PTRansition <number>
:STATus:QUEStionable:FREQuency[:EVENt]?
:STATus:QUEStionable:INTegrity:CONDition?
:STATus:QUEStionable:INTegrity:ENABle <number>
:STATus:QUEStionable:INTegrity:NTRansition <number>
:STATus:QUEStionable:INTegrity:PTRansition <number>
:STATus:QUEStionable:INTegrity[:EVENt]?
:STATus:OPERation:CONDition?
:STATus:OPERation:ENABle <integer>
:STATus:OPERation:NTRansition <integer>
:STATus:OPERation:PTRansition <integer>
:STATus:OPERation[:EVENt]?
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <integer>
:SYSTem:DATE <year>,<month>,<day>
:SYSTem:ERRor[:NEXT]?
:SYSTem:KLOCK?
:SYSTem:MESSage <string>
:SYSTem:PRESet
:SYSTem:TIME <hour>,<minute>,<second>
:SYSTem:VERSion?
:TRACe:COPY <src_trace>,<dest_trace>
:TRACe[:DATA] TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6, <definite_length_block> | <comma_separated_ASCII_data>
:TRACe:MODE WRITe|MAXHold|MINHold|VIEW|BLANk
:TRIGger[:SEQuence]:DELay <numeric>
:TRIGger[:SEQuence]:DELay:STATe OFF|ON|0|1
:TRIGger[:SEQuence]:EXTermal:DELay <numeric>
:TRIGger[:SEQuence]:EXTermal:LEVel <numeric>
:TRIGger[:SEQuence]:EXTermal:SLOPe POSitive|NEGative
:TRIGger[:SEQuence]:HOLDoff <numeric>
:TRIGger[:SEQuence]:IF:DELay <numeric>
:TRIGger[:SEQuence]:IF:LEVel <numeric>
:TRIGger[:SEQuence]:IF:SLOPe POSitive|NEGative

Supported 89600 commands
:TRIGger[:SEQuence]:SLOPe POSitive|NEGative
:TRIGger[:SEQuence]:SOURce IMMediate|VIDeo|EXTernal<1|2>
:TRIGger[:SEQuence]:VIDeo:LEVel <numeric>
:TRIGger[:SEQuence]:VIDeo:LEVel:FREQuency <freq>

10.11 Commands for Compatibility

The following commands are provided for compatibility to other signal analyzers only. For new remote control programs use the specified alternative commands.

DISPlay[:WINDow<n>]:STATe <State>

This command changes the display state of the selected measurement window.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs

(See chapter 10.4.2, "Working with Windows in the Display", on page 620).

Parameters:
<State> ON | OFF

OFF
The window is closed.

*RST: OFF

Usage: SCPI confirmed

DISPlay[:WINDow<n>]:TYPE <WindowType>

This command selects the results displayed in a measurement window.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see chapter 10.4.2, "Working with Windows in the Display", on page 620).

Parameters:

<WindowType>

DIAGram
Selects a diagram.

MTABle
Selects a marker table

PEAKlist
Selects a peak list

RSUMmary
Selects a result summary.

SGRam
Selects a spectrogram.

SYSTem:COMPatible <Mode>

This command enables compatibility to other spectrum and signal analyzers by R&S.

Compatibility is necessary, for example, regarding the number of sweep points.

Note that this command is maintained for compatibility reasons only. Use the `SYST:LANG` command for new remote control programs (see `SYSTem:LANGuage` on page 809).

Parameters:

<Mode> DEFault | FSU | FSP | FSQ | FSV

Example: `SYST:COMP FSP`

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

This command defines the holding time before the baseband power trigger event.

The command requires option R&S FSW-B17.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 646 command for new remote control programs.

Parameters:

<Period>
Range: 150 ns to 1000 s
*RST: 150 ns

Example:
`TRIG:SOUR BBP`
Sets the baseband power trigger source.
`TRIG:BBP:HOLD 200 ns`
Sets the holding time to 200 ns.

TRIGger[:SEQuence]:RFPower:HOLDoff <Time>

This command defines the holding time before the next trigger event. Note that this command is available for any trigger source, not just RF Power.

Note that this command is maintained for compatibility reasons only. Use the TRIGger[:SEQuence]:IFPower:HOLDoff on page 646 command for new remote control programs.

Parameters:

<Time> Default unit: S

10.12 Programming Examples

Some advanced programming examples for complex measurement tasks are provided here.

10.12.1 Service Request

The service request routine requires an extended initialization of the instrument in which the relevant bits of the transition and enable registers are set. In addition the service request event must be enabled in the VISA session.

10.12.1.1 Initiate Service Request

```
REM ---- Example of initialization of the SRQ in the case
' of errors -------
PUBLIC SUB SetupSRQ()
CALL InstrWrite (analyzer, "*CLS") 'Reset status reporting system
CALL InstrWrite (analyzer, "*SRE 168") 'Enable service request for
'STAT:OPER, STAT:QUES and ESR
'register
CALL InstrWrite (analyzer, "*ESE 60") 'Set event enable bit for
'command, execution, device-
'dependent and query error
CALL InstrWrite (analyzer, "STAT:OPER:ENAB 32767")
'Set OPERation enable bit for
'all events
CALL InstrWrite (analyzer, "STAT:OPER:PTR 32767")
'Set appropriate OPERation
'Ptransition bits
CALL InstrWrite (analyzer, "STAT:QUES:ENAB 32767")
'Set questionable enable bits
'for all events
CALL InstrWrite (analyzer, "STAT:QUES:PTR 32767")
'Set appropriate questionable
'Ptransition bits
CALL viEnableEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_QUEUE, 0)
'Enable the event for service
'request
```

```
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, SRQWaitTimeout, VI_NULL,
 VI_NULL)
IF (status = VI_SUCCESS) THEN CALL Srq
'If SRQ is recognized =>
'subroutine for evaluation
END SUB
REM ************************************************************************

Private mbSession As MessageBasedSession

Sub Main()
    Console.WriteLine("Example of initialization    _
                of the SRQ in the case of errors.")
    Dim SRQWaitTimeout = 4000 ' Timeout As Integer for WaitOnEvent
    'Opening session
    Try
        'FSW is alias, instead of use resource string.
                'For example on TCP use TCPIP0::192.168.1.2::inst0::INSTR
        mbSession = CType(ResourceManager.GetLocalManager().Open("FSW"), _
                                      MessageBasedSession)
        mbSession.TerminationCharacterEnabled = True
        Try
            mbSession.Write("*CLS") 'Reset status reporting system
            mbSession.Write("*SRE 168") 'Enable service request for
            'STAT:OPER, STAT:QUES and ESR register
            mbSession.Write("*ESE 60") 'Set event enable bit for
            'command, execution, device-dependent and query error
            mbSession.Write("STAT:OPER:ENAB 32767")
            'Set OPERation enable bit for all events
            mbSession.Write("STAT:OPER:PTR 32767")
            'Set appropriate OPERation Ptransition bits
            mbSession.Write("STAT:QUES:ENAB 32767")
            'Set questionable enable bits for all events
            mbSession.Write("STAT:QUES:PTR 32767")
            'Set appropriate questionable Ptransition bits
            Console.WriteLine("Wait on event - Blocking")
            mbSession.EnableEvent(MessageBasedSessionEventType.ServiceRequest, _
                                                EventMechanism.Queue)
            'Enable the event for service request

            '------------------------------------------------
            ' Your command plase use here
            ' mbSession.Write("Your command")
            '------------------------------------------------

            Dim Status = mbSession.WaitOnEvent( _
                                MessageBasedSessionEventType.ServiceRequest, SRQWaitTimeout)
            If (Status.EventType() = _
                                MessageBasedSessionEventType.ServiceRequest) Then
                Console.WriteLine("SRQ is recognized")
```

```
                'If SRQ is recognized => subroutine for evaluation
                Srq()
            End If
        Catch exp As Exception
            Console.WriteLine(exp.Message)
        End Try
    Catch exp As InvalidCastException
        Console.WriteLine("Resource selected must be a message-based session")
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try

    ' Close session
    mbSession.Dispose()
    ' Wait for end
    Console.WriteLine("Press any key to end")
    Console.ReadKey()
End Sub
```

10.12.1.2 Waiting for the Arrival of a Service Request

There are basically two methods of waiting for the arrival of a service request:

Blocking (user inputs not possible):

This method is appropriate if the waiting time until the event to be signaled by an SRQ is short (shorter than the selected timeout), if no response to user inputs is required during the waiting time, and if – as the main criterion – the event is absolutely certain to occur.

Reason:

From the time the viWaitOnEvent() function is called until the occurrence of the expected event, it does not allow the program to respond to mouse clicks or key entries during the waiting time. Moreover, it returns an error if the SRQ event does not occur within the predefined timeout period.

The method is, therefore, in many cases not suitable for waiting for measurement results, especially when using triggered measurements.

The following function calls are required:

```
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, SRQWaitTimeout, VI_NULL,
 VI_NULL)
'Wait for service request user
'inputs are not possible during
'the waiting time!
IF (status = VI_SUCCESS) THEN CALL Srq
'If SRQ is recognized =>
'subroutine for evaluation


'--------- Sweep in first Spectrum Tab and query marker --------------------
Dim Status = mbSession.WaitOnEvent( _
```

```
MessageBasedSessionEventType.ServiceRequest, SRQWaitTimeout)
'Wait for service request user inputs are not possible
'during the waiting time!
If (Status.EventType() = MessageBasedSessionEventType.ServiceRequest) Then
'If SRQ is recognized => subroutine for evaluation
    Srq()
End If
```

Non-blocking (user inputs possible):

This method is recommended if the waiting time until the event to be signaled by an SRQ is long (longer than the selected timeout), and user inputs should be possible during the waiting time, or if the event is not certain to occur. This method is, therefore, the preferable choice for waiting for the end of measurements, i.e. the output of results, especially in the case of triggered measurements.

The method necessitates a waiting loop that checks the status of the SRQ line at regular intervals and returns control to the operating system during the time the expected event has not yet occurred. In this way, the system can respond to user inputs (mouse clicks, key entries) during the waiting time.

It is advisable to employ the Hold() auxiliary function, which returns control to the operating system for a selectable waiting time (see section Waiting Without Blocking the Keyboard and Mouse), so enabling user inputs during the waiting time.

```
result% = 0
For i = 1 To 10 'Abort after max. 10 loop
'iterations
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_TMO_IMMEDIATE, VI_NULL,
 VI_NULL)
'Check event queue
If (status = VI_SUCCESS) Then
result% = 1
CALL Srq 'If SRQ is recognized =>
'subroutine for evaluation
Else
CALL Hold(20) 'Call hold function with
'20 ms 'waiting time. User inputs
'are possible.
Endif
Next i
If result% = 0 Then
Debug.Print "Timeout Error; Program aborted"'Output error message
STOP 'Stop software
Endif
```

10.12.1.3 Waiting Without Blocking the Keyboard and Mouse

A frequent problem with remote control programs using Visual Basic is to insert waiting times without blocking the keyboard and the mouse.

If the program is to respond to user inputs also during a waiting time, control over the program events during this time must be returned to the operating system. In Visual Basic, this is done by calling the `DoEvents` function. This function causes keyboard-or mouse-triggered events to be executed by the associated elements. For example, it allows the operation of buttons and input fields while the user waits for an instrument setting to be completed.

The following programming example describes the `Hold()` function, which returns control to the operating system for the period of the waiting time selectable in milliseconds.

```
Rem ***********************************************************************
Rem The waiting function below expects the transfer of the desired
Rem waiting time in milliseconds. The keyboard and the mouse remain
Rem operative during the waiting period, thus allowing desired elements
Rem to be controlled
Rem ***********************************************************************
Public Sub Hold(delayTime As Single)
Start = Timer 'Save timer count on calling the
'function
Do While Timer < Start + delayTime/1000 'Check timer count
DoEvents 'Return control to operating
'system to enable control of
'desired elements as long as
'timer has not elapsed
Loop
End Sub
Rem ***********************************************************************
```

The waiting procedure is activated simply by calling `Hold(<Waiting time in milliseconds>)`.

10.12.1.4 Service Request Routine

A service request is processed in the service request routine.

The variables userN% and userM% must be pre-assigned usefully!

```
REM ------------ Service request routine ----------------------------------
Public SUB Srq()
ON ERROR GOTO noDevice 'No user existing
CALL viReadSTB(analyzer, STB%) 'Serial poll, read status byte
IF STB% > 0 THEN 'This instrument has bits set in
'the STB
SRQFOUND% = 1
IF (STB% AND 16) > 0 THEN CALL Outputqueue
IF (STB% AND 4) > 0 THEN CALL ErrorQueueHandler
IF (STB% AND 8) > 0 THEN CALL Questionablestatus
IF (STB% AND 128) > 0 THEN CALL Operationstatus
IF (STB% AND 32) > 0 THEN CALL Esrread
```

```
END IF
noDevice:
END SUB 'End of SRQ routine
REM ***********************************************************************

REM ---------- Subroutine for evaluation Service Request Routine ----------

Public Sub Srq()
    Try
        Dim mySTB As Short = mbSession.ReadStatusByte()
                                    'Serial poll, read status byte
        Console.WriteLine("Reading Service Request Routine:" + mySTB.ToString())
        If mySTB > 0 Then 'This instrument has bits set in the STB
            If (mySTB And 16) > 0 Then Call Outputqueue()
            If (mySTB And 4) > 0 Then Call ErrorQueueHandler()
            If (mySTB And 8) > 0 Then Call Questionablestatus()
            If (mySTB And 128) > 0 Then Call Operationstatus()
            If (mySTB And 32) > 0 Then Call Esrread()
        End If
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub 'End of SRQ routine
```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

10.12.1.5 Reading Out the Output Buffer

```
REM -------- Subroutine for the individual STB bits -----------------------
Public SUB Outputqueue() 'Reading the output buffer
result$ = SPACE$(100) 'Make space for response
CALL InstrRead(analyzer, result$)
Debug.Print "Contents of Output Queue:"; result$
END SUB
REM ***********************************************************************

REM -------- Subroutine for the output queue -----------------------
Public Sub Outputqueue() 'Reading the output buffer
    Try
        Dim result As String = mbSession.ReadString()
        Console.WriteLine("Contents of Output Queue:" + result)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub
```

10.12.1.6 Reading Error Messages

```
REM -------- Subroutine for reading the error queue -----------------------
Public SUB ErrorQueueHandler()
ERROR$ = SPACE$(100) 'Make space for error variable
CALL InstrWrite (analyzer, "SYSTEM:ERROR?")
CALL InstrRead(analyzer, ERROR$)
Debug.Print "Error Description:"; ERROR$
END SUB
REM ***********************************************************************

REM -------- Subroutine for reading the error queue -----------------------
Sub ErrorQueueHandler()
    Dim result As String
    Dim hasErr As Boolean = True
    Do
        mbSession.Write("SYST:ERR?")
        result = mbSession.ReadString()
        Dim parts As String() = result.Split(",")
        If parts(0) = 0 Then
            hasErr = False
            Console.WriteLine(result)
        Else
            Console.WriteLine(result)
        End If
    Loop While hasErr
End Sub
```

10.12.1.7 Evaluation of SCPI Status Registers

```
REM ------ Subroutine for evaluating Questionable Status Register ---------
Public SUB Questionablestatus()
Ques$ = SPACE$(20)
'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "STATus:QUEStionable:EVENt?")
CALL InstrRead(analyzer, Ques$)
Debug.Print "Questionable Status:"; Ques$
END SUB
REM ***********************************************************************
REM ------ Subroutine for evaluating Operation Status Register ------------
Public SUB Operationstatus()
Oper$ = SPACE$(20) 'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "STATus:OPERation:EVENt?")
CALL InstrRead(analyzer, Oper$)
Debug.Print "Operation Status:"; Oper$
END SUB
REM ***********************************************************************
```

```
REM ------ Subroutine for evaluating Questionable Status Register ---------
Public Sub Questionablestatus()
    Dim myQSR As String = Nothing
    Try
        myQSR = mbSession.Query("STATus:QUEStionable:EVENt?") 'Read QSR
        Console.WriteLine("Questionable Status:" + myQSR)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub

REM ------ Subroutine for evaluating Operation Status Register ------------
Public Sub Operationstatus()
    Dim myOSR As String = Nothing
    Try
        myOSR = mbSession.Query("STATus:OPERation:EVENt?") 'Read OSR
        Console.WriteLine("Operation Status:" + myOSR)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub
```

10.12.1.8 Evaluation of Event Status Register

```
REM ------ Subroutine for evaluating the Event Status Register ------------
Public SUB Esrread()
Esr$ = SPACE$(20) 'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "*ESR?") 'Read ESR
CALL InstrRead(analyzer, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN Debug.Print "Operation complete"
IF (VAL(Esr$) AND 2) > 0 THEN Debug.Print "Request Control"
IF (VAL(Esr$) AND 4) > 0
THEN Debug.Print "Query Error"
IF (VAL(Esr$) AND 8) > 0
THEN Debug.Print "Device dependent error"
IF (VAL(Esr$) AND 16) > 0
THEN Debug.Print "Execution Error; Program aborted"'Output error message
STOP 'Stop software
END IF
IF (VAL(Esr$) AND 32) > 0
THEN Debug.Print "Command Error; Program aborted"'Output error message
STOP 'Stop software
END IF
IF (VAL(Esr$) AND 64) > 0 THEN Debug.Print "User request"
IF (VAL(Esr$) AND 128) > 0 THEN Debug.Print "Power on"END SUB
REM **********************************************************************

REM ------ Subroutine for evaluating the Event Status Register ------------
Public Sub Esrread()
```

```
    Try
        Dim myESR As Short = mbSession.Query("*ESR?") 'Read ESR
        If (myESR And 1) > 0 Then Console.WriteLine("Operation complete")
        If (myESR And 2) > 0 Then Console.WriteLine("Request Control")
        If (myESR And 4) > 0 Then Console.WriteLine("Query Error")
        If (myESR And 8) > 0 Then Console.WriteLine("Device dependent error")
        If (myESR And 16) > 0 Then
            Console.WriteLine("Execution Error; Program aborted") 'Output error message
            Stop 'Stop software
        End If
        If (myESR And 32) > 0 Then
            Console.WriteLine("Command Error; Program aborted") 'Output error message
            Stop 'Stop software
        End If
        If (myESR And 64) > 0 Then Console.WriteLine("User request")
        If (myESR And 128) > 0 Then Console.WriteLine("Power on")
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub
```

11 Maintenance

The R&S FSW does not require regular maintenance. Maintenance is essentially restricted to cleaning the R&S FSW. It is however advisable to check the nominal data from time to time.

NOTICE

Instrument damage caused by cleaning agents

Cleaning agents contain substances that may damage the instrument, e.g. cleaning agents that contain a solvent may damage the front panel labeling or plastic parts.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

The storage temperature range for the R&S FSW is specified in thr data sheet. The instrument must be protected against dust if it is to be stored for a long period.

When transporting or shipping the instrument, it is advisable to use the original packing material (especially the two protective covers for the front and rear panel).

12 Troubleshooting

If problems arise during measurement, try the following methods to solve them.

Uncompleted sequential commands - blocked remote channels

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 (GPIB, LAN or other interface) to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel in order to abort the measurement.

To regain control over a blocked remote channel

1. Send a "Device Clear" command from the control instrument to the R&S FSW to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:
   - **Visa**: `viClear()`
   - **GPIB**: `ibclr()`
   - **RSIB**: `RSDLLibclr()`

   The remote channel currently processing the uncompleted command is then ready to receive further commands again.
2. On the remote channel performing the measurement, send the SCPI command `ABORt` to abort the current measurement and reset the trigger system.

Ignored commands

When a remote command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the *RST command) and then implement the required settings.

12.1 Error Information

If errors or irregularities are detected, a keyword and an error message, if available, are displayed in the status bar.

Depending on the type of message, the status message is indicated in varying colors.

Table 12-1: Status bar information - color coding

Color	Type	Description
red	Fatal	A serious error occurred in the application; regular operation is no longer possible.
red	Error	An error occurred during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be completed correctly.
orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
gray	Information	Information on the status of individual processing steps.
gray	Message	An event or state has occurred that may lead to an error during further operation.
green	No errors	No messages displayed.

If any error information is available for a measurement channel, the ! icon is displayed next to the channel name. This is particularly useful when the MultiView tab is displayed, as the status bar in the MultiView tab always displays the information for the currently selected measurement only.

Furthermore, a status bit is set in the `STATus:QUEStionable:EXTended:INFO` register for the application concerned (see "STATus:QUEStionable:EXTended:INFO Register" on page 454). Messages of a specific type can be queried using the `SYST:ERR:EXT?` command, see `SYSTem:ERRor:EXTended?` on page 800.

The following keywords are used:

FIFO OVL	For Digital Baseband Interface (R&S FSW-B17) only: Input sample rate from connected instrument is too high For details on the Digital Baseband Interface (R&S FSW-B17) see the R&S FSW I/Q Analyzer User Manual.
IFOVL	Overload of the IF signal path after the input mixer. ● Increase the reference level.
INPUT OVLD	The signal level at the RF input connector exceeds the maximum. The RF input is disconnected from the input mixer to protect the device. In order to re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input.
LOUNL	Error in the instrument's frequency processing hardware was detected.
NO REF	Instrument was set to an external reference but no signal was detected on the reference input.
OVEN	OCXO reference frequency (option R&S FSW-B4) has not yet reached its operating temperature. The message usually disappears a few minutes after power has been switched on.
OVLD	Overload of the input mixer. ● Increase the RF attenuation (for RF input). ● Reduce the input level (for digital input)

UNCAL	One of the following conditions applies: ● Correction data has been switched off. ● No correction values are available, for example after a firmware update. ● Record the correction data by performing a self alignment
WRONG_FW	The firmware version is out-of-date and does not support the currently installed hardware. Until the firmware version is updated, this error message is displayed and self-alignment fails. (For details refer to chapter 8.3.4.4, "Firmware Updates", on page 401).

12.2 Error Messages in Remote Control Mode

In remote control mode error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. The answer format of R&S FSW to the command is as follows:

```
<error code>, "<error text with queue query>; <remote control
command concerned>"
```

The indication of the remote control command with prefixed semicolon is optional.

Example:

The command `TEST:COMMAND` generates the following answer to the query `SYSTem:ERRor?`

```
-113,"Undefined header;TEST:COMMAND"
```

There are two types of error messages:

- Error messages defined by SCPI are marked by negative error codes. These messages are defined and described in the SCPI standard and not listed here.
- Device-specific error messages use positive error codes. These messages are described below.

Table 12-2: Device-specific error messages

Error code	Error text in the case of queue poll Error explanation
1052	**Frontend LO is Unlocked** This message is displayed when the phase regulation of the local oscillator fails in the RF front-end.
1060	**Trigger-Block Gate Delay Error- gate length < Gate Delay** This message is displayed when the gate signal length is not sufficient for the pull-in delay with a predefined gate delay.
1064	**Tracking LO is Unlocked** This message is displayed when the phase regulation of the local oscillator fails on the tracking generator module.

Error code	Error text in the case of queue poll Error explanation
2028	**Hardcopy not possible during measurement sequence** This message is displayed when a printout is started during scan sequences that cannot be interrupted. Such sequences are for example: ● Recording the system error correction data (alignment) ● Instrument self test In such cases synchronization to the end of the scan sequence should be performed prior to starting the printout.
2033	**Printer Not Available** This message is displayed when the selected printer is not included in the list of available output devices. A possible cause is that the required printer driver is missing or incorrectly installed.
2034	**CPU Temperature is too high** This message is displayed when the temperature of the processor exceeds 70 °C.

Table 12-3: Power Sensor errors

Status bar message	Description
Zeroing could not be performed	Zeroing could not be performed because the RF power applied is too high.
Power sensor zero failed	

12.3 Obtaining Technical Support

If problems occur, the instrument generates error messages which in most cases will be sufficient for you to detect the cause of an error and find a remedy.

Error messages are described in chapter 12, "Troubleshooting", on page 855.

In addition, our customer support centers are there to assist you in solving any problems that you may encounter with your R&S FSW. We will find solutions more quickly and efficiently if you provide us with the information listed below.

- **System Configuration:** The "System Configuration" dialog box (in the "Setup" menu) provides information on:
  – **Hardware Info:** hardware assemblies
  – **Versions and Options:** the status of all software and hardware options installed on your instrument
  – **System Messages:** messages on any errors that may have occurred

  An .xml file with information on the system configuration ("device footprint") can be created automatically.
- **Error Log:** The `RSError.log` file (in the log directory of the main installation directory) contains a chronological record of errors.
- **Support file:** a *.zip file with important support information can be created automatically. The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display.

See also chapter 8.3.5, "Service Functions", on page 403.

To collect the support information

1. Press the SETUP key.
2. Select "Service > R&S Support" and then "Create R&S Support Information".

   The file is stored as `C:\R_S\instr\user\service.zip`.

   Attach the support file to an e-mail in which you describe the problem and send it to the customer support address for your region as listed at the beginning of the R&S FSW Getting Started manual.

List of remote commands (base unit)

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